Power Tool Woodworking For Everyone

FOURTH EDITION

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Chapter 1
Introduction

Many people feel that power tools are complicated machines, to be operated only by skilled technicians. Actually they are a means for almost anyone to achieve high-quality workmanship with a minimum of practice.

Power tools are woodworking experts. They do not require the long period of apprenticeship needed to accomplish fine work with hand tools. The essentials of woodworking are reduced to a few fundamentals of proper machine setup. Accuracy, speed, and power are built into the machine; the operator merely sets it and guides it.

Anyone who has ever tried to cut a board with a handsaw will probably agree that a certain amount of skill is required for even this most elementary woodworking operation. With a table saw, however, the operator merely sets the rip fence or the miter gauge, turns on the motor, and moves the board forward. The saw cuts the board quickly and easily, producing an edge that is straight and square.

A power tool does not care who flicks the switch. It will perform in exactly the same way whether the operator is skilled or unskilled. It does a good job—a consistently good job. All the little variations, all the small discrepancies that occur in handwork, are eliminated.

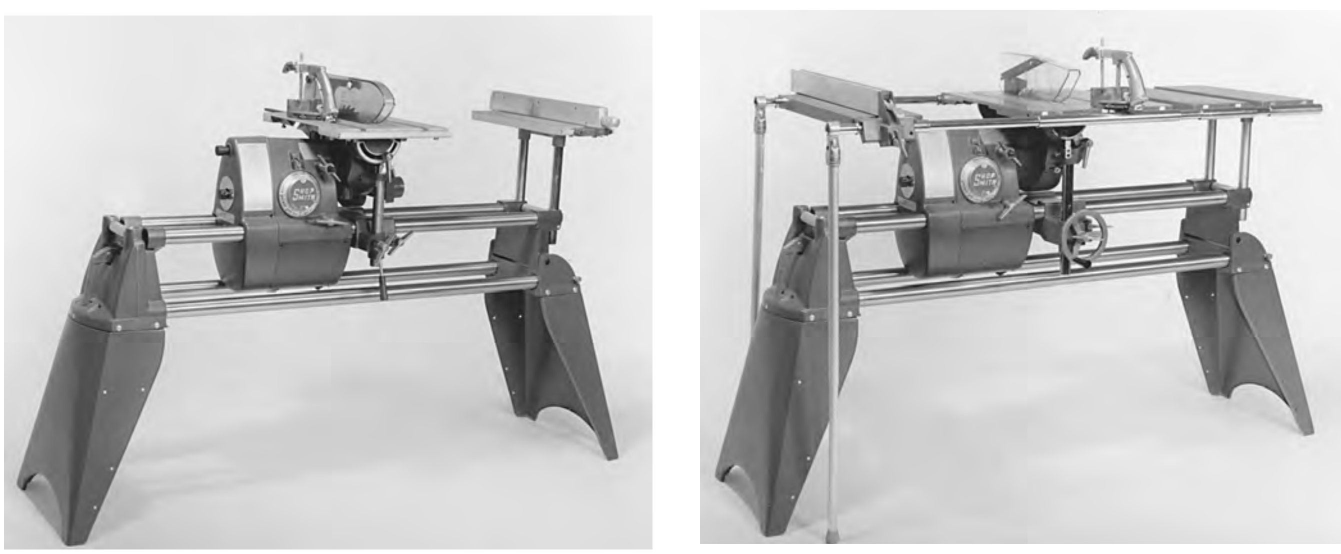
The purpose of this book is to supplement the self-confidence that comes with ownership of power tools. All the information needed for basic power tool function is included in this volume and any woodworking project can be completed through use of the techniques and procedures described. Even highly advanced techniques are shown to be no more than step-by-step procedures that can be followed by anyone.

All of the operations and techniques shown throughout the book can be performed on the Shopsmith Woodworking System. Whether you have all the components of the System or are just starting out, this book will help you to perform woodworking procedures with ease, confidence and accuracy. As you use your System, your skills and confidence will increase and soon you'll find your self attempting more advanced procedures and techniques. You'll also notice that your projects are becoming more professional looking.

Woodworking is a wonderful means for personal expression, a great source of satisfaction and a perfect way to relax. So, start to build your System, get to know it, use it frequently, work safely and enjoy the rewards.

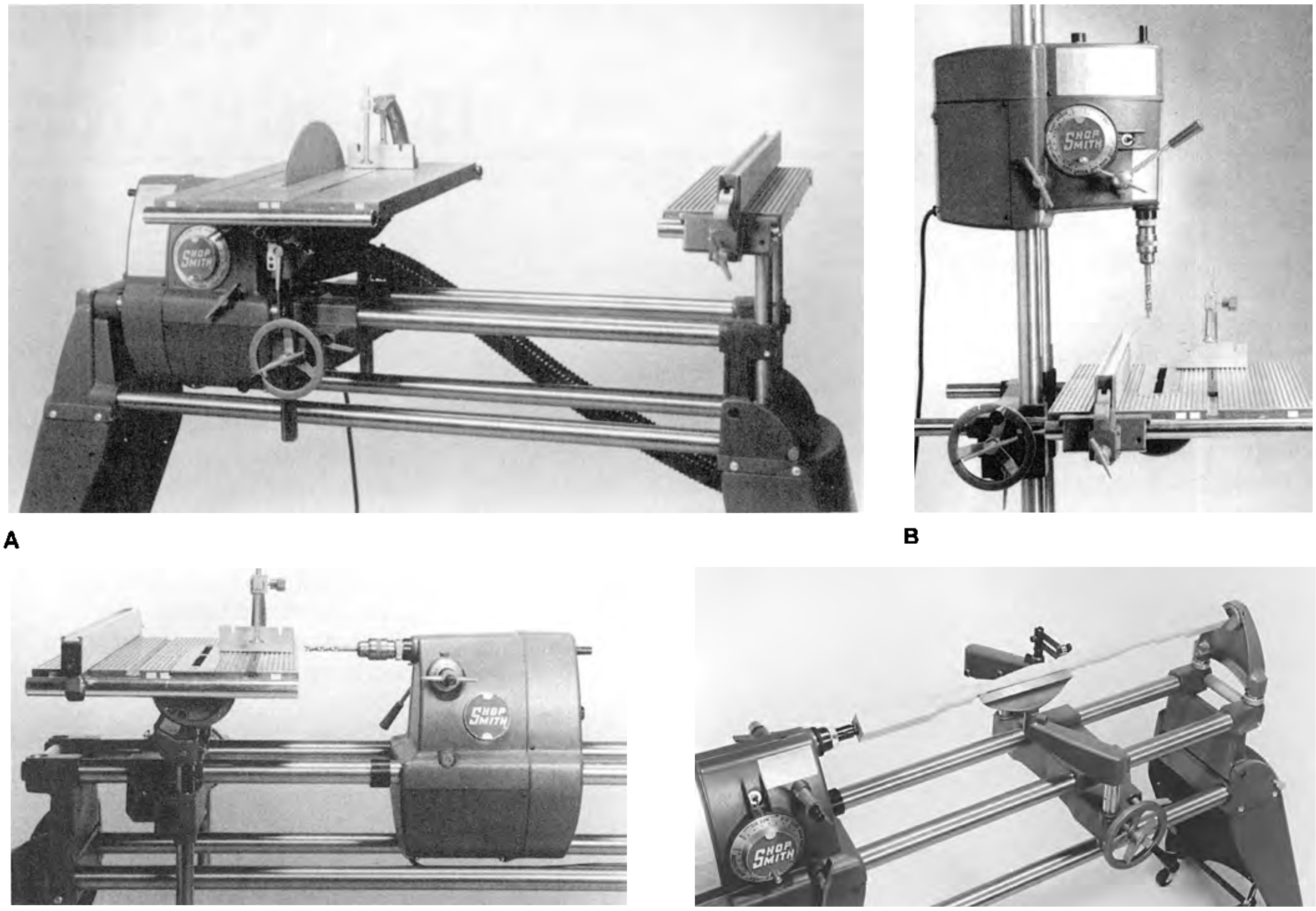
BUILDING THE SYSTEM

The Shopsmith Woodworking System begins with the Mark V (Figure 1-1), a multi-purpose power



A B

Figure 1-1. *The Shopsmith Woodworking System begins with the Mark V. The (A) Model 500 and (B) Model 510 are shown in the table saw mode.*



A B C D

Figure 1-2. The Shopsmith Mark V Model 510 is shown in the (A) disc sander, (B) drill press, (C) horizontal boring, and (D) lathe modes.

tool based on the notion that separate power tools have a number of common parts. If these parts are arranged in a logical, adaptable format, the essentials for five basic power tools—table saw, disc sander, drill press, horizontal boring machine and lathe—will be readily available (Figure 1-2). This multi-purpose concept does not limit or detract from the effectiveness or abilities of the tools. In fact, some of the capabilities and capacities are superior to most single-purpose tools.

Basically, the Mark V is a frame or "bench" that holds a power plant and a worktable. The upper tubes of this bench can be tilted horizontally or vertically. The power plant and the worktable slide independently along the upper tubes so that they can be positioned right next to each other or almost three feet apart. You can mount many different accessories to the power plant, such as saw blades, drill bits, and sanding discs and operate them at variable speeds. The worktable can be positioned over, under, or beside these accessories to hold workpieces at different angles. In this way, the three components—bench, power plant, and worktable—combine to make a unique, capable, and versatile woodworking system. The bench gives the Mark V its stability, the power plant supplies the power you need to perform a multitude of woodworking tasks, and the worktable supports the stock as you work.

One of the most impressive advantages the Mark V offers is the simultaneous use of modes, making special and routine applications simpler. As an example, with the auxiliary spindle, it is possible to set up dual sanding functions. With two sanding discs mounted (Figure 1-3), you can work with two different grits of sandpaper. The

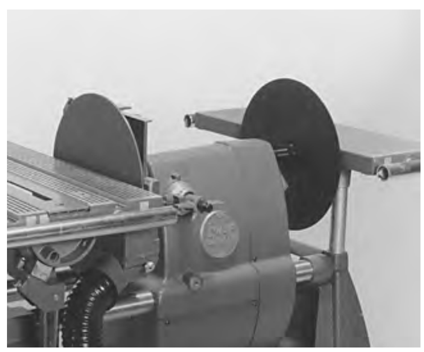


***Figure 1-3.** A dual disc sander setup. Note how the extension table is used as a work support surface for the extra disc.*

disc and drum sander combination (Figure 1-4) provides capabilities for straight edge, inside curve and outside curve sanding. Another dual setup is the saw/jointer combination (Figure 1-5). With this setup you can joint one edge of a board before beginning a sawing operation. This produces a smooth, straight edge to place against the rip fence and assures a straight, square cut. When you're ripping, cut the stock slightly oversize so that you can also finish the second edge on the jointer. ***Warning: Never mount a cutter or blade on the auxiliary spindle. Also, whenever a dual tool setup is used, the speed dial must be set for the slowest operating tool. Do not run the tool, even when it's not being used, at a higher speed than recommended. Guards should be in place.***

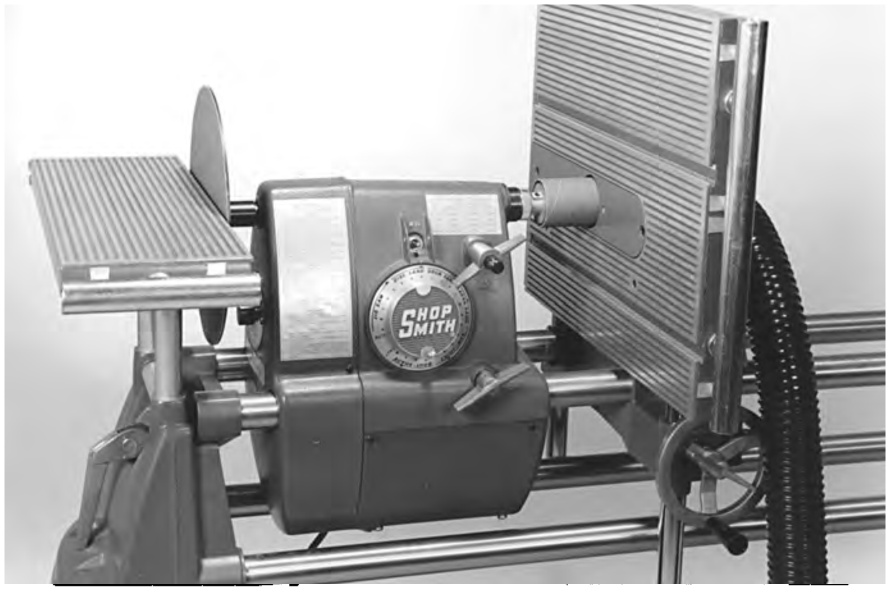


Figure 1-4. *The disc sander/drum sander combination. Be sure to use only the speeds that are in the disc sander range.*

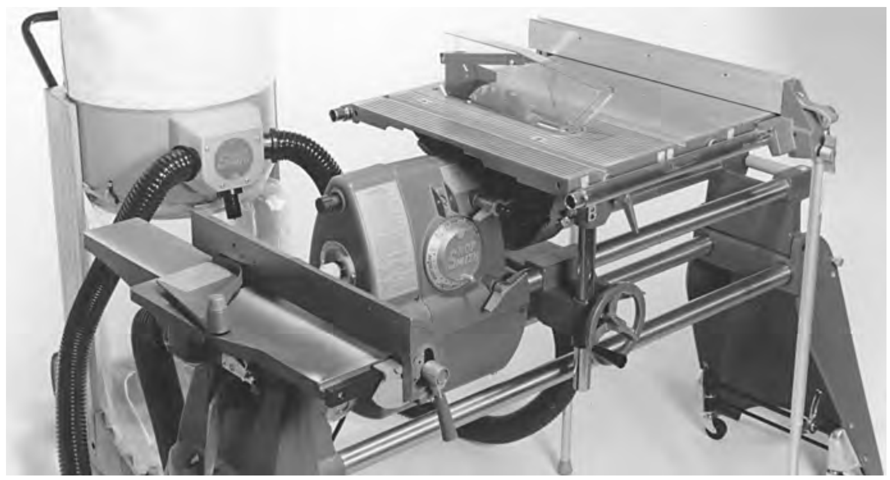


Figure 1-5. *The saw/jointer setup lets you square up one edge of a board before beginning a sawing operation. This produces a smooth, straight edge to place against the rip fence. A dust collection system is shown attached to both machines.*

Add Major Accessories

Add the Major Accessories—Jointer, Bandsaw, Belt Sander, Scroll Saw, Jigsaw and Planer—to your workshop and increase your capabilities even more. The Major Accessories mount on the Mark V and are connected to the power plant by a power coupler (Figure 1-6). The major accessories can also be mounted on Shopsmith Power Stands (Figure 1-7) if you desire freestanding machines. The Professional Planer comes with its own power stand and a model of the Scroll Saw comes with legs and a motor.

Jointer—As you might guess from its name, the jointer (Figure 1-8) is extremely useful for making many woodworking joints because it will produce a very smooth, straight edge on a board. This edge will be square to the face of the stock or any other angle between 45° and 90°. This kind of high-quality edge is essential for joining stock together edge-to-edge to make wide workpieces.

The jointer's capabilities also permit you to straighten the edges and surfaces of warped stock; remove minor cups; surface rough stock; cut edge rabbets, tenons, bevels, chamfers; and make tapers and special shapes used in furniture designs.

Bandsaw—The bandsaw (Figure 1-9) gets it name from the continuous loop or "band" formed by the flexible blade. The blade cuts with a downward motion, toward the table. Because it cuts continuously, you'll find the band-

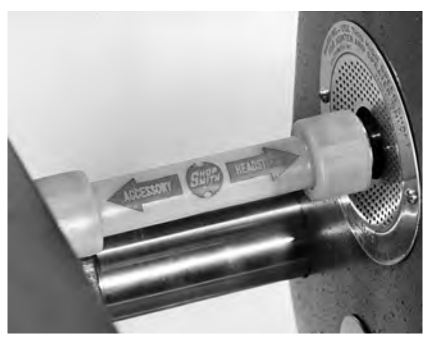


Figure 1-6. *A power coupler makes the connection between the hub on the Mark V auxiliary spindle and the hub on the drive shaft of the major accessory, in this case, the jointer.*

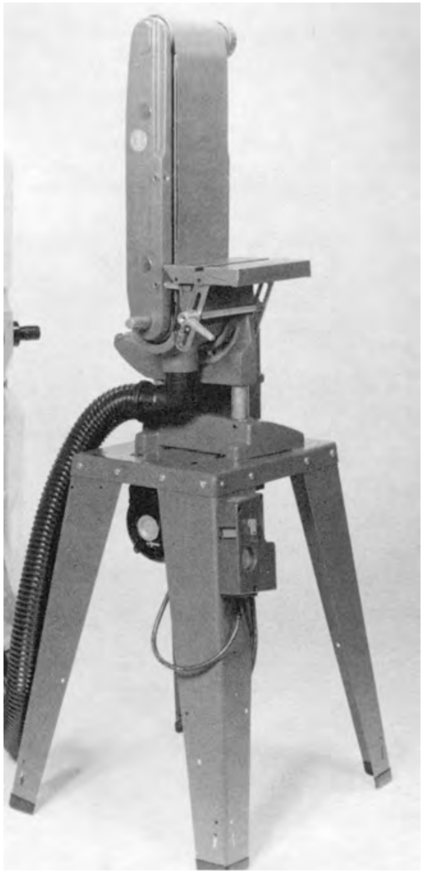


Figure 1-7. *The major accessories can also be mounted on Shopsmith Power Stands. The belt sander is shown.*

saw is one of the fastest cutting tools in your shop.

The bandsaw will perform a wide variety of workshop operations. The two most common uses are cutting curves and irregular shapes, and resawing (slicing thin boards from thick ones). You can also crosscut; rip cut; cut bevels, miters, compound curves, duplicate parts; and make many other special cuts as well.

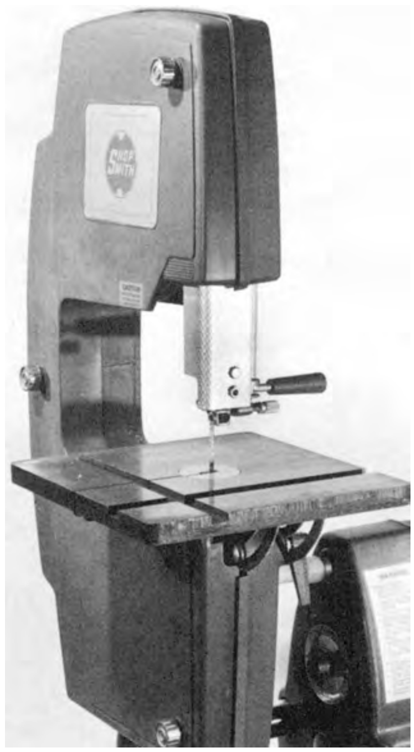


Figure 1-9. *The Shopsmith 11" Bandsaw.*

You can cut materials other than wood. With the proper blade installed, the bandsaw will cut plastic, plastic laminates, particle board, and even soft non-ferrous metals such as copper, brass and aluminum.

Belt Sander—The belt sander (Figure 1-10) is extremely useful for doing many different finishing jobs. It will produce a smooth surface on a board in less time and with less work than hand sanding.

The belt sander also offers an important advantage over disc sanders and orbital sanders: The abrasive belt travels in one direction only, leaving no "swirl marks." With a belt sander, you can sand parallel to the wood grain.

The belt sander's capabilities permit you to sand edge, end, miter and bevel cuts quickly and accurately. You can also sand convex and concave shapes and create compound curves in workpieces. The belt sander can also be used to sharpen tools by using the sharpening guide.

Scroll Saw—The scroll saw (Figure 1-11) cuts curves and other irregular shapes in wood, plastics, and soft metals. Fine-toothed blades leave fewer millmarks;

Figure 1-8. *The Shopsmith 4" Jointer.*

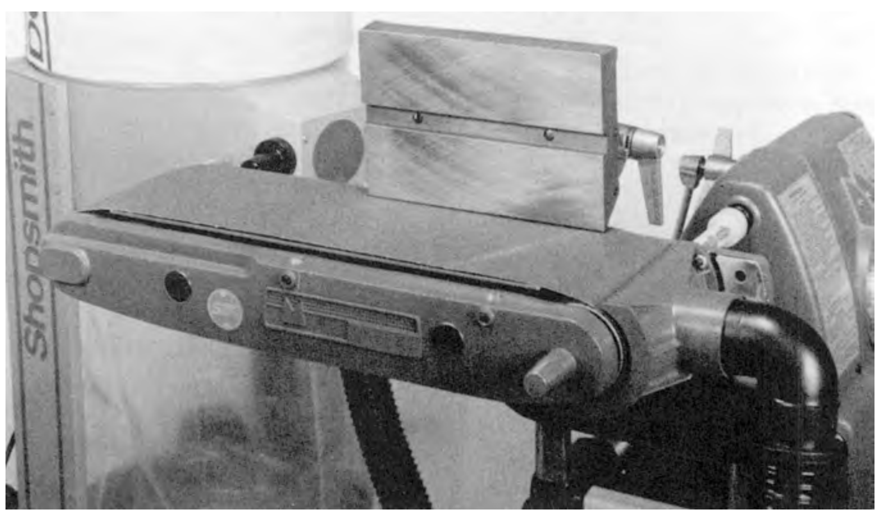


Figure 1-10. *The Shopsmith 6" Belt Sander.*

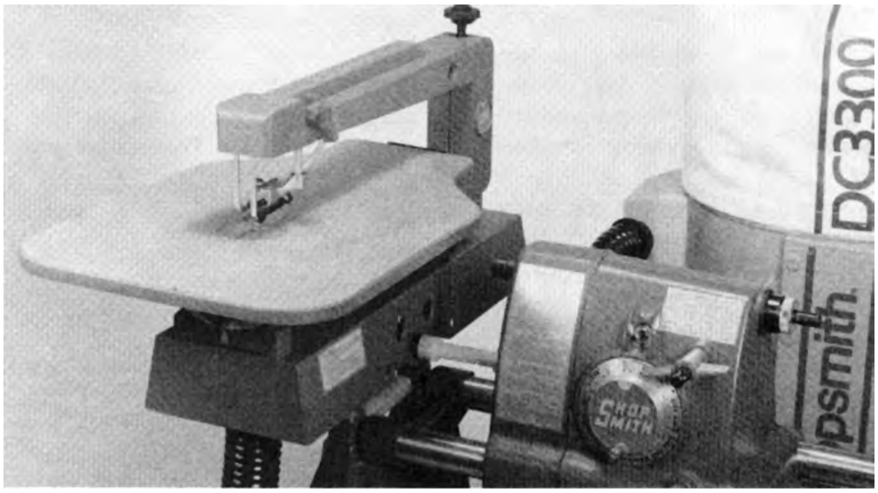


Figure 1-11. The Shopsmith 20" Scroll Saw.

Figure 1-12. The Shopsmith 18" Jigsaw.

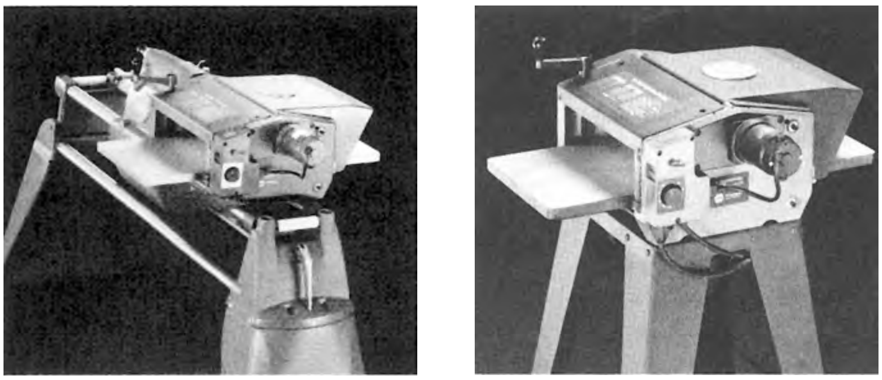


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Figure 1-13. (A) The Shopsmith 12" Thickness Planer. (B) The Shopsmith Professional Planer.

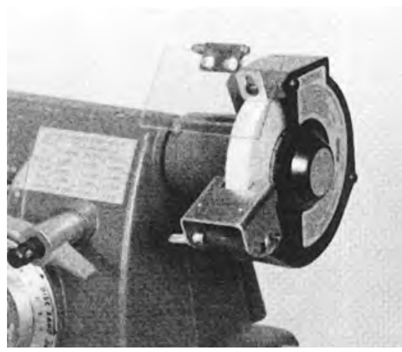


Figure 1-14. The Shopsmith Grinding Wheel.

thus requiring less sanding. Thin blades can cut small radii, allowing you to cut small details accurately.

The scroll saw can make piercing cuts enabling you to saw internal curves and designs in a workpiece without cutting through from the outside. In addition, it cuts at any angle between "0" and 45°.

Jigsaw—The jigsaw (Figure 1-12) performs the same operations as the ones mentioned for the scroll saw, plus it converts to a sabre saw to cut large workpieces. Also, the lower chuck will hold machine files so that you can shape and smooth the edges of wood, plastic, and metal workpieces.

Note: The jigsaw is no longer manufactured by Shopsmith, Inc. However it is mentioned here as a reference for those woodworkers who already have a jigsaw.

Thickness Planer and Professional Planer— The planers (Figure 1-13) are used to plane stock to a uniform thickness, reduce thick boards to thinner ones, surface rough lumber, plane boards to identical thicknesses, true up boards that have been glued edge-to-edge and can be used with the jointer to square up stock. The planer gives you the versatility to plane lumber for any number of applications, from ultra-thin stock for musical instruments and toys to thick stock for furniture and carpentry projects.

Add Specialty Accessories and Machines

Add the specialty accessories—Dadoing, Shaping, Molding, Joining, Mortising, Routing and Drum Sanding—to your Shopsmith Woodworking System and you'll be able to add professional finishing touches to your projects. Touches such as decorative edges, interesting surface designs and unique joinery.

Grinding and sharpening accessories such as the Grinding Wheel (Figure 1-14) and the Sharpening Guide (Figure 1-15) will enable you to sharpen lathe chisels, shaper cutters, and jointer and planer knives. Sharp tools are very important. They cut easily and more accurately, and are safer to use.

When you add the specialty machines—Lathe Duplicator, Biscuit Joiner, Routing System and Strip Sander—you are set for practically any operation. The lathe duplicator (Figure 1-16) lets you make identical turnings such as matching table legs or spindles for a railing quickly and accurately. You can also do freehand turning. The routing system (Figure 1-17) helps you create duplicate workpieces with the use of fixtures and templates. It is also used for creating decorative surfaces and edges on workpieces and many types of joinery. The strip sander (Figure 1-18) will sand the internal and external edges of projects, sharpen tools, and perform buffing operations.

The entire Shopsmith Woodworking System is even more appealing when retractable casters (Figure 1-19) are installed on the Mark V and Power Stands. The casters are designed for easy installation and quick positioning of the machine to be lifted either 1/4″ or 1/2″ off the floor. When the casters are in the neutral position, the machine rests solidly on the floor.

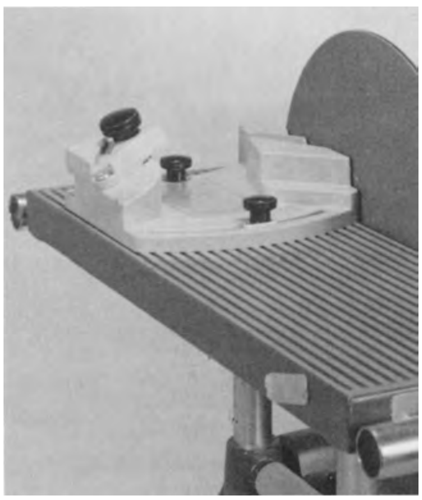


Figure 1-15. The Shopsmith Sharpening Guide.

SAFETY

Safety is a frame of mind, and should be an important part of everything we use or do. You can have an accident when driving, trip when climbing stairs, fall when pruning a tree, or slip in the tub. We are surrounded by potential hazards.

The people who don't become victims are those who accept the possibilities and prepare for them. Woodworking safety requires good common sense.

Some woodworkers have been known to neglect to use guards and will ignore correct procedures, feeling that they are knowledgeable enough to be immune. Accident statistics are comprised of these people, and it is interesting to note that included are more professionals than amateurs. Safe woodworking is not a matter of experience or expertise, or the sophistication of the tool you are using. Safety rules should be studied and followed, not ignored.

Warnings, Cautions and Notes appear throughout this book. When you come to one of these statements, plese read and understand it fully. Their meanings are:

Warning: A Warning is given when failure to follow the directions is likely to result in injury, loss of limb, or other serious injury.

Caution: A Caution is given when failure to follow the directions is likely to result in damage to the equipment.

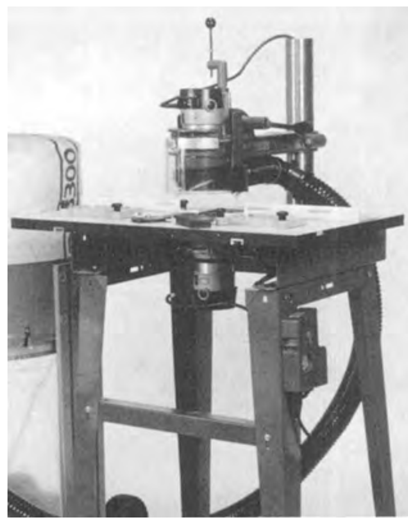


Figure 1-17. The Shopsmith Routing System.

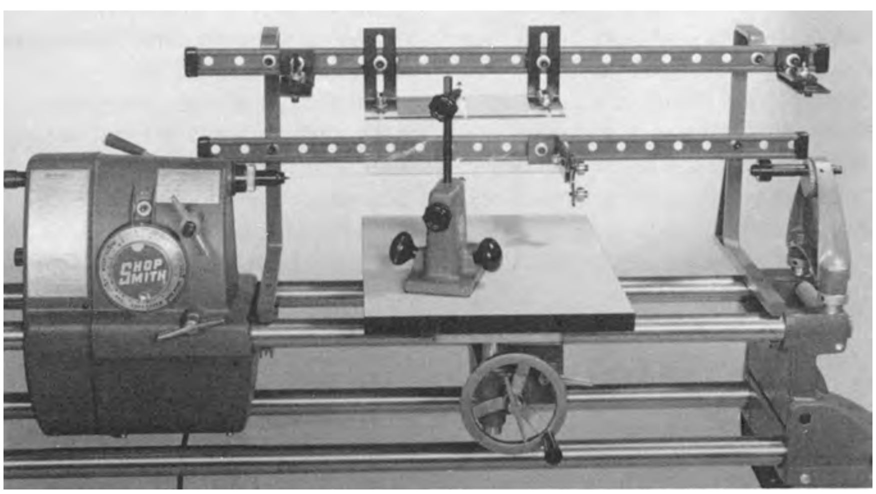


Figure 1-16. The Shopsmith Lathe Duplicator.

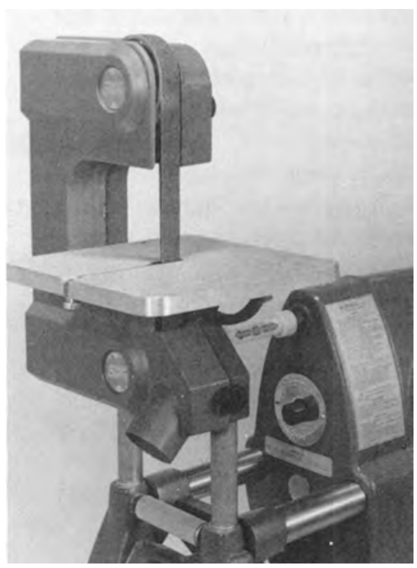


Figure 1-18. The Shopsmith Strip Sander.

Figure 1-19. *The retractable casters are foot operated. They raise the machine for mobility or allow it to seat solidly on the floor.*

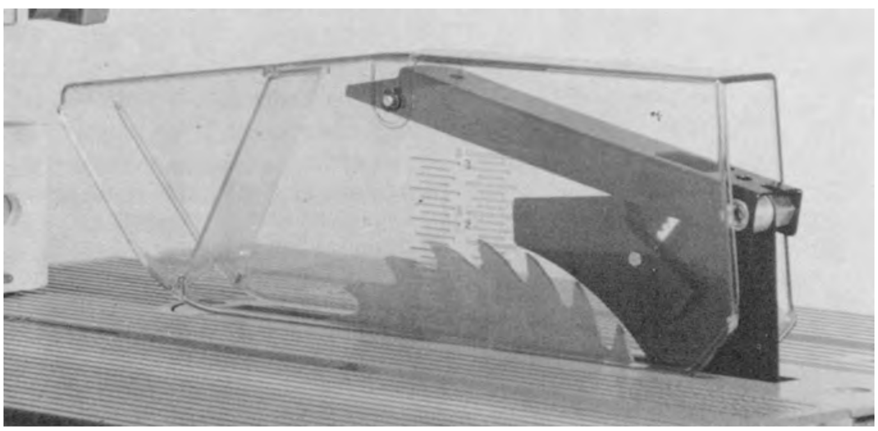


Figure 1-20. *Most shop accidents happen on unguarded power tools. Guards like the upper saw guard keep your hands out of the danger zone and help prevent kickback.* ***Warning: Be sure to keep all guards mounted during operations.***

Figure 1-21. *The miter gauge with safety grip is more than a safety device. It clamps the workpiece for positive control, making it easier to achieve accuracy. It's great for sawing, but equally useful for other operations.*

Note: A Note is used to highlight an important procedure, practice or condition.

Safety Factors Built into the System

Warning: For your safety, always read, understand and follow the procedures in the Owners Manual and use the guards and safety equipment that came with your machines.

The Shopsmith Woodworking System has many built-in safety features, but the effectiveness of these features depends on you.

Guards—Most shop accidents happen on unguarded power machines. Therefore, it is important to keep guards in working order and to always keep them mounted on the machine during operations. Guards, like the upper saw guard shown in Figure 1-20, are designed to prevent kickback and to help keep your hands out of the danger zone.

Safety Accessories and Devices—Accessories and devices such as the miter gauge with safety grip, fixtures and extensions help to keep your hands away from the blade, cutter or disc. The miter gauge with safety grip holds the stock securely and safely during the operation (Figure 1-21). Rip fence and miter gauge extensions, and fixtures that you can make help to support and guide the stock (Figure 1-22).

Shopsmith Safety Kit—The safety kit (Figure 1-23) contains a push stick, push block, feather board and fence straddler.These devices either help guide, hold and control the stock safely during operations on the Mark V or Major Accessories.

The push stick (Figure 1-24) is used to guide small to medium sized stock. Place the foot on top of the stock and hook the heel over the back edge.

The push block (Figure 1-25) is used to hold down and guide the stock. As you press down, forward, and to the side, the rubber pad grips the stock. The handle is tilted to help keep your hands out of the danger zone.

The feather board (Figure 1-26) is used to press stock against the rip fence or the table. Mount the feather board in a table slot, in the slot of a fence extension, or clamp it to the table. The fingers must be angled in the same direction that you feed the stock—use the arrow on top of the feather board as a guide. Position the fingers so they

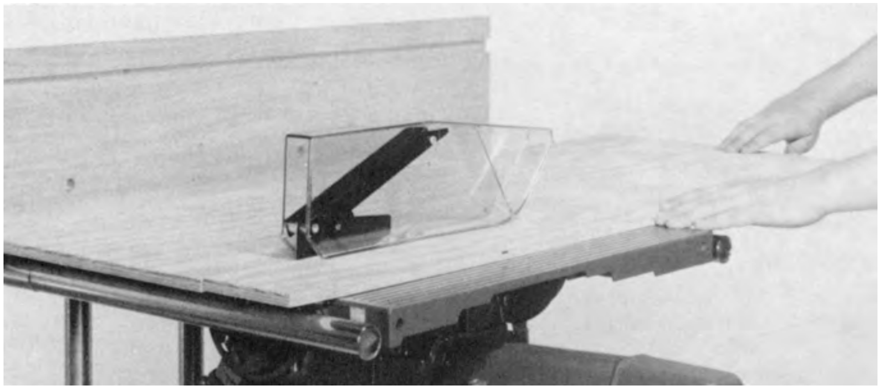


Figure 1-22. *Rip fence and miter gauge extensions, and fixtures will help to guide and support the stock safely. The rip fence extension shown is supporting long stock during a ripping cut.*

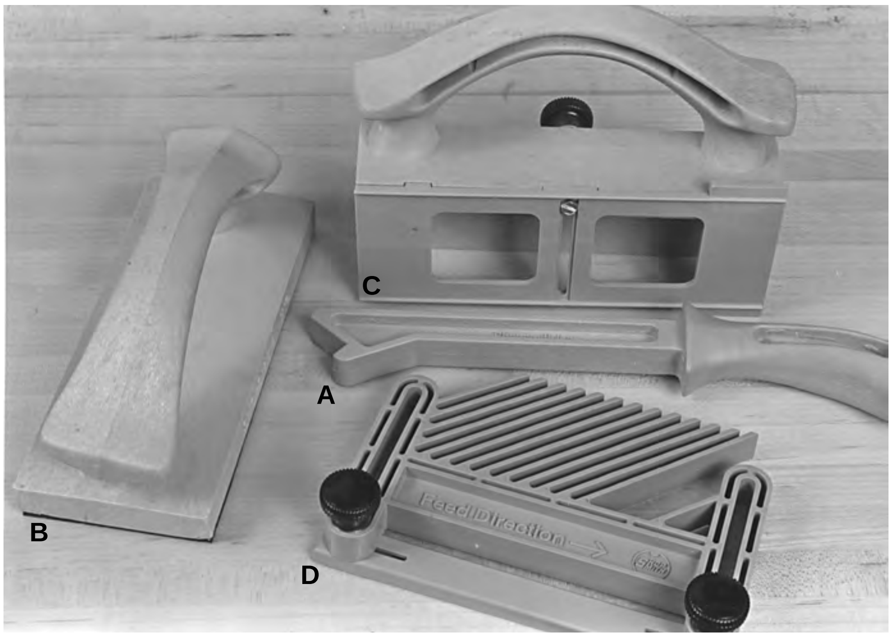


Figure 1-23. *The Shopsmith Safety Kit includes (A) a push stick, (B) a push block, (C) a fence straddler, and (D) a feather board.*

Figure 1-24. *A push stick is used to maneuver small to medium-sized stock. Hold the workpiece down with the foot of the push stick and hook the heel over the back edge.*

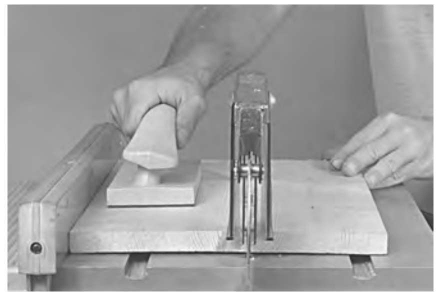


Figure 1-25. *Use the push block to hold down and guide the stock. As you press down, the pad grips the stock. The handle is tilted to help keep your hands out of the danger zone.*

Figure 1-26. *Use the feather board to help press the stock against the rip fence (as shown) or the table. Place the mounting bar in the table slot and tighten the locking knobs. Remember that the fingers must be angled in the same direction that you feed the stock.*

press against the stock just before it gets to the blade or cutter, then tighten the locking knobs. To reverse the direction of the fingers, remove the mounting bar, turn the feather board over, then replace the bar.

The fence straddler (Figure 1-27) is used to hold down and guide small narrow stock past a blade or cutter. The body rides on the rip fence, while the heel hooks over the back edge of the stock. To change the height of the heel, loosen the locking knob. To reverse the heel, rotate the side 180° Be sure the locking knob is secure before using the straddler.

Mark V Table Inserts—The Mark V worktable has an opening that is shaped to receive various table inserts, each of which is designed to accommodate a particular blade or cutter (Figure 1-28). The purpose of the insert is to support the stock and to minimize the opening around the cutting tool. If you're working with very thin stock that could be drawn down into the opening, make special inserts like the one shown in Figure 1-29. As you can see, there is no room for thin material to be pulled beneath the table. Construction details for the special inserts are found in Chapter 2, "Special Table Inserts."

Mark V Spindles—The main Mark V spindle and the upper auxiliary spindle which projects at the rear of the power plant are designed with a "reverse taper" to keep accessories secured. All the accessories and arbors that mount on the spindles must be positioned so the locking screw seats firmly against the flat (Figure 1-30). This is a safety feature that is provided as a precaution against tools coming off the spindle should the locking screw become loose.

To properly mount an accessory, push it all the way on the spindle. Then use a 5/32" Allen wrench to tighten the setscrew against the flat of the spindle. To make sure the accessory is securely mounted, rock the accessory back and forth slightly as you tighten the setscrew and then again after it is tight, while keeping the spindle from turning. If the accessory seems to loosen, tighten the setscrew again until you've removed any 'play.' ***Warning: During any prolonged operation, always check the locking screw occasionally to be sure that normal tool vibration hasn't caused the screw to loosen.***

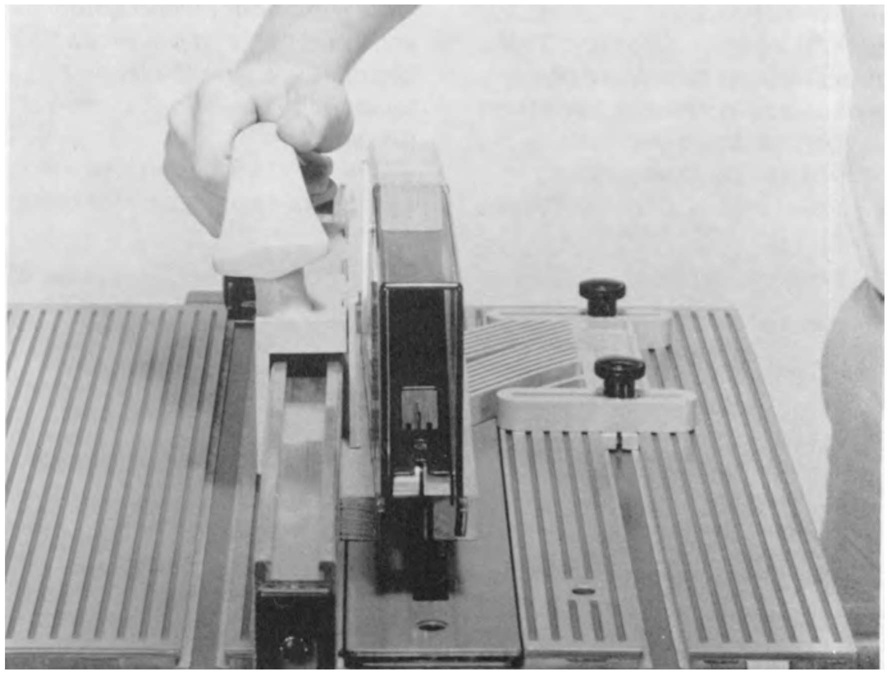


Figure 1-27. *Use the fence straddler to guide small, narrow stock. The body rides on the rip fence, while the heel hooks over the back edge of the stock. To change the height of the heel, loosen the locking knob.*

Figure 1-28. *Mark V table inserts are designed to accommodate various cutting tools. Here, from left to right, are Model 500 inserts for a saw blade, dado head, and molder head. A shaper and drum sander insert is also available.*

Important Safety Equipment

Besides the built-in safety features of the machines, there is other safety equipment that you'll need to add to your shop.

Eye, Ear and Nose Protection—Figure 1-31 shows products that should be standard equipment in any shop. They don't saw, sand, drill or plane, but they protect you when doing such operations. Safety glasses, goggles or a face shield should be worn for all workshop operations. Ordinary eyeglasses do not provide adequate eye protection.

Many people feel that a dust mask should only be worn when doing sanding operations. Actually, sawing, jointing, planing, shaping and routing can produce dust that is fine enough to accumulate in the lungs—a potentially harmful situation. ***Warning: The bonding agents in some plywoods can irritate the throat and lungs; the dust from some woods can be toxic causing an allergic reaction or other injury.***

Wear a respirator when doing any operation that produces fine particles. Be sure to clean or replace the filters in the respirator regularly.

When you work around power equipment, hearing protectors are just as important as eye protectors. ***Warning: High frequencies can be generated by high-speed motors and even some woodworking operations. The effects are cumulative; each prolonged exposure can have an effect that, over the years, may result in a hearing loss.*** A good pair of hearing protectors will screen out high frequencies while still permitting normal conversation.

Dust Collection System—As you work, with your Shopsmith Woodworking System, you'll find there's another hazard that literally springs up under your feet if you don't do something about it—sawdust.

Sawdust like other woodworking clutter, can cause you to lose your footing and fall into the machinery. It can also be a fire hazard. Tracking sawdust from your shop into your home can be a nuisance to those with whom you live. ***Warning: Breathing sawdust can be a health hazard. Several medical studies have shown that***

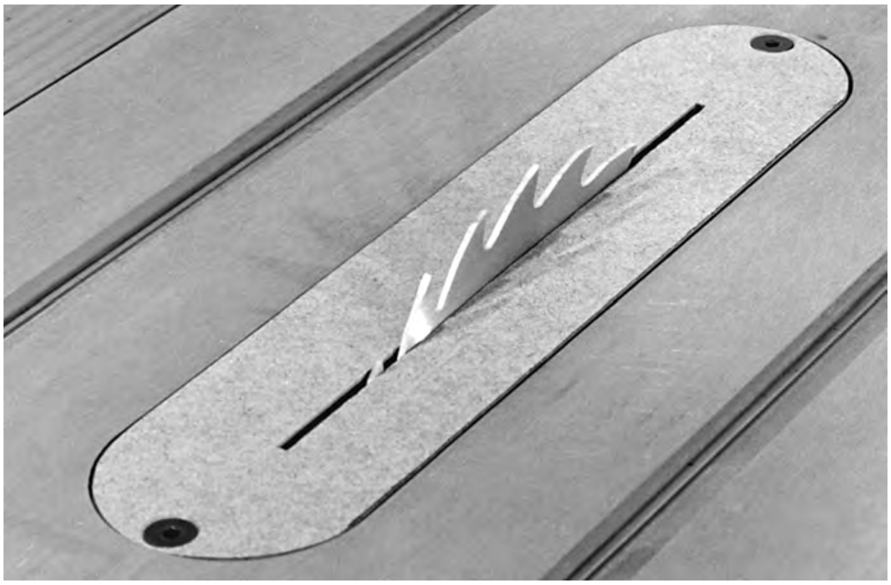


Figure 1-29. *Special inserts that you can make keep thin material from being pulled down beneath the table.*

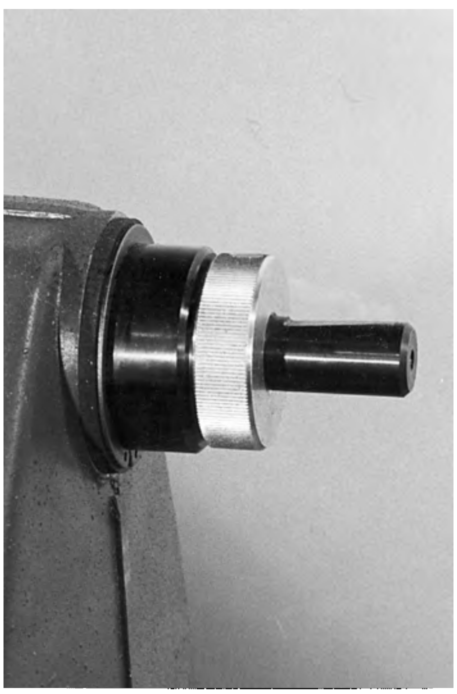


Figure 1-30. *The Mark V main and auxiliary spindles have a reverse taper. The locking setscrew of all spindle-mounted accessories must seat securely against the flat.*

Figure 1-31. *These are devices that protect you from eye, ear, face and respiratory injuries. Their cost is slight when you consider the protection they afford. And they can be used for activities in addition to power tool work.*

prolonged exposure to sawdust may cause impaired breathing. Sawdust may also cause you physical discomfort, especially if you have emphysema, asthma, or an allergic reaction.

If you work in a shop where the dust in the air can become highly concentrated, or if your woodworking generates a lot of fine wood dust, wear a close-fitting dust mask, open a window and use an exhaust fan to ventilate your shop.

One of the most effective ways to protect yourself from the effects of sawdust and keep your shop clean at the same time is to use a dust collection system. The hoses from a system connect to the dust chutes on your power tools. The Shopsmith Dust Collector (Figure 1-32) is an extremely effective dust collection system. It will give you virtually dust-free woodworking.

Refer to Chapter 25 for Dust Collector information. Pay special attention to Table 25-1, a listing of toxic woods and possible reactions.

GENERAL SAFETY RULES FOR POWER TOOLS

Here are some general safety rules to follow when operating power tools:

- **Read, understand and follow the Owners Manual for any tool you operate.**
- **Keep your hands and fingers out of the danger zone.**
- **Ground all tools (unless double insulated).**
- **Wear proper eye and ear protection. Also, wear a dust mask.**
- **Keep guards in place and in working order. Most injuries occur on unguarded power tools.**
- **Remove adjusting keys and wrenches.**
- **Do not wear loose clothing, ties, gloves, or jewelry. Roll sleeves up above your elbows, wear nonslip footwear, and tuck long hair under a hat.**
- **Do not operate power tools if you are fatigued, taking medication, or under the influence of alcohol or drugs.**
- **Do not use power tools in damp, wet or explosive atmospheres.**
- **Keep work areas well lit, clean, and free from clutter.**
- **Make sure accessories, safety devices and fixtures are properly adjusted and secured before turning on the machine.**
- **Secure all locks.**
- **Make sure the machine rests firmly on the floor when in use—not up on the retractable casters.**
- **Operate tools at the correct speed for the operation.**
- **Never stand directly in the line of rotation of a moving blade, cutter, disc or stock. If a kickback occurs you could be hit by the stock.**
- **Do not work with stock that is too small or too large to handle safely.**
- **Do not use second-hand lumber or wood that is wet, pitchy or has loose knots.**
- **Do not force a tool; it will do the job better and more safely at the rate for which it was designed.**
- **Do not use a tool or accessory to do a job for which it was not designed.**
- **Feed the workpiece into the cutter against the rotation of the cutter only.**
- **Repair or replace damaged parts before further use. If a strange noise or vibration develops, turn off and unplug the machine. Correct the problem.**
- **Use clamps, fixtures, and other devices to hold, support and control workpieces.**
- **Do not overreach. Keep proper footing and balance at all times.**
- **Turn off the tool and wait until it comes to a complete stop**

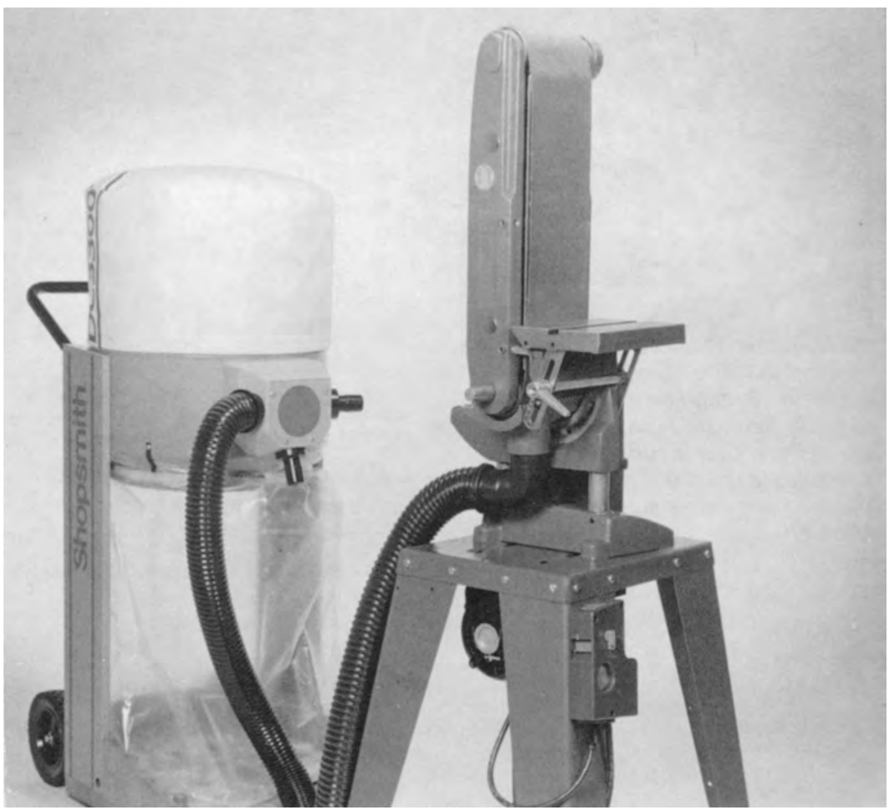


Figure 1-32. *To help control sawdust, attach the hoses from your dust collection system to the dust chutes on your power tools. For virtually dust-free woodworking use the Shopsmith Dust Collector.*

before removing workpieces and scraps.

- **Never try to stop the tool by grabbing the workpiece or any part of the tool. Turn off the tool and let it come to a complete stop by itself.**
- **Do not leave the tool running unattended. Turn power off. Don't leave tool until it comes to a complete stop.**
- **Avoid unintentional starting. Make sure the switch is in the "off" position before plugging in or unplugging the tool.**
- **Turn off and unplug tools before changing accessories and setups, making adjustments, and performing maintenance and repair.**
- **Do not stand or lean on the tool. You could fall onto the tool or it could tip over injuring you and/or damaging the tool.**
- **Keep parts and tools sharp, clean and maintained according to the Owners Manual.**
- **Make your workshop child-proof. Unplug tools, use padlocks, master switches and remove starter keys.**
- **Keep children away. All visitors should stay a safe distance from power tools, and wear eye and ear protection.**
- **Use only recommended Shopsmith parts and accessories on your Shopsmith Woodworking System. NEVER use non-Shopsmith replacement parts or accessories. They are not designed like Shopsmith parts. Using non-Shopsmith parts may create a hazard and could void your warranties.**

SPEEDS

The Mark V is equipped with a speed dial that is calibrated by letter through variable speed ranges (Figure 1-33). Correct speeds are important for safety and good craftsmanship. The speed setting is determined by the operation being performed and the material being processed. Speed dial settings for particular operations are given throughout the text. When there is doubt about what speed to use, start with a slow speed and increase it slowly to the point where the operation is going smoothly. The main and upper auxiliary spindles turn from 700 RPM to 5200 RPM. The lower auxiliary spindle turns 1.6 times faster than the other two, or between 1120 RPM and 8320 RPM.

***Figure 1-33.** The speed dial is letter calibrated through an rpm range of 700 to 5200. **Caution: Turn the dial only when the motor is running.** When an operation is complete, always turn the dial to 'Slow' before shutting off the Mark V.*

The Mark V speed dial settings with the RPM in parentheses that are given throughout the text are for 60 hz operations only. Most owners have the 60 hz machines. If you have a 50 hz machine, use Table 1-1 to convert the RPM for 60 hz operations to the proper speed dial settings for 50 hz operations.

Table 1-1: Speed Dial Conversion Chart for 50 hz Operations

RPM	Speed Dial Setting
585	Slow
625	A
710	B
790	C
875	D
960	E
1080	F
1210	G
1335	H
1460	I
1580	J
1710	K
1835	L
2000	M
2170	N
2330	O
2500	P
2710	Q
2915	R
3165	S
3415	T
3665	U
3915	V
4250	W
4335	Fast

NOTE: To determine the speed dial setting for 50 hz operations find the RPM closest to but not exceeding the RPM recommended in the text. Set the speed dial to the letter given.

Chapter 2
Table Saw: Basic Cuts

Sawing—crosscutting (cutting perpendicular to or "across" the wood grain), ripping (cutting parallel to or "with" the grain), making miter joints and other joinery cuts—is the most common, most necessary woodworking operation. You'll spend most of your operating time on the Mark V sawing. For this reason, we have devoted four chapters of this book to the use of the Mark V in the table saw mode.

There are six basic saw cuts: crosscut, rip, miter, cross bevel, rip bevel, and compound miter (Figure 2-1). All other cuts, no matter how intricate, are combinations of these basic cuts. It is essential, therefore, to master the basic cuts in order to use the table saw to its fullest capabilities. In this chapter, we concern ourselves primarily with crosscutting and ripping.

It is interesting to note that perhaps ninety percent of all operations on the table saw are ripping and crosscutting. It should also be noted that the table saw should not be used in through-sawing operations without the saw guard in place. ***Warning: Always use saw guards and safety devices as recommended.***

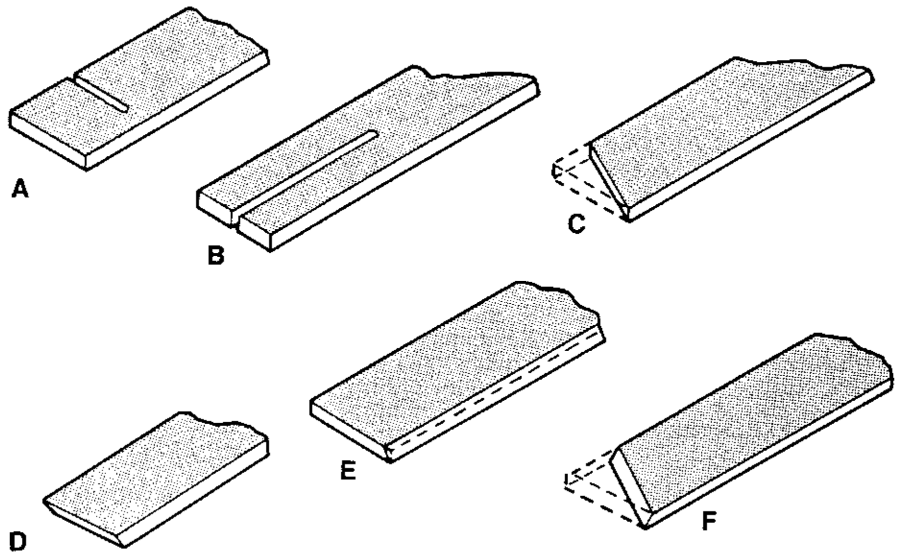


Figure 2-1. *The six basic cuts: (A) crosscut, (B) rip, (C) miter, (D) cross bevel, (E) rip bevel, and (F) compound miter.*

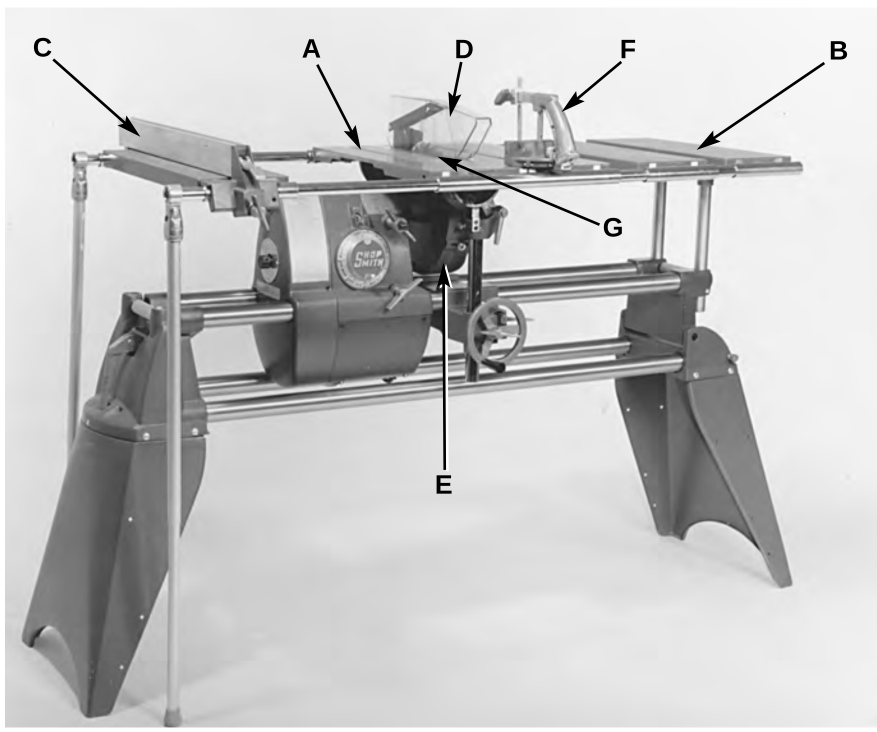


Figure 2-2. *The accessories that are used for table sawing operations are the (A) worktable, (B) extension table, (C) rip fence, (D) upper saw guard, (E) lower saw guard, (F) miter gauge, and (G) saw blade. The Model 510 with the extension table system is shown.*

TABLE SAW MODE—SETUP AND FEATURES

Use the accessories shown in Figure 2-2 for sawing operations. To set up your Mark V in the table saw mode, follow the instructions in the Owners Manual that came with your machine.

As you work in the sawing mode, you'll find that the Mark V is an extremely capable table saw with several special features:

• In the sawing mode, the Mark V has 3-1/4" depth of cut at "0." With the table tilted at 45°, the maximum depth of cut is 2-3/8".

• The table tilts up to 45° right, and the miter gauge can be angled a full 60° in either direction (from 90° to 30° right or left). Both the table and the miter gauge have auto-stops to help you adjust the tilt or the angle quickly to "0", 45°, or 90°.

• The miter gauge has a safety grip to give you better control over the workpiece.

• The speed is variable, enabling you to get a better cut in many different types of wood, using a variety of blades.

• When properly aligned, the rip fence automatically squares itself with the main spindle—parallel to the saw blade.

• The extension table can be mounted in either the base mount or the power mount to give you extra support where you need it.

• The quill feed can be used to make fine adjustments in the position of the saw blade—making it easier to be accurate.

• The dust chute on the lower saw guard can be connected to a dust collection system to help you collect sawdust and wood chips.

SAW BLADES

There are several types of saw blades available for the table saw. Each of them are ground and/or set to accomplish specific woodworking operations. The following are the most common blades and what they do:

All-Purpose Blade—This blade (Figure 2-3) is the sawing workhorse of most woodworking shops. The deep gullets between the teeth provide plenty of room for waste removal on ripping operations and the sharp tooth points do a reasonably good job when crosscutting. An all-purpose blade enables you to start with basic operations like crosscutting, ripping, and mitering, but it is not the only blade you can use. You'll get better results on particular types of sawing when you use a blade that was specially designed for the work you are doing.

Crosscut Blade—A crosscut blade has many small teeth ground with alternating top bevels, sharp points and shallow gullets (Figure 2-4). The teeth cut cleanly across wood fibers, and since the waste that is produced is a fine sawdust, the blade functions efficiently with shallow gullets. However, small teeth and shallow gullets can cause the blade to "choke" if you try to force the cut. Here, even more than with other blade designs, feed pressure should be slow and steady—only enough so the teeth will cut as they were designed to cut.

The crosscut blade does a respectable job on miter cuts, may be used on plywood, but should never be used for ripping.

Ripping Blade—A ripping blade (Figure 2-5) has large teeth ground with a square chisel tooth, large gullets and is designed for sawing with the grain of the wood. There is considerable support metal to back up the cutting edges, and generous gullets catch and disperse the sawdust.

Because it has a special design, the ripping blade should never be used for general sawing.

Hollow-Ground Blade—A hollow-ground blade (Figure 2-6), or "planer blade" as it is sometimes called, produces a cut nearly as smooth as a planed edge. Most blades have *set* teeth; that is, alternate teeth are bent a bit in opposite directions This forms a kerf that is wider than the blade thickness so the blade has clearance in the cut. The hollow-ground blade is reduced in thickness from the points of its teeth to the full-gauge center area that is indicated by the arrow in the photograph. Since this design, rather than set teeth, gives it clearance in the cut, it produces smoother cuts than other blades. The blade can function without binding or burning itself or the wood by using it with the correct projection.

In a strict sense, it is a combination blade, but it is not one to leave on the machine for general sizing cuts. It does fine on plywood, but may not be tempered to stay sharp for an extended period of time under the abrasive action of the plywood glue. Additional uses for the hollow-ground blade include smooth crosscuts or miter cuts, trimming moldings, and other advanced cutting techniques.

Plywood Blade—A plywood blade has many small teeth and very little set (Figure 2-7). This blade trims and cuts plywood and other laminates. Because of the very small teeth, it produces a smooth cut and also reduces splintering along the kerf. The plywood blade can also be used for crosscutting soft woods, preferably finish cuts only. General use will dull the teeth quickly, as will certain types of plywood cores (particle and fibre). For cutting particle or fibre core plywood and other sheet stock, it would be better to use a carbide-tipped blade.

Carbide-Tipped Blade—Carbide-tipped blades (Figure 2-8) are more expensive than conventional blades; but, since they stay sharp for much longer periods of time, they can prove to be more economical in the long run. They are high-quality saw blades specially designed for splinter-free results in hardwoods, softwoods, and materials like hardboard and plywood, whether you are crosscutting, ripping, or mitering.

Carbide is a tough material, but it is also brittle. Be careful when handling such blades; store them so they can't contact another blade or object. Never use a carbide blade to saw second-hand lumber that could contain nails.

Cutting Tips—With any table saw blade, remember that the

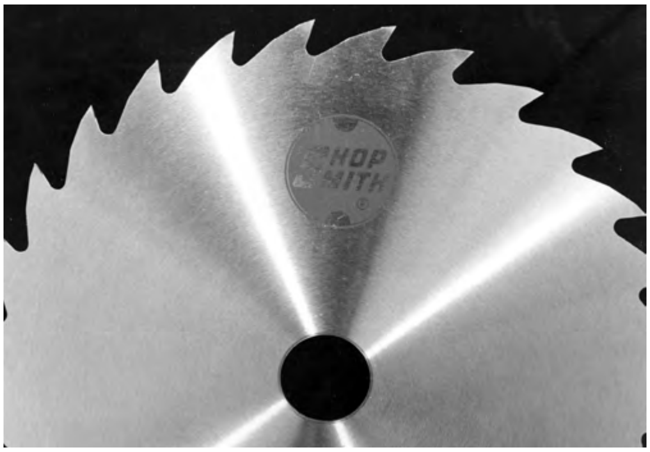


Figure 2-3. *An all-purpose blade can be used for crosscutting, ripping, and mitering. It is a good "sizing" blade, but it will not cut as smoothly as some other special blades.*

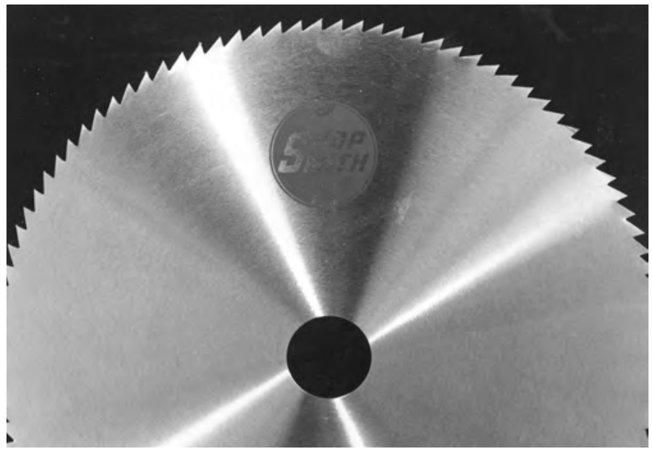


Figure 2-4. *A crosscut blade has many small teeth that cleanly cut wood fibers. The blade does a fair job on miter cuts and sawing plywood. It should never be used for ripping.*

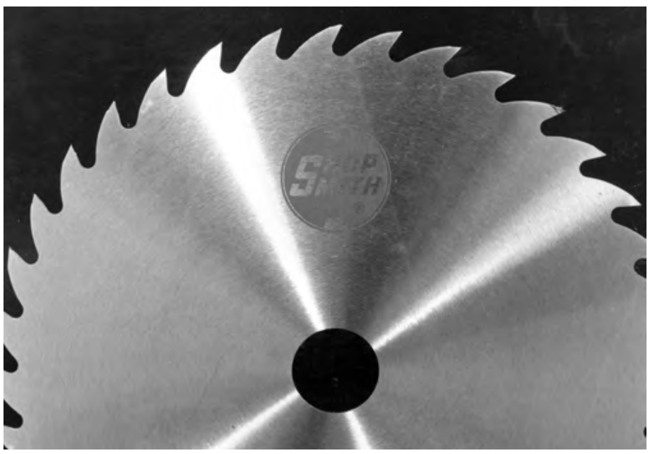


Figure 2-5. *Each tooth of the ripping blade works like a tiny chisel to chip out its own bit of wood. Deep gullets collect and spew out the heavy waste. This blade should never be used for general-purpose sawing.*

Figure 2-6. *A hollow-ground blade does not have set teeth. Kerf clearance is provided by gauge reduction from the tips of the teeth to the center core that is indicated by the arrow. The blade requires more projection than other designs.*

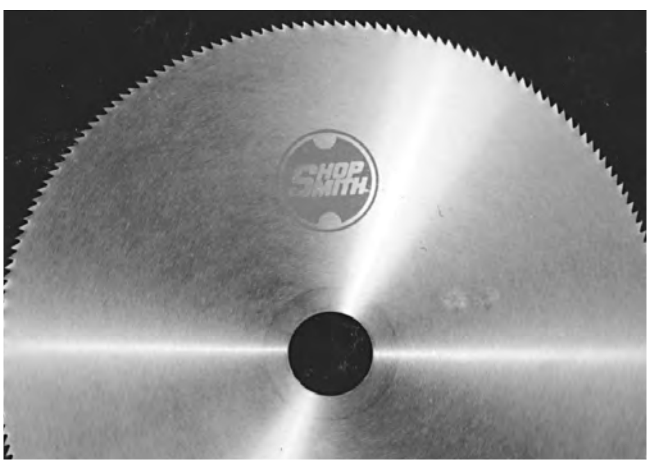


Figure 2-7. *A plywood blade has many small teeth and very little set. It is used for trimming and cutting plywood and laminates, and for finish crosscuts in soft woods. It produces a smooth and near splinter-free cut.*

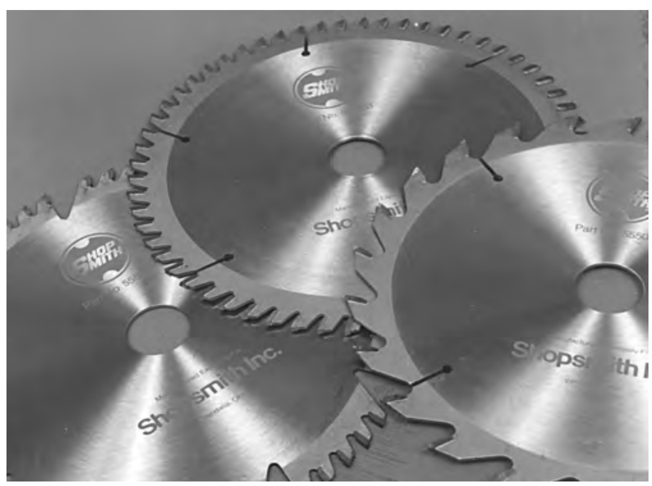


Figure 2-8. *Carbide-tipped saw blades are smooth cutters used for many operations and different materials: (A) combination, (B) crosscut, and (C) rip.*

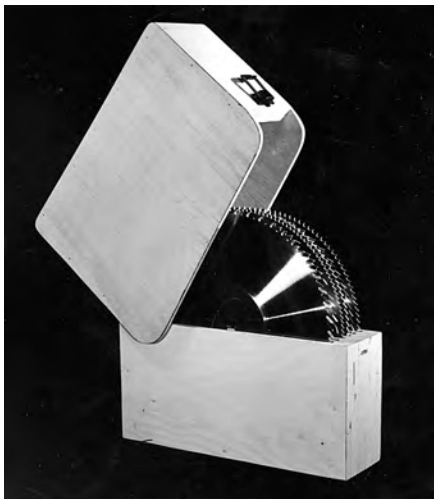


Figure 2-9. A special storage case will protect your saw blades. Add a handle and you'll have a tote for carrying blades.

teeth above the table's surface rotate in the direction of the operator and enter the top surface of the workpiece first; therefore, place the wood with the finished side upward. This applies to plain plywood, veneers, and any form of plywood with laminates attached. When both sides of the wood are finished, use a fine-tooth blade with minimum set or a hollow-ground blade. Also keep in mind that the kerf is the slot formed by the blade. Its width will differ depending on the style, the gauge, and the amount of set on the teeth of the blade. The kerf should always be on the waste side of the cutline.

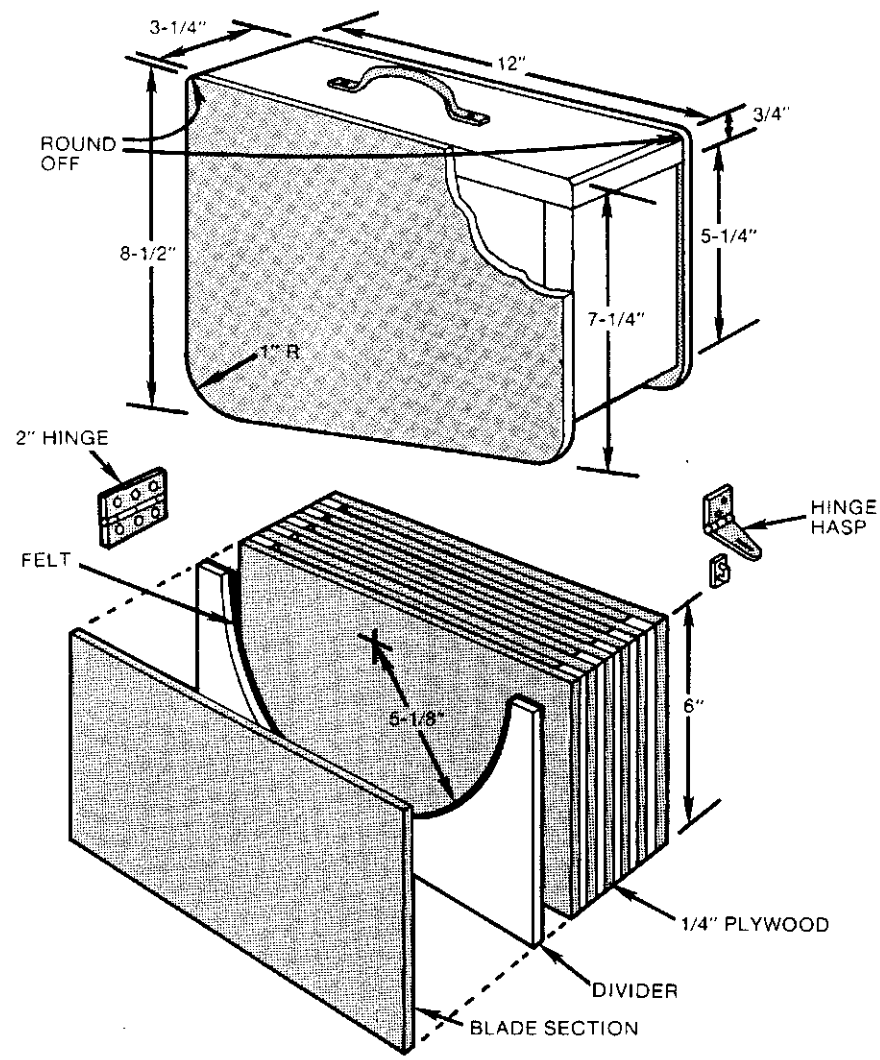


Figure 2-10. Construction details of a saw blade storage case. You can widen it for more blades by adding layers of plywood to create more slots.

Saw Blade Maintenance

Any saw blade will work more efficiently when it is clean and free of deposits that sawing wood can leave. Don't remove deposits by working with a sharp instrument like a knife. Some woodworkers use a commercial pitch remover or work on the tooth areas with a solvent and old toothbrush. An easy method to try is simply to soak the entire blade in warm water and detergent. Wipe the blade with a cloth while it is in the soapy water, rinse, then thoroughly dry it. Apply a very light film of paste wax and buff.

Sharp blades are, of course, a must. They cut more efficiently and are safer to use since the operator doesn't have to utilize excessive force to feed the stock—a situation that could cause hands to slip.

Some woodworkers sharpen their own blades, but it isn't recommended. A less than perfect job will do more harm than good and can even ruin the blade. The cost of sharpening is small, and the professional's experience and special equipment will ensure that the blade will be returned in like-new condition.

Storing Blades

The simplest way to store blades is to place them on hooks that are spaced so the blades won't touch each other. This, however, requires much space. To minimize space requirements, use a hook long enough to hold several blades, and use heavy cardboard or some other soft material as spacers between the blades.

A blade storage case like the one shown in Figure 2-9 will hold six blades and, when fitted with a handle, will serve as a tote for a full assortment of blades. Layers of 1/4" plywood (Figure 2-10), some solid and some with a semi-circular cutout, are laminated to make up the storage area. You can provide for more blades by adding more plywood layers, but you must adjust the dimensions of the hinged cover if you do. To hold the blades steady and keep them from moving about, cement a piece of thick foam rubber to the underside of the cover's top piece.

SPECIAL TABLE INSERTS

There are times when you can substitute a special insert for standard equipment. The purpose of a special insert is to minimize the clearance around a cutting tool. A special insert is necessary, for example, when cutting pieces of wood so thin that the saw blade pulls them down beneath the table.

Special inserts, like those shown in Figure 2-11, are easily made from 1/4" hardboard by using a standard insert as a pattern for shape and hole location. Once the special insert is made, raise the table to its highest position and install the insert (Figure 2-12). To cut the slot in the insert, turn on the machine, set the speed dial to the proper speed, and very slowly lower the table over the blade (Figure 2-13). Each time you use the insert you must align the slot exactly with the blade.

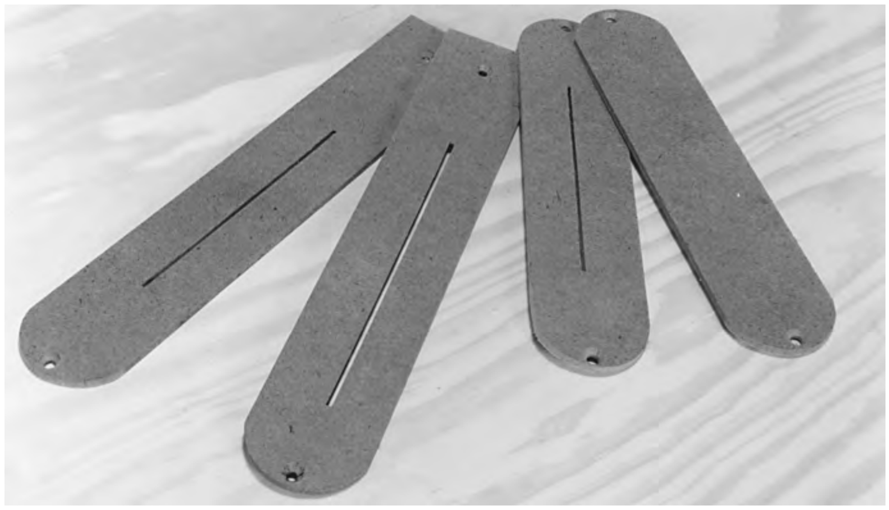


Figure 2-11. *Special table inserts can be made of 1/4" hardboard: (A) Model 510 and (B) Model 500. Use a standard insert as a pattern for the shape and hole locations.*

TABLE SAW SAFETY

Warning: Before using the table saw, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V in the sawing mode extends 3" on all sides of the blade, 2' in back of the blade, and 8' in front of the blade. The reason for the extended danger zone in front of the blade is that a saw blade can kick a board back. The blade may also kick a board forward, but not as hard as backward.

Safety Rules for Table Saws—Here are some safety rules for operating the table saw:

- **Always wear proper eye and ear protection.**
- **Always keep your hands, fingers, and other parts of your body out of the danger zone.**
- **Use push sticks, push blocks and other safety devices to help guide and control workpieces.**
- **Never operate the table saw without the upper and lower saw guards in place. The one exception to this rule is when you saw part way through a board—cutting a dado, groove or rabbet—then you must remove the upper saw guard. Whenever you remove the upper saw guard, keep the lower saw guard in place and work with extreme caution. Use safety devices to move the stock past the blade.**
- **Never stand directly in front of or in back of the blade; always stand to one side or the other.**
- **Make all adjustments with the blade stopped, with the one exception of changing the speed. Never try to change the configuration of the table or the power plant before the machine has stopped.**
- **Let the blade get up to full speed before cutting.**
- **Always cut against the rotation of the blade. This keeps the blade from grabbing the wood out of your hands.**

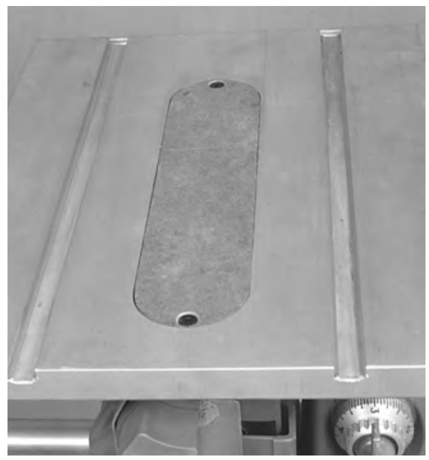


Figure 2-12. *Special inserts install into the table just like standard ones.*

Figure 2-13. *To make the slot in the insert, slowly lower the table as the machine is running. Note: The saw guard is removed for clarity.*

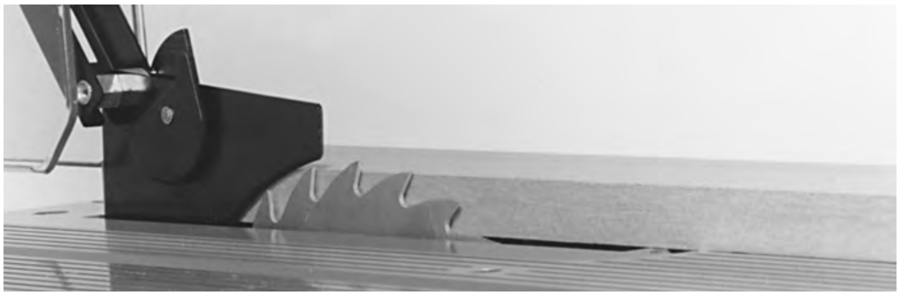


Figure 2-14. Before beginning a table saw operation, adjust the table height so the blade protrudes 1/4" to 3/8" above the stock, as shown.

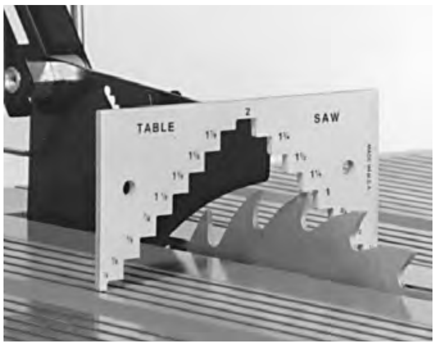


Figure 2-15. Use a step gauge to set blade projection.

- **Use the miter gauge or rip fence to guide your work. Freehand cuts are extremely dangerous, inaccurate and not recommended.**
- **Make a five-point check: all five locks—power plant, carriage, table height, table tilt and quill—should be secure.**
- **Never reach under the table to tighten the locks, remove scrap or make adjustments while the saw is running.**
- **Never reach over the blade while it's running, even with the upper guard in place.**
- **Do not rip large sheets of plywood or similar materials by yourself. Get at least one helper.**
- **Always use the proper table insert for the operation.**
- **Turn off the power and let the machine come to a full stop before you remove workpieces or clear scraps away from the blade.**

Saw Guards—The Mark V is equipped with saw guards to provide a physical barrier between you and the moving blade, no matter what height or angle you adjust the worktable.

These saw guards have several other safety features. The lower saw guard has a dust chute that allows you to attach a dust collection system so you can collect the waste while you're sawing. The upper saw guard is clear so you can see the cutline. There's a removable plastic insert in front of the blade to catch wood pitch. This can be easily cleaned to keep your line of sight clear.

The upper saw guard on the Model 500 is mounted on a splitter that keeps the saw kerf from closing and binding the blade. On this splitter there are two anti-kickback pawls that help keep the blade from kicking the stock back toward you.

The upper saw guard on the Model 510 has a riving knife that is positioned 1/8" from the blade regardless of stock thickness. The riving knife has anti-kickback cams that help capture the stock in the event of a kickback.

Avoiding Kickback—If, for any reason, the saw blade should bind in the workpiece, it can kick the stock back toward the operator with great force and speed. Also, if any piece of scrap (or other object) is left on the table and slides into the moving blade, it can be thrown with considerable force. Actually, kickback is one of the greatest hazards in running a table saw. Some of the common causes of kickback include:

Failing to use the upper saw guard and safety devices.

Crosscutting against the rip fence without using a spacer.

Using a dull or dirty blade or a blade with insufficient set.

Cutting freehand or ripping badly warped wood.

Dropping pieces of stock on an unguarded saw blade.

Letting go of material before it is past the saw blade.

Ripping stock with loose or large, unsound knots.

Cutting wet or improperly seasoned wood.

BLADE PROJECTION

Blade projection (Figure 2-14) refers to the amount of blade that is visible above the workpiece. Except in the case of hollow-ground blades, which are set slightly higher, keep the projection within 1/4" and 3/8".

The upper guard has a depth-of-cut scale so it is easy to adjust the projection of the blade. Just lower the guard over the blade and then adjust the table height. For example, if you are sawing 3/4" stock and want a 1/4" projection, adjust the table height until the tip of the blade aligns with the 1" mark on the guard.

Another way to set blade projection is to use a step gauge like the one shown in Figure 2-15. A gauge you can make by laminating 1/8" pieces of hardboard is shown in Figure 2-16.

Both the scale on the saw guard and a height gauge can be used to set the projection of saw blades and other cutters like the dado accessory.

TABLE SAW SPEEDS

Before you begin any table saw operation, set the Mark V to run at the correct speed. To do this: turn the machine on, turn the speed dial to the correct speed and let the saw come up to speed.

Caution: Never turn the speed dial when the Mark V is stopped. You could damage the speed changing mechanism. Always turn the speed *to "Slow" before turning off the machine.*

The correct speed is determined by the operation you're about to perform and the type of material you're sawing. Generally, you can use faster speeds in softer woods. Faster speeds will also give you a smoother cut. Slower speeds give the machine more torque to get through hard, dense woods.

To determine the right speed for the job, refer to Table 2-1. A good rule of thumb is: The deeper the cut or the harder the wood, the slower the speed. But if the blade turns too slowly, you may get a rough, splintery cut.

Table 2-1: Table Saw Speed Chart

Operation	Hardwood	Softwood
General Sawing	R (3500 RPM)	R (3500 RPM)
Heavy Ripping	O (2800 RPM)	P (3000 RPM)
Trim Cuts	S (3800 RPM)	S (3800 RPM)

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

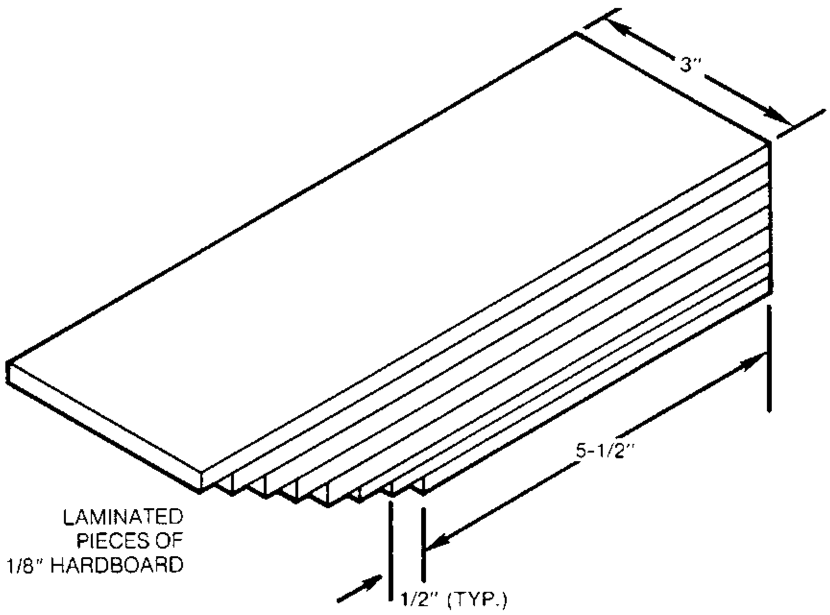


Figure 2-16. *Construction details of a homemade height gauge.*

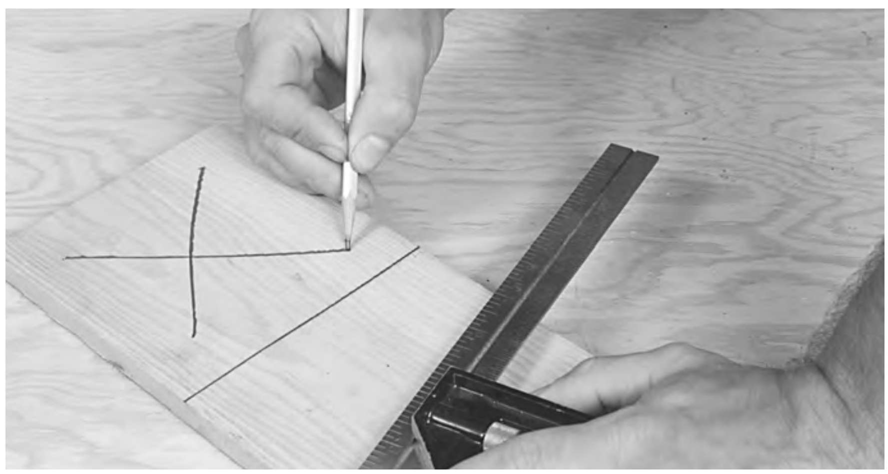


Figure 2-17. *Mark the stock where you want to cut it, using a square and a sharp pencil. An "X" will help you remember which is the waste side of the stock.*

CROSSCUTTING

Crosscutting, cutting a board perpendicular to or *across* the grain, is one of the most common woodworking operations. It's also known as a "cutoff" operation, or cutting a board to length.

Basic Crosscutting Techniques

To make a crosscut, first mount the proper saw blade. Make sure both the upper and lower saw guards are in place and that the splitter on Model 500 or the riving knife on the Model 510 is directly in line with the saw blade.

Adjust the table height so that the saw blade will protrude about 1/4" above the stock. When the table height is properly adjusted, make a five-point check. All five locks—power plant, carriage, table height, table tilt, and quill—should be secure.

Check that the miter gauge is square to the blade, and adjust the safety grip to the thickness of the stock. ***Warning: Always use the miter gauge to guide the stock as you saw it.***

Decide on which side—right or left—of the blade is the most comfortable for you to stand when you saw. ***Warning: Do not stand directly in line with the blade. Place the miter gauge in the slot on the same side of the blade that you're standing.***

Mark the stock where you want to cut it, using a square and a sharp pencil (Figure 2-17). Remember that the saw usually makes a 1/8" kerf as it cuts. If you cut straight down in the middle of your line, your stock will be 1/16" short. Instead, cut on the outside of the line.

Squeeze the safety grip to clamp the stock in the miter gauge. Push the stock forward until it touches the saw teeth so that you can see if the cutline is properly aligned with the blade.

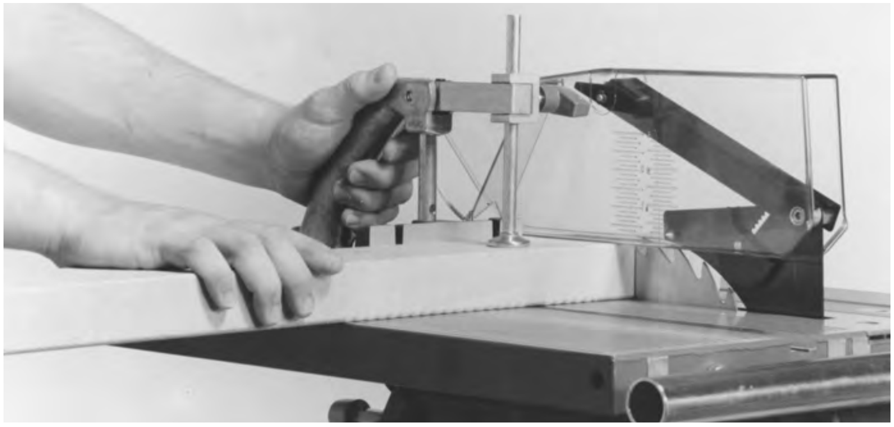


Figure 2-18. *Use your free hand to help support the board and keep it flat against the miter gauge.*

Figure 2-19. *When crosscutting long stock on the Model 510, use the extension table system.*

Pull the stock away from the blade. Turn on the Mark V, turn the speed dial to the proper speed, and let the machine come up to speed. Then carefully guide the stock past the blade. Use your free hand to help support the stock and keep it flat against the face of the miter gauge (Figure 2-18).

When crosscutting narrow stock or cutting off a thin piece, use a special insert (Figure 2-11) or move the blade close to the table saw insert on the side of the blade where the stock is being cut. This will help keep small pieces of stock from falling through the insert.

Don't feed the stock any faster than the blade will cut. If the machine bogs down, slow your feed rate and let the saw get back up to running speed.

Warning: Never use your free hand to push against the free end of the stock. This binds the blade and can result in a dangerous kickback.

Use your free hand for additional support only. After the cut is complete, turn the speed dial to "Slow" and turn off the machine. ***Warning: Never pick up a cutoff while the blade is still running. Your hand holding the miter gauge could slip into the blade; your free hand might nudge the cutoff into the blade, causing a kickback; or the action of the blade on the cutoff might pull your free hand into the blade.*** It takes only a few seconds for the blade to stop after the switch has been turned off.

Crosscutting Long Boards

Chances are that when you start cutting boards to length, you'll start out with boards 8′ long or longer. Crosscutting a long board can be awkward on a table saw, but here are a few simple techniques to help make this task easier.

If possible, don't start by cutting little pieces off the end of the long board. This is hard to do accurately. Instead, start cutting long boards in the middle. This gets them down to a manageable length quickly.

Use an extension table mounted in either the power mount or the base mount—whichever end of the board needs the most support. If you crosscut a lot of long boards, you will want to invest in a second extension table so that you can support the stock at both ends. The Model 510 has the extension table system that provides additional support for cross-cutting operations (Figure 2-19).

A miter gauge extension will also provide extra work support because it increases the surface area of the miter gauge. Actually, it's good practice to use an extension on all crosscut work, especially if the workpiece is long.

The extension that is available for the Mark V, shown mounted in Figure 2-20, comes with attach-

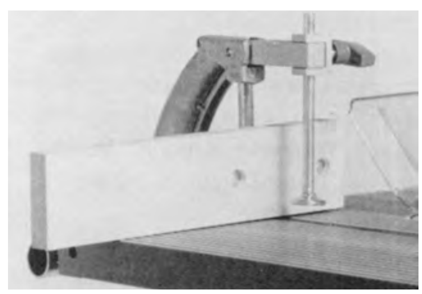


Figure 2-20. *The standard miter gauge extension provides extra support when crosscutting.*

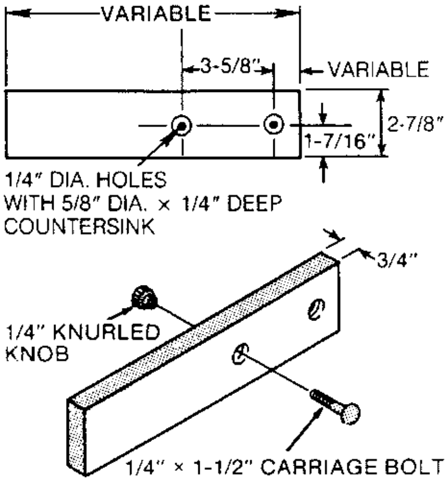


Figure 2-21. *Dimensions and hole locations for a homemade miter gauge extension.*

ment hardware and is easily mounted because of the pair of slots that are part of the miter gauge design. The position of the extension can be reversed so it can be placed in the miter gauge for use on either side of the saw blade.

It's a good idea to have several extensions on hand, each one for a specific purpose. Should you wish to make your own, the standard extension can be used as a pattern or use the dimensions and hole locations in Figure 2-21.

Figure 2-22 shows an adjustable miter gauge extension that is ideal for crosscutting and mitering. Use a router to form the 1/4" slot that positions the extension on the miter gauge. In the same way, form a 5/8" wide counterbored slot centered on the 1/4" slot to accept the two carriage bolt heads. Glue fine sandpaper to the face, as mentioned later, for more holding power.

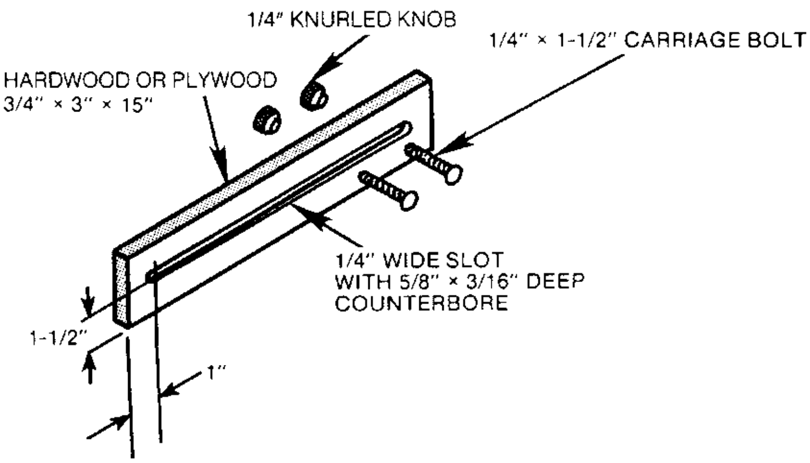


Figure 2-22. *Construction details of an adjustable miter gauge extension.*

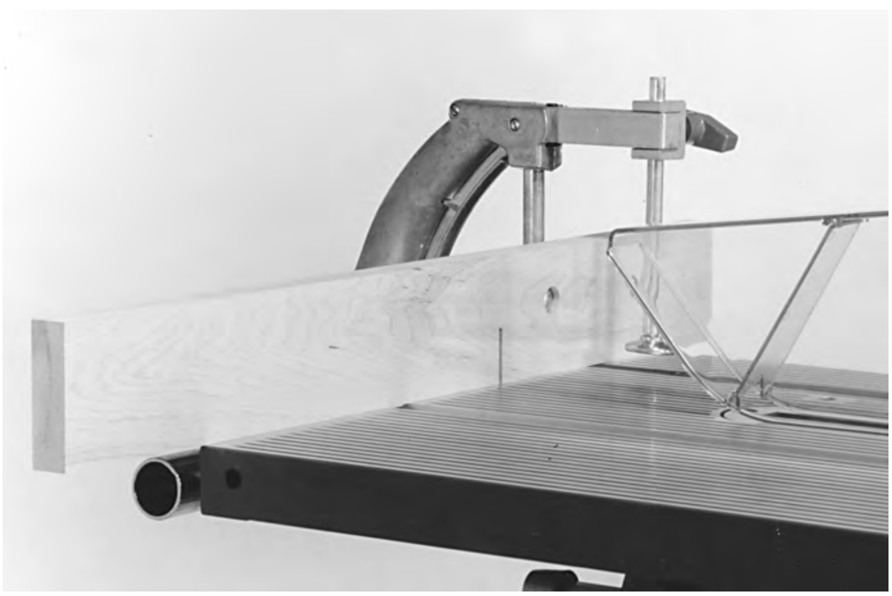


Figure 2-23. *Use a long miter gauge extension when crosscutting long stock.*

Miter gauge extensions do not have to be a specific length. When crosscutting extra-long pieces, the extension can span across the table and beyond it (Figure 2-23). When necessary, the extension can rest on the extension table. When you use a long extension, the saw blade will cut through it. This will not harm the extension, and the kerf that is formed can be used as a guide. The cut line can be marked on the stock with a square and then aligned with the kerf in the extension. Thus you know beforehand the line that the saw blade will follow. When you mark the stock, be sure to place the head of the square against the edge that will bear against the extension. Check the miter gauge adjustment if the kerf doesn't follow the line. You can use the miter gauge safety grip with an extension.

Many woodworkers face extensions with fine sandpaper to provide a high-friction surface that is an aid on all operations, but especially useful when the miter gauge is adjusted for an angular cut. The sandpaper helps to keep the workpiece from moving or drifting when cutting miters. The sandpaper may be applied to the extension with rubber cement.

Crosscutting to Length

Except for squaring off the end of a board, crosscutting is usually done to cut a piece, or several pieces, to an exact length. When you need only one piece, the simplest method is to cut to a line that you have marked with a square. You can visually align the mark on the workpiece with the saw blade or you can use a miter gauge extension that has a kerf through it (Figure 2-24).

Other methods should be used when you need more than one piece of the same length. One method is to work with the miter gauge stop rod (Figure 2-25). By adjusting the two rods, any number of pieces can be cut to any length up to 18". The stop rod can be used at either side of the miter gauge, which allows it to be used whether the miter gauge is on the left or right side of the blade. For short pieces, up to 8" long, secure the short rod in the miter gauge and use the long rod as an adjustable stop. For longer workpieces, up to 18", secure the long rod in the miter gauge and use the short rod as an adjustable stop.

Adjust the stop rod for the length you require (Figure 2-26) by measuring between the end of the rod and the blade. If the blade has set teeth, be sure to measure from the tip of a tooth that points toward the rod. Once the setting is made, any number of pieces can be sawn to the same length by butting the end of the workpiece against the stop rod and making the pass.

Warning: Do not position the miter gauge stop rod so that it crosses in front of the blade.

A miter gauge extension that you make yourself can be used for cutting duplicate pieces (Figure 2-27). The extension, which can be used whether the miter gauge is on the left or right side of the saw blade, will allow cutting of duplicate pieces as long as 24". To use it, measure between the sliding stop and the saw blade and then do the sawing.

Construction details of the extension are shown in Figure 2-28. When you make the stop, allow just a fraction of clearance so it can slide smoothly in the extension's T-shaped slot. Accessories you make, like this one, should be carefully made, smoothly sanded, and given one or two applications of a penetrating sealer. When you treat them right, they become tools that will function for as long as you do woodworking.

Spacers for the Rip Fence— The rip fence can assist in cutting-

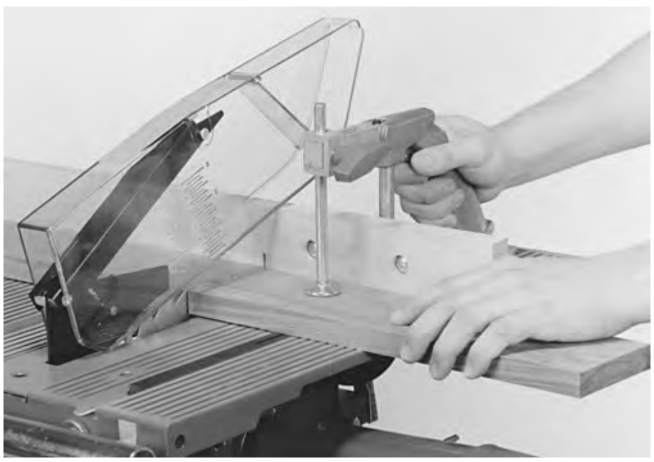


Figure 2-24. The kerf in a miter gauge extension can be used as a guide when crosscutting to length.

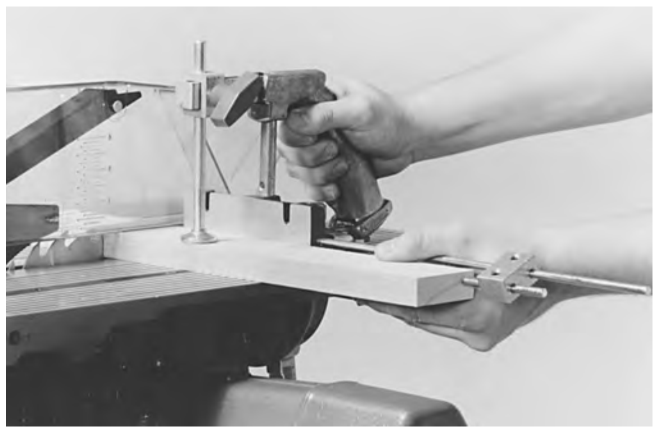


Figure 2-25. The miter gauge stop rod can be used to gauge the length of long or short workpieces depending on which rod is secured in the miter gauge.

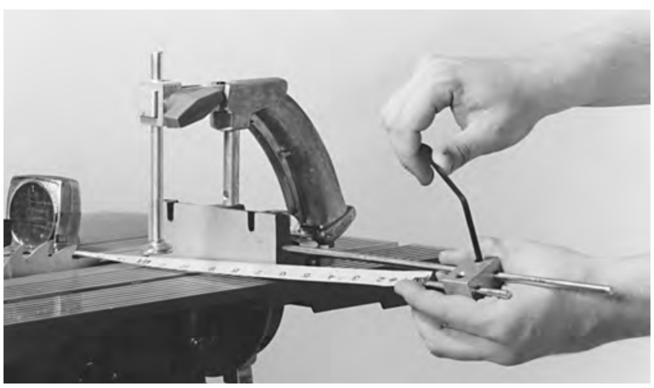


Figure 2-26. To adjust the miter gauge stop rod for length of cut, measure between the rod and blade. If the blade has set teeth, measure from the tip of a tooth that points toward the rod.

Figure 2-27. The miter gauge extension has a sliding stop so it can be used to gauge the length of one or more workpieces. Notice how the extension table provides extra support.

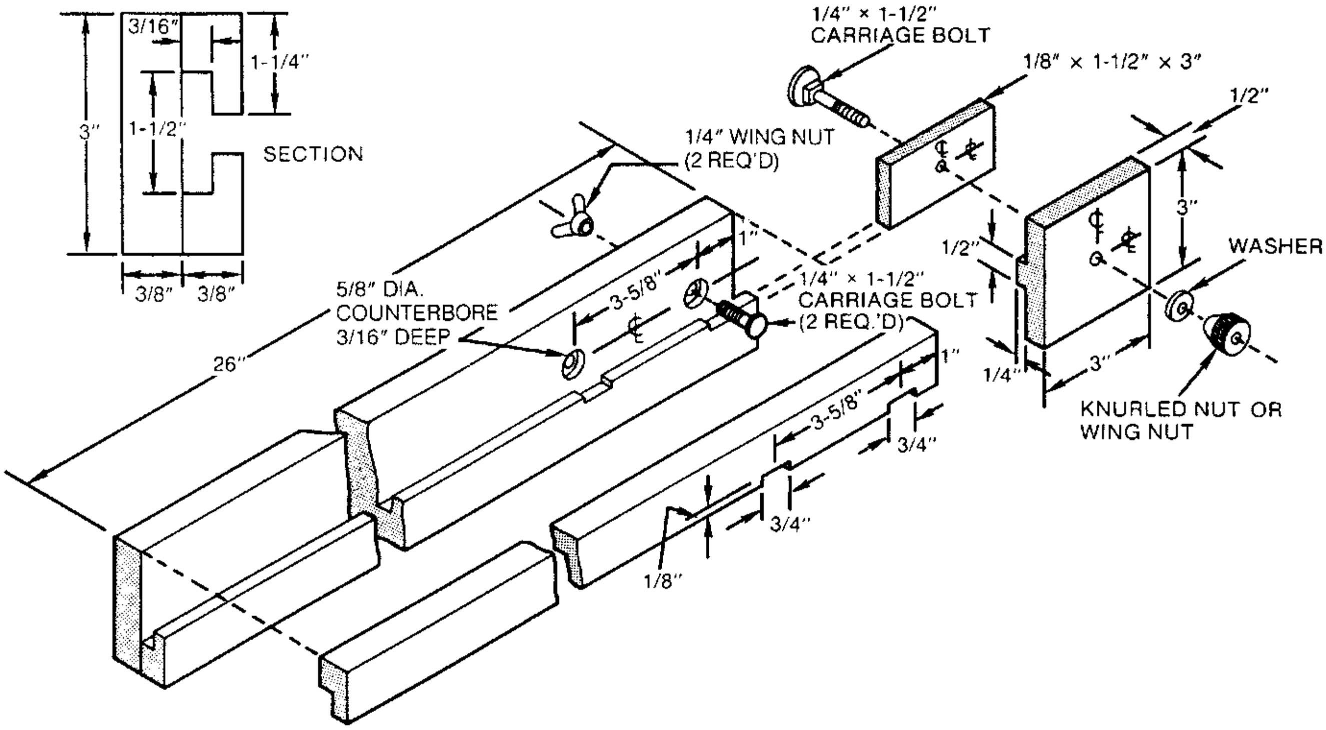


Figure 2-28. Construction details of a miter gauge extension with sliding stop.

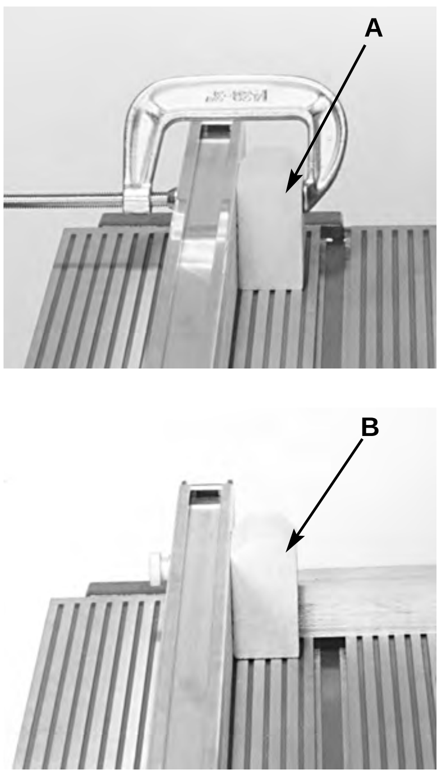


Figure 2-29. *The workpiece is placed well ahead of the blade and butted against a spacer that is (A) clamped or (B) screwed to the rip fence. When the pass is complete, there will be ample room between the fence and the blade so the cutoff can't be trapped and kicked back.*

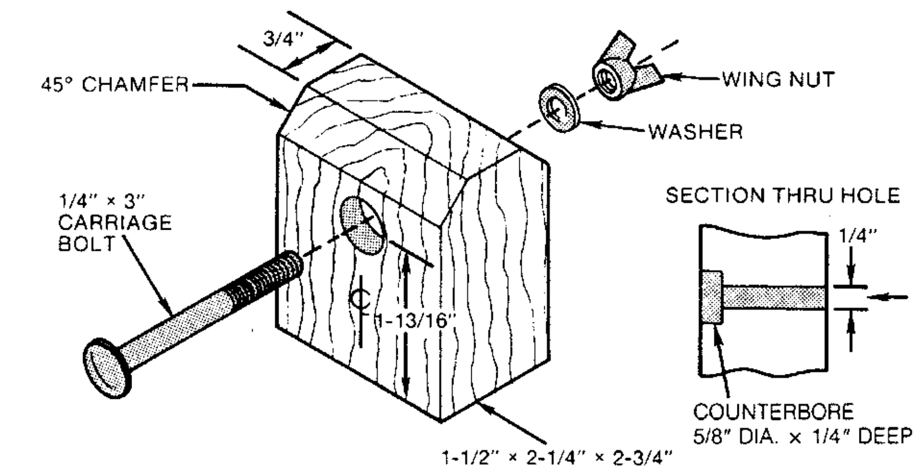


Figure 2-30. *Construction details of a screw-type spacer.*

to-length operations if a spacer is clamped or screwed to the rip fence (Figure 2-29). The spacer must be at least 1-1/2" thick. Figure 2-30 shows how a screw-type spacer is made. ***Warning: The rip fence alone must never be used as a stop to gauge the length of a cutoff. The cutoff, when the pass is complete, will bind between the fence and the blade and be kicked back.***

The distance between the fence and the blade minus the thickness of the spacer determines the length of the cutoff. The workpiece is butted against the spacer and then advanced for cutting. When the pass is completed, there is ample room between the rip fence and the blade so the workpiece can't be trapped.

Another spacer design is shown in Figure 2-31. An advantage of this one, made as shown in Figure 2-32, is that it can be placed anywhere on the rip fence, which makes it usable for other wood-

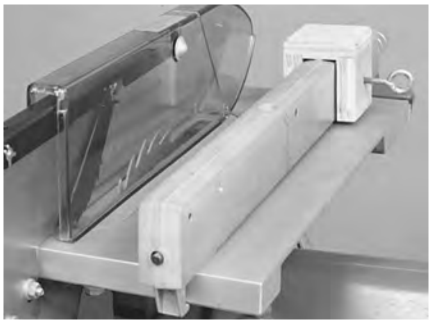


Figure 2-31. Another stop design. Its advantage is that it can be locked at any point along the rip fence. This makes it usable for more than cutoff work.

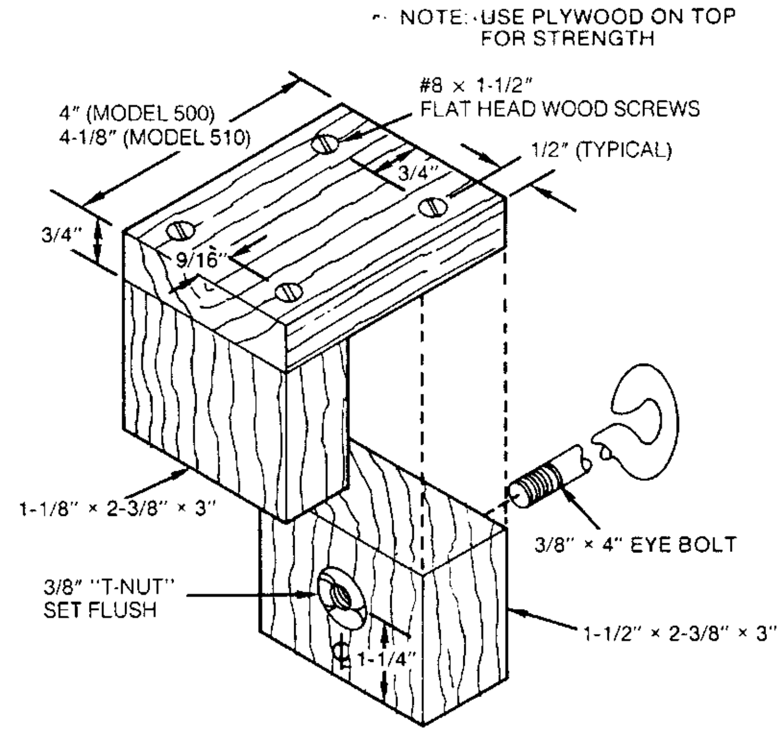


Figure 2-32. Construction details of a movable spacer.

working operations. ***Warning: The workpiece MUST clear the spacer well before the end of the cut to avoid binding the workpiece between the spacer and the blade.***

Crosscutting Wide Stock

Crosscutting wide boards requires maximum support in front of the blade. On the Model 500, actual table length in front of the blade with projection set to cut 3/4" stock is about 7", which is good support for average work. On the Model 510 there is 10" of table in front of the blade.

A front table extension (Figure 2-33) is available as an accessory for the Model 500. This increases the usable table depth in front of the saw blade by 7". A single locking knob makes it easy to attach or remove; its miter gauge slot is compatible with the slots in the worktable.

Crosscutting Extra-Thick Stock

When you are cutting unusually thick material and the machine's maximum depth of cut won't allow you to cut through in a single pass, you can do the job by making two passes. ***Warning: When cutting part way through stock, it is necessary to remove the upper saw guard. Whenever the upper guard is removed, keep the lower guard in place and work with extreme caution.***

Set the blade's projection to a little more than half the stock's thickness and make one pass. Use a square so you can pencilmark the line of the kerf down one side of the stock. Invert the stock and place it so the pencil mark is in line with the saw blade and make a second pass (Figure 2-34).

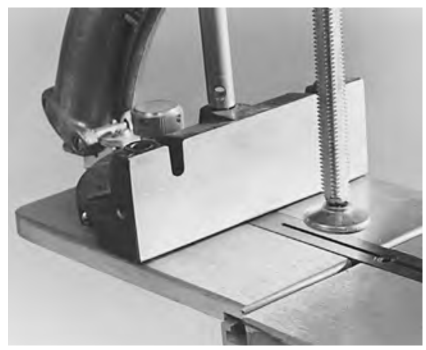


Figure 2-33. The front table extension, an accessory for Model 500, can line up with either table slot and increases table depth in front of the blade by 7".

Figure 2-34. You can cut extra-thick material by working this way. Make one cut a bit more than halfway through the stock. Mark the cutline, invert the stock, and make a second pass. ***Warning: Work with extreme caution because the upper saw guard is removed for both passes.***

RIPPING

Ripping is cutting parallel to or *with* the grain of the wood. It's also known as cutting to width.

General Ripping

Mount the proper saw blade. Before turning on the machine check that the saw guards are in place, adjust the table height, and make a five-point check. All five locks—power plant, carriage, table height, table tilt, and quill—should be secure.

When ripping, use the rip fence to help guide the wood. Mount the rip fence to the table, slide the rip fence so that it's the desired distance away from the saw blade, then lock it in place. Use the quill feed to make fine adjustments (Figure 2-35). Be sure to measure from the fence to the tip of a tooth that's set toward the fence. When properly aligned, the rip fence automatically sets itself parallel to the saw blade. However, on critical setups, it's wise to check this. Measure the distance from the rip fence to the saw blade at both the front and back of the machine. Mount a feather board in front of the blade to help hold the stock against the fence. Refer to "Safety" in Chapter 1 for correct use of feather boards.

Stand in front of the Mark V, on the opposite side of the blade than the rip fence. (This position will help you keep the stock pressed against the fence as you rip it.) Turn on the Mark V, turn the speed dial to the proper speed, and let the saw come up to speed. Place the stock on the table and against the rip fence. Slowly feed the stock into the blade while keeping it pressed firmly against the rip fence (Figure 2-36). Don't force the cut or go any faster than the blade can cut. ***Warning: As you finish the cut, use a push stick or push block to help feed the last portion of the stock past the blade (Figure 2-37). This will keep your hands and fingers out of danger. When the cut is complete, turn off the machine and let it come to a complete stop before removing the stock or any scraps.***

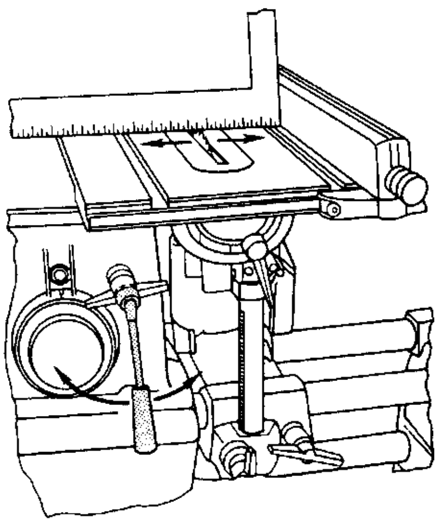


Figure 2-35. *To set up for ripping, use the quill feed to make fine adjustments in the distance from the saw blade to the rip fence. Measure from the fence to the tip of a saw tooth that's set toward the fence.*

A

B

Figure 2-37. *As you finish the rip cut, use a (A) push stick or (B) push block to help feed the last portion of the stock.*

Ripping Narrow Stock

When ripping narrow stock—1-1/2″ to 3″ wide—use the fence straddler to finish the cut (Figure 2-38). When ripping stock less than

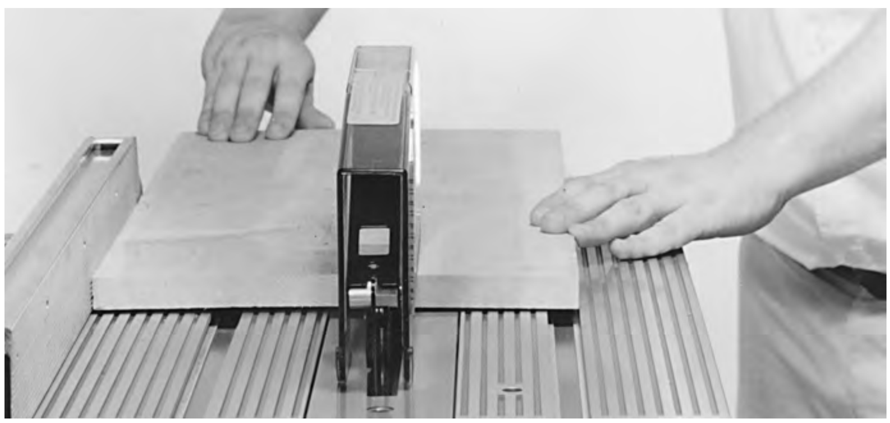


Figure 2-36. *The rip fence gauges the cut width and acts as a control throughout the pass. Hands are placed so they can't come close to the cut area.*

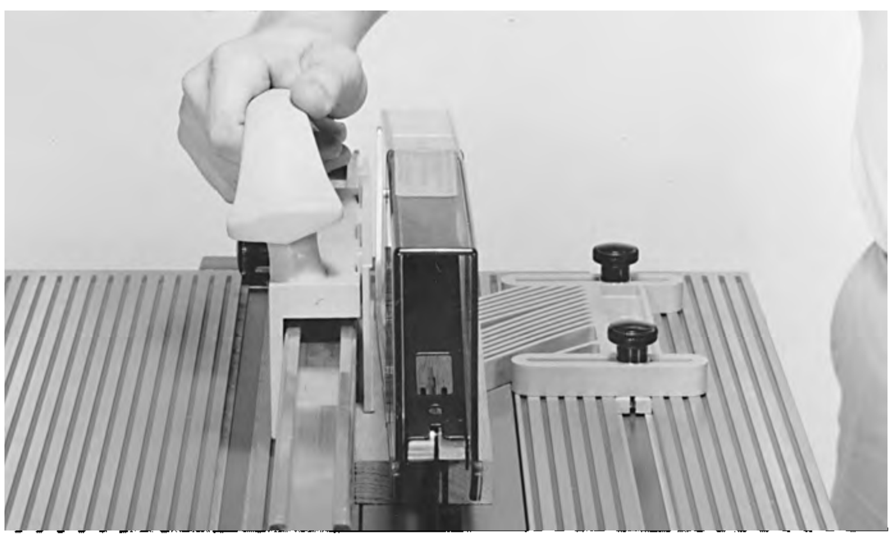


Figure 2-38. *When ripping narrow stock, use a fence straddler to help finish the cut.*

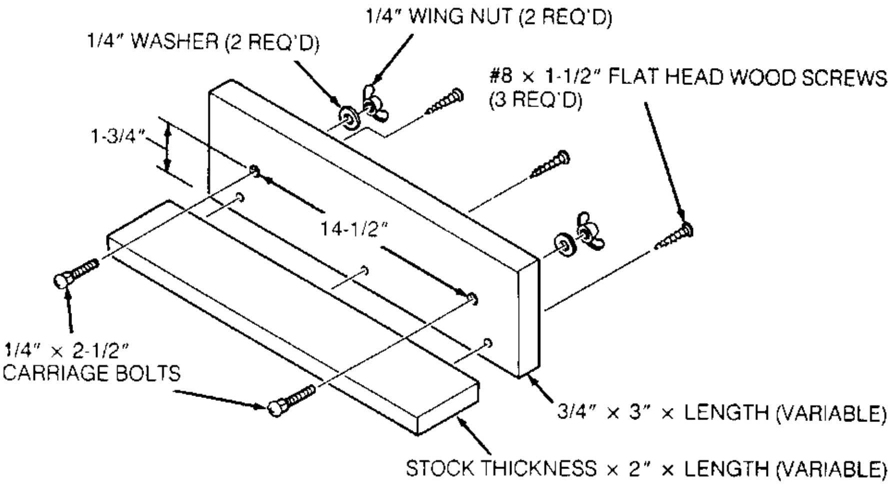


Figure 2-39. *Construction details of a spacing fixture that is used when ripping stock less than 1-1/2" wide.*

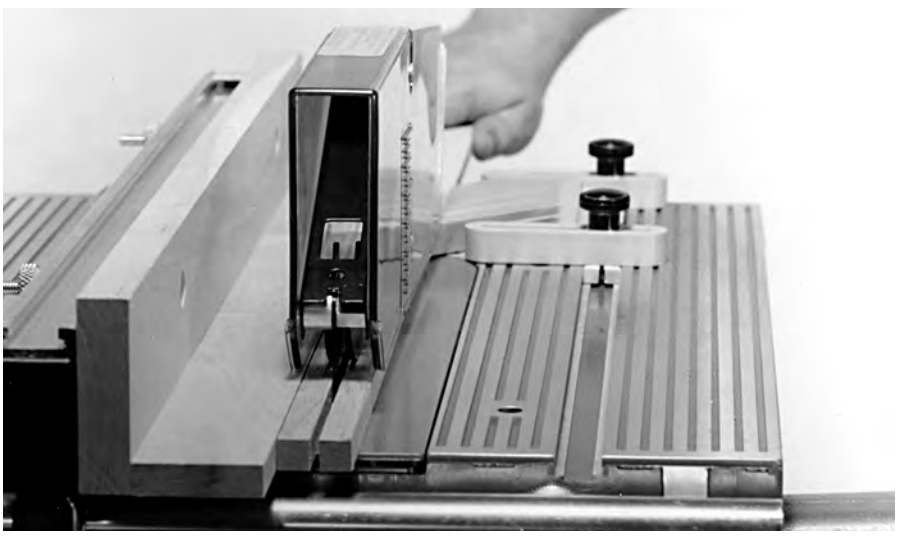


Figure 2-40. *Clamp a spacing fixture to the rip fence to keep the fence from interfering with the saw guard or the stock being cut.*

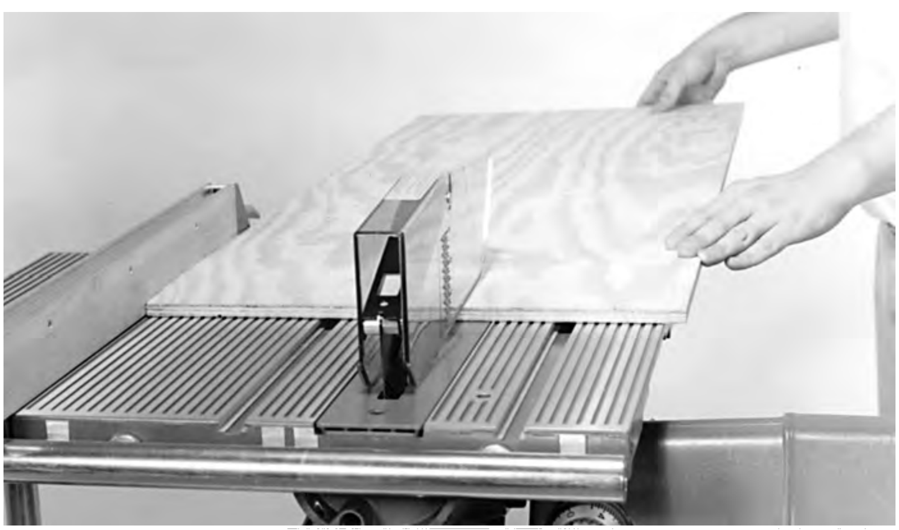


Figure 2-41. *To rip wide stock, mount the rip fence so it straddles the extension table and the worktable. The rip fence accurately guides the stock.*

1-1/2" wide make a spacing fixture, no higher than the thickness of the stock (Figure 2-39) and screw it to the rip fence so that the fence doesn't interfere with the saw guard or the stock being cut. Use a similar size piece of scrap stock to push the good stock past the blade (Figure 2-40). *Caution: Do not use the plastic push stick from the safety kit.* When the good stock is clear of the blade, turn off the Mark V. Hold the scrap push stick steady until the blade comes to a complete stop, then move it away from the blade. To keep small pieces of stock from falling through the table insert, move the blade close to the insert on the side of the blade where the stock is being cut, or use a special table insert. The construction details for the special table inserts are shown in Figure 2-11.

Ripping Wide Stock

If you're ripping stock that is 5-1/2" to 8-1/2" wide (Model 500) and 8-3/4" to 10-3/4" wide (Model 510), you can mount the rip fence so it straddles the extension table and the worktable. Be sure that the extension table and the worktable and rip fence are properly aligned, then slide the power plant and carriage to the right so that the worktable butts against the extension table. Position the rip fence so the saw blade is the desired distance from the rip fence and make fine adjustments with the quill feed. As you feed the stock, the rip fence will accurately guide the stock (Figure 2-41).

Ripping Large Stock

Whenever you need to rip large pieces of stock such as plywood, paneling and other sheet materials it is very important that the stock be properly supported throughout the cut. Also, get a helper if the material you're ripping is too large to safely handle by yourself. There

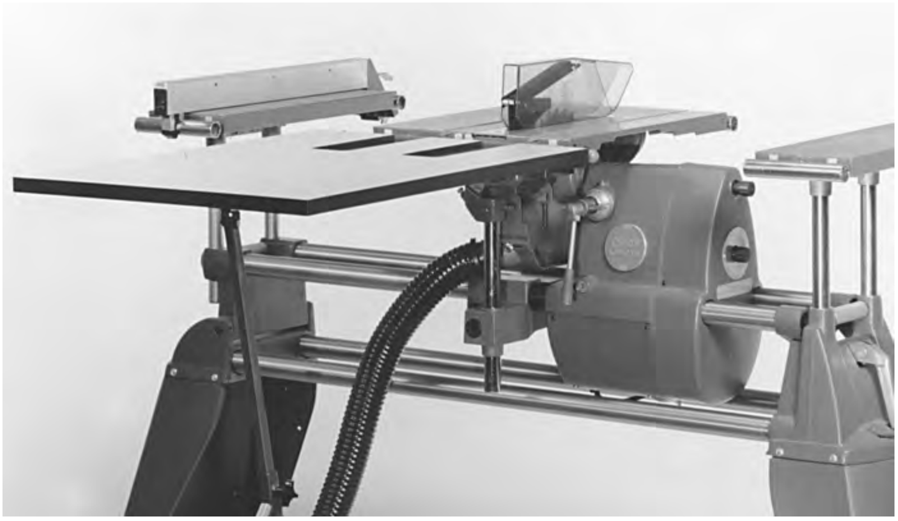


Figure 2-42. A support table helps support large stock at the outfeed end of the worktable.

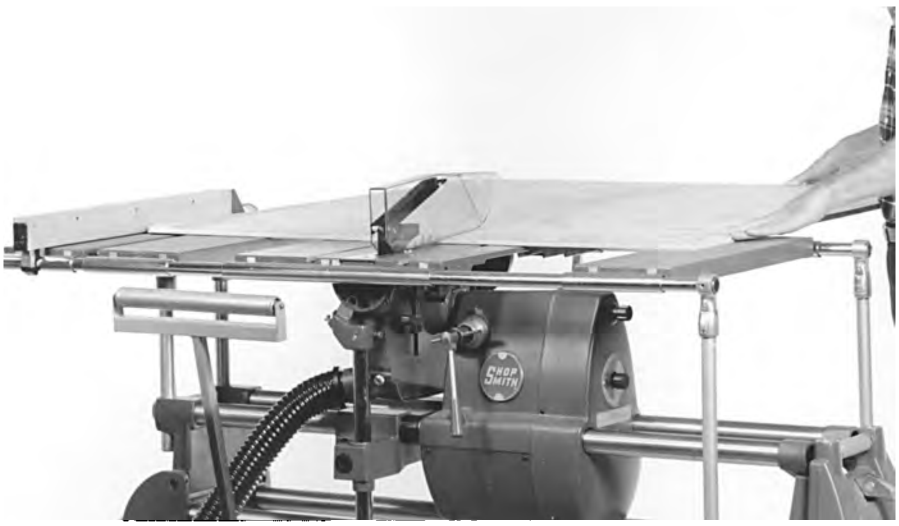


Figure 2-43. The Model 510 extension table system supports wide stock.

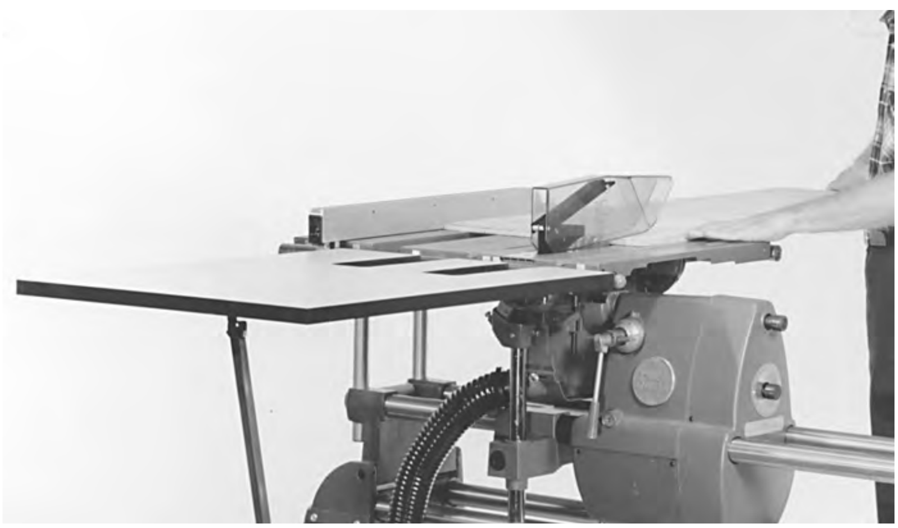


Figure 2-44. Use a support table when ripping long stock.

are several setups that provide the proper support.

One setup for ripping sheet materials is to mount an extension table on one or both sides of the machine, then mount the rip fence on the extension table.

You can also mount a support table (Figure 2-42) or use a roller stand at the outfeed end of the worktable. For even more support, also use a support table (Model 510 only) or roller stand at the infeed end of the worktable. With the Model 510, you can also use the extension table system (Figure 2-43).

Ripping Long Stock

When ripping long stock it is extremely important to support the stock during the cut. ***Warning: If the stock is too long to safely handle by yourself get a helper to assist you.***

One way to support the stock is to mount a support table to the outfeed end of the worktable (Figure 2-44) or position a roller stand 1′ to 4′ away from the outfeed end of the worktable (Figure 2-45). You may also want to position a roller stand at the infeed end of the worktable. If the stock is extremely long (over 6′), you will want to use a roller stand positioned 2′ to 4′ beyond the support table (Figure 2-46). On the Model 510 you can mount a second support table at the infeed end of the worktable for extra support.

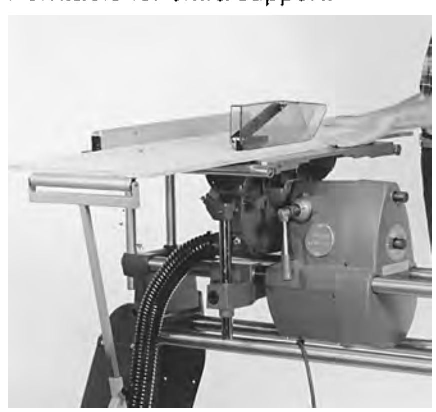


Figure 2-45. A roller stand provides support for long stock.

As you feed the stock, it comes off the outfeed end of the table and the support table and/or the roller stand will support it.

Figure 2-47 shows a rip fence extension that is used for ripping long and wide boards, and even plywood. To make the rip fence extension (Figure 2-48), use 3/4" plywood or clear straight hardwood. Drill and counterbore holes for the mounting bolts. Attach the support to the back with glue and screws. Mount 1-3/4" wide strips to the bottom edge for more support.

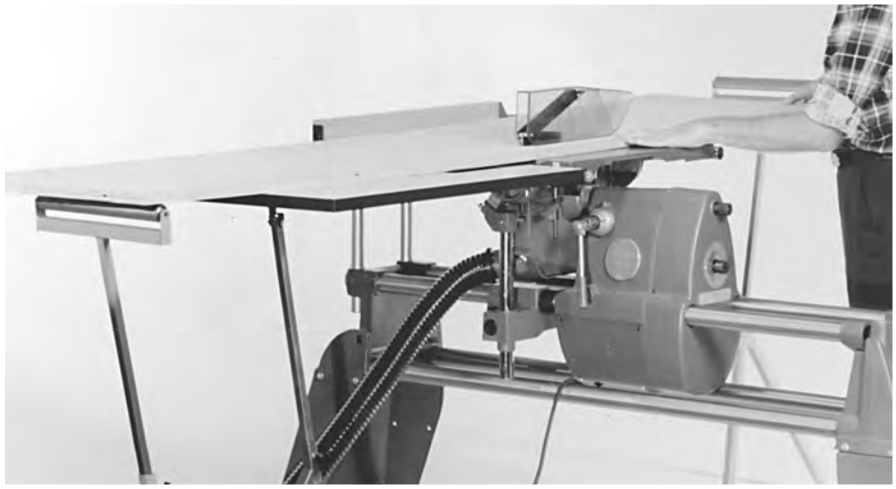


Figure 2-46. *If the stock is extremely long, use a support table and two roller stands.*

Sawing Stock with Irregular Edges

Sometimes a piece of stock may not have an edge that is straight enough to be used against the rip fence. Maybe the piece has been cut on both edges with a jigsaw or bandsaw, or it might be uneven, rough lumber. These pieces of stock can be rip cut by the guide-strip method. A narrow, straight piece of stock is clamped or tack-nailed to the underside of the stock to be used as a guide. Or make a guide as shown in Figure 2-49.

On the Model 510, mount the rip fence to the extension table and

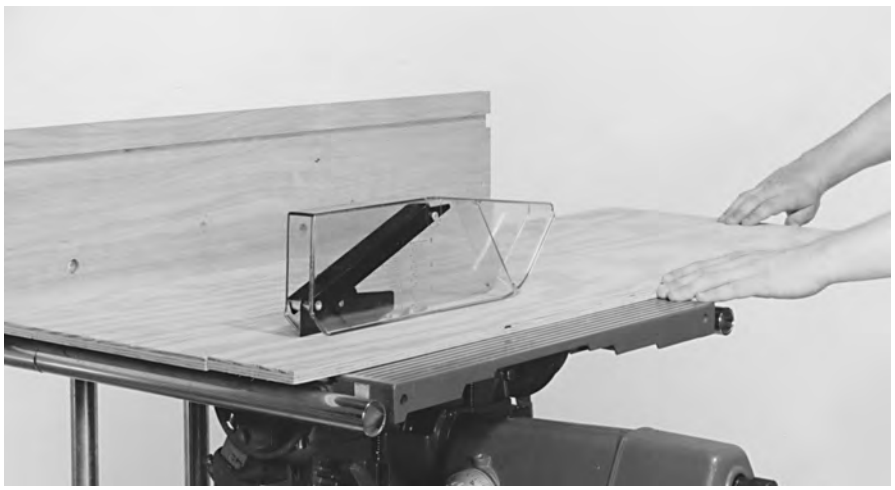


Figure 2-47. *Use a rip fence extension when ripping long and wide boards, and even plywood.*

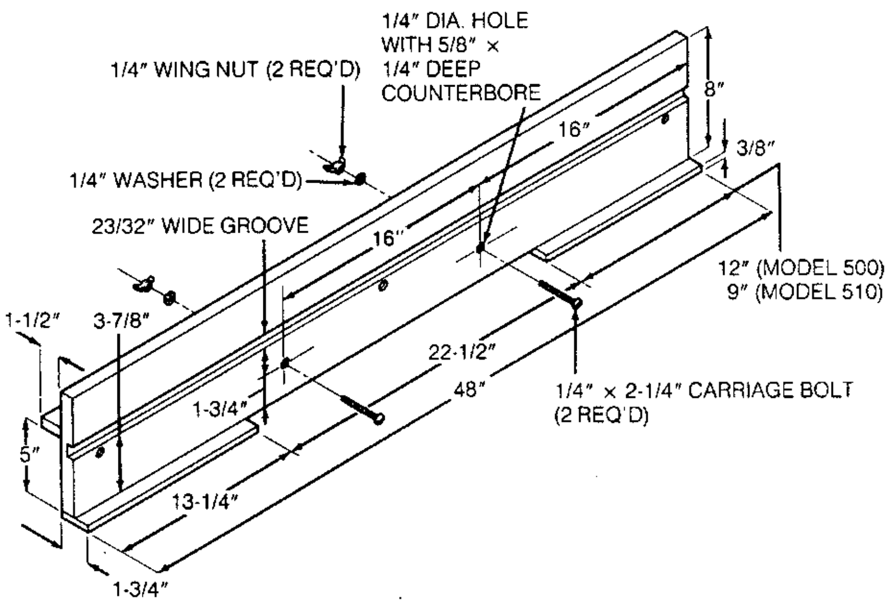


Figure 2-48. *Construction details of a rip fence extension.*

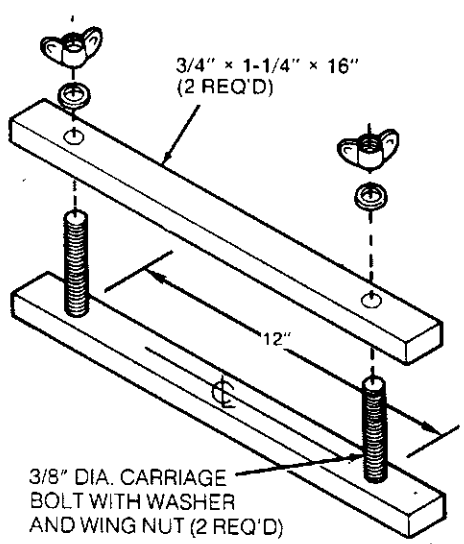
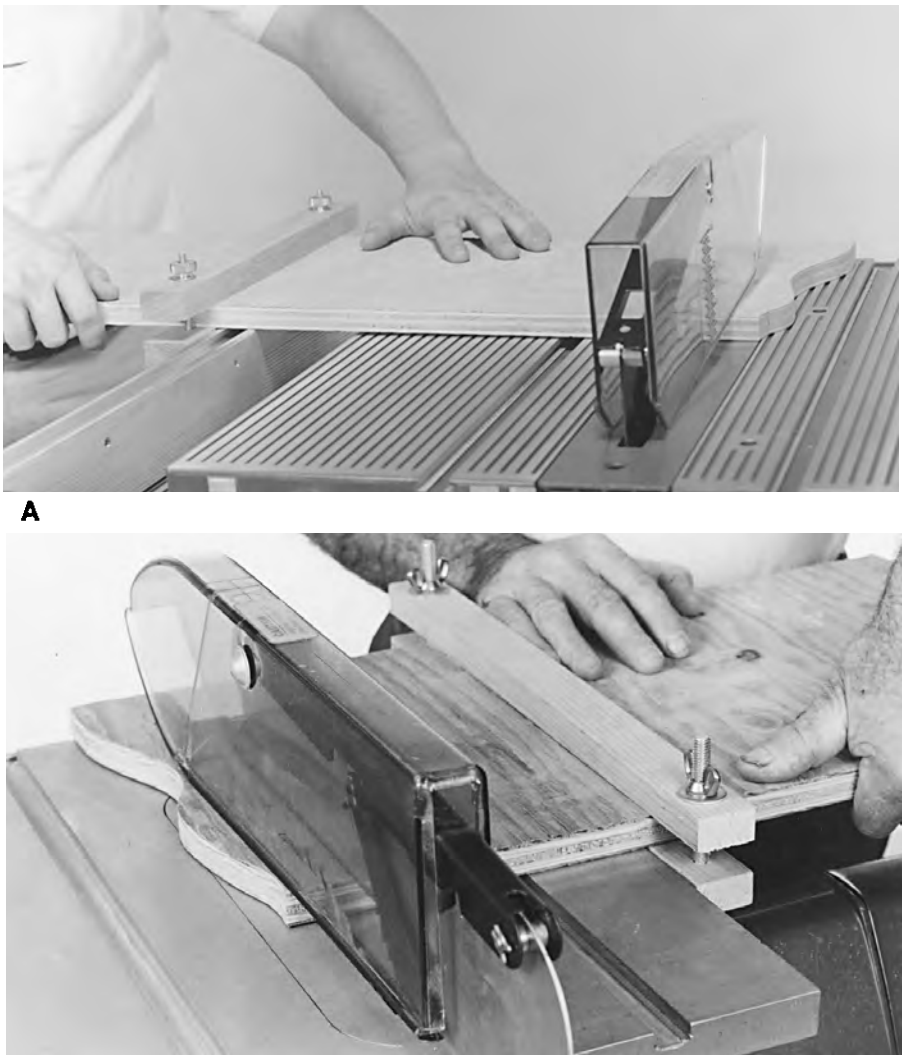


Figure 2-49. *Construction details of a guide used for ripping stock with irregular edges.*



A

B

Figure 2-50. *You can straighten stock with irregular edges by working this way. The guide rides against (A) the rip fence on the Model 510 and (B) against the edge of the table on the Model 500.*

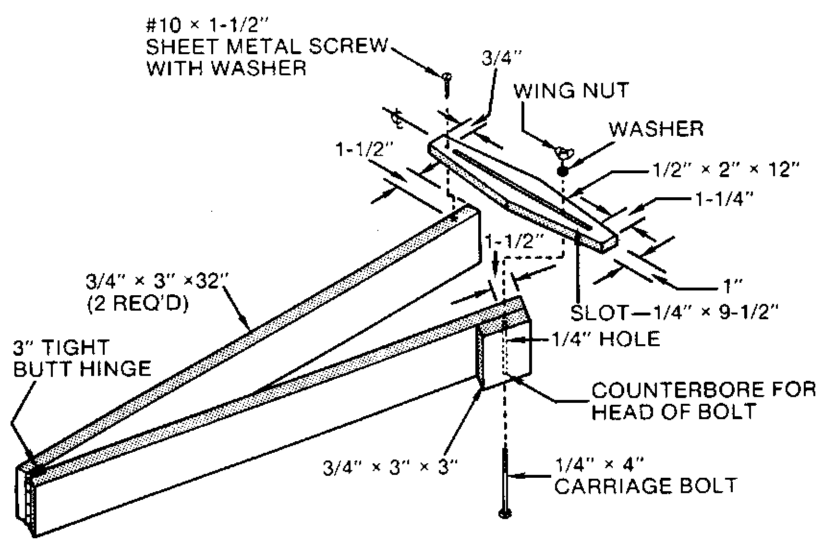


Figure 2-51. *Construction details of a taper guide.*

lower it until the top of the rip fence is flush with the top of the table. The guide will ride against the rip fence (Figure 2-50A). On the Model 500, the guide rides against the edge of the table (Figure 2-50B). Where you place the guide strip will determine how much of the irregular edge of the stock will be removed.

Since the worktable can be moved along the way tubes, some large-sized pieces of stock can be handled in this fashion.

Taper Ripping

Taper rip cuts, needed for many projects, call for a taper guide that has one straight side that can move along the rip fence and an adjustable side that can be locked at an angle to gauge the amount of taper. You can buy a taper guide or make one as shown in Figure 2-51. Surface-mount or mortise the hinge on the ends of the legs. The crosspiece, or brace, that is used to secure settings can be made of metal instead of wood.

After the guide is assembled, mark a line across both legs 12" away from the hinged end. Because of the 12" marks, you can preset the guide for particular tapers by measuring between the legs (Figure 2-52). For example, if you were making a stool with legs that are 12" long, 3" wide at the

Figure 2-52. ***Mark across the legs 12" away from the hinged end; then you can measure between the marks to set the guide for a particular taper per foot.***

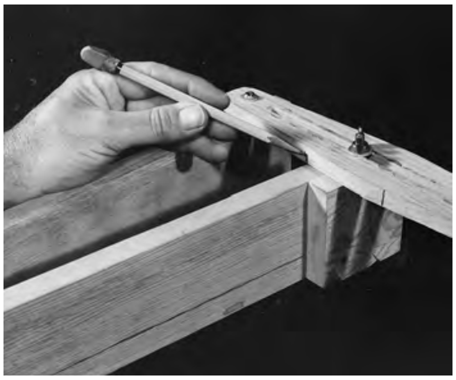


Figure 2-53. You can calibrate the cross brace for particular taper-per-foot settings.

Figure 2-54. This is how the workpiece is placed in the taper guide. Place hands as you would for regular rip cuts. Be sure the guide rides against the fence throughout the pass.

Figure 2-55. When you require the same taper on opposite edges, reposition the workpiece, set the guide for twice the original taper, and make a second pass.

top, and 2″ wide at the bottom, you would need to cut a 1″ per foot taper. By separating the legs 1″ at the 12″ mark, you would have the correct setting for the guide to cut the taper on two adjacent sides only.

To provide a scale for future adjustments, separate the legs to various dimensions across the 12″ marks and use a pencil to mark the settings on the cross brace (Figure 2-53).

When a project component, a table leg, for example, needs to be tapered on four sides, make one pass and then a second pass on an adjacent side of the stock without changing the guide's setting. Adjust the guide to twice the original setting and then make a third and fourth pass consecutively on the next adjacent sides.

Use a taper guide as shown in Figure 2-54. The workpiece is placed flush against the leg of the guide. Both the guide and the workpiece are then moved forward to make the cut. Notice that the worktable is positioned at the right end and lined up with the extension table to increase the workpiece support area. The operation is done just like a routine rip cut. The only difference is that the workpiece is fed forward by moving the guide.

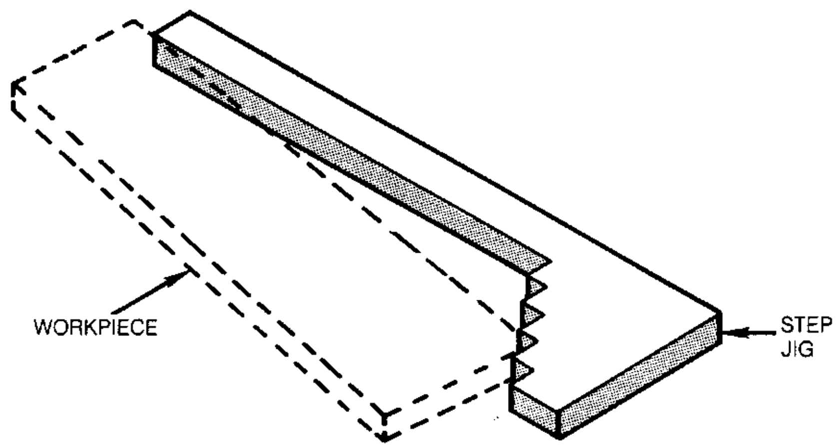


Figure 2-56. A step guide is a good aid if you do production work and will frequently be needing a particular taper.

When the same taper is required on the opposite side of the stock, make the first cut as just described; then adjust the guide to twice its original opening. Position the stock so the edge already tapered is against the guide, and make a second pass (Figure 2-55).

Other Tapering Techniques— The step guide, diagrammed in Figure 2-56, is a good aid for production-type work because it eliminates having to set the variable guide for different tapers. The steps in the guide, which are dimensioned for particular cuts, gauge the amount of taper. Each step will consistently produce the same taper. The work is placed so that one corner is in the correct step and the opposite end butts against the arm of the guide. The straight edge of the guide rides against the rip fence.

Chapter 3
Table Saw: Joinery

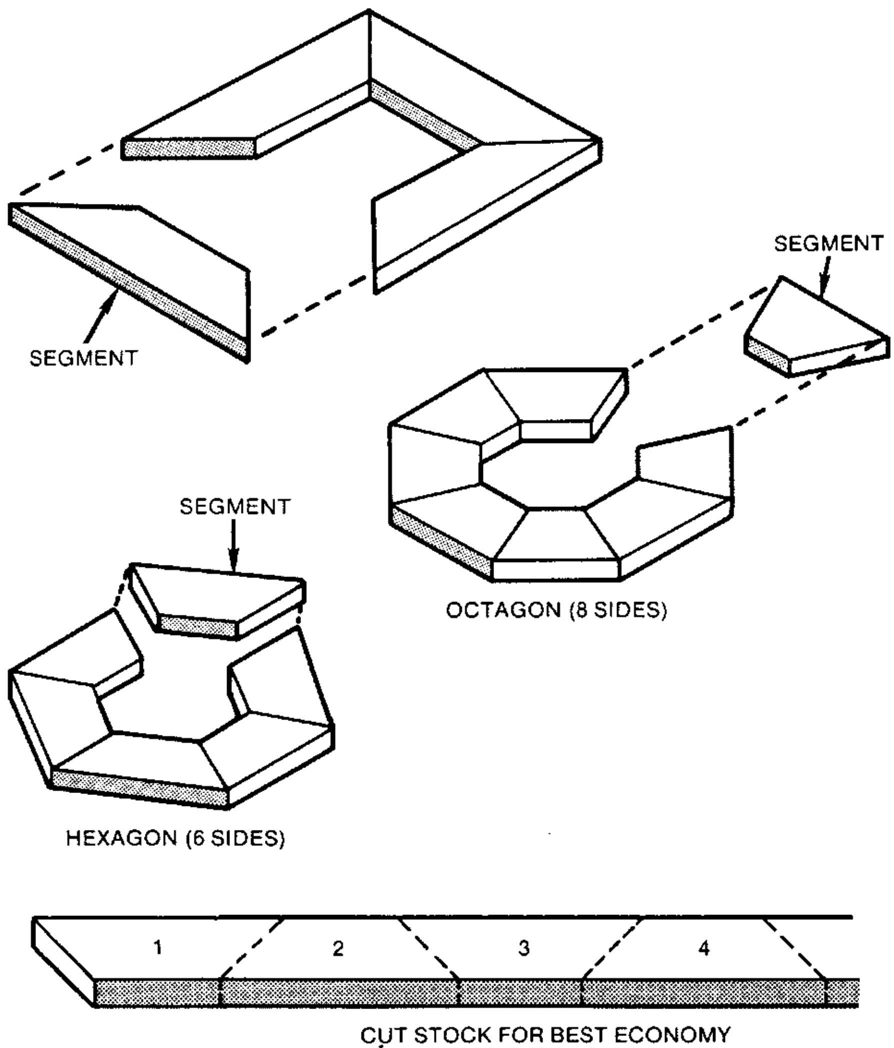


Figure 3-1. *Some examples of how miter cuts can be used to form four-, six- and eight-sided projects.*

Wood joinery is one of the most rewarding parts of any woodworking project. Ranging from simple, attractive miter and bevel joints to the more complicated lock corner and finger joints, this chapter will cover the wood joinery that can be done on the Mark V in the table saw mode.

Warning: Read and understand "Table Saw Safety" in Chapter 2.

MITER CUTS

Both miter and bevel cuts are made with the stock held at an angle (other than 90°) to the saw blade. For instance, anytime you change the miter gauge from its normal 90° position, you will be sawing a miter. Some examples of miter cuts used to form four-, six-, and eight-sided figures are illustrated in Figure 3-1. The cut pieces, joined to make forms, are called segments.

It is important to remember that a miter cut angle is always one-half of the joint angle. The joint angle in a four-sided picture frame is 90°, but the cut angle is 45°. Use the following formula to determine the correct miter gauge setting for a project with any number of segments: Divide 360° by the number of sides and then divide the answer by 2. To apply this formula to an octagon, for example, divide 360° by 8; then divide the answer, 45°, by 2. This will yield 22-1/2°, which would be the correct setting for the miter gauge.

To make any miter cut, set the miter gauge at the desired angle, and secure the lock knob.

Warning: Place the miter gauge in one of the slots so that the face of the gauge is angled toward the blade. If you mount the miter gauge so the face is angled away from the blade, the wood may bind and kickback.

Note: Since most miter cuts are made at 45°, the miter gauge has positive stops to help you quickly adjust the gauge to 45° left or 45° right. However, it's wise to check critical setups with a drafting triangle or combination square.

Mark the workpiece where you want to cut it. (It's best to measure from the inside corners of the miter.) Align the workpiece with the saw blade and clamp it securely with the miter gauge safety grip.

From this point on, the procedure is similar to crosscutting. Make a five-point check. All five locks—power plant, carriage,

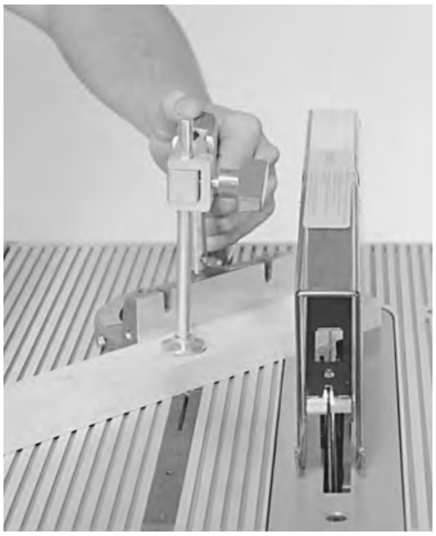


Figure 3-2. To make a miter cut, set the miter gauge at the desired angle, then proceed as if you were crosscutting.

table height, table tilt, and quill—should be secure. Turn the machine on, set the proper speed and let the machine come up to speed. Push the workpiece slowly past the blade (Figure 3-2). When the cut is finished, turn the machine off and let the blade come to a complete stop before removing the workpiece or scraps.

Miter sawing is no more difficult than straight crosscutting but accuracy is most critical. An error of 1° doesn't sound like much, but when it's repeated on even just four parts, it adds up to frustration at assembly time. Make it a habit to test machine settings on scrap stock. Saw the good material only when you are sure the setting is perfect. Guard against drift which is the tendency of the blade's rotation to pull the workpiece—perhaps just enough to spoil a perfect cut. A fence extension that is faced with sandpaper helps keep the workpiece in place (Figure 3-3). Hold the workpiece securely; use the miter gauge safety grip.

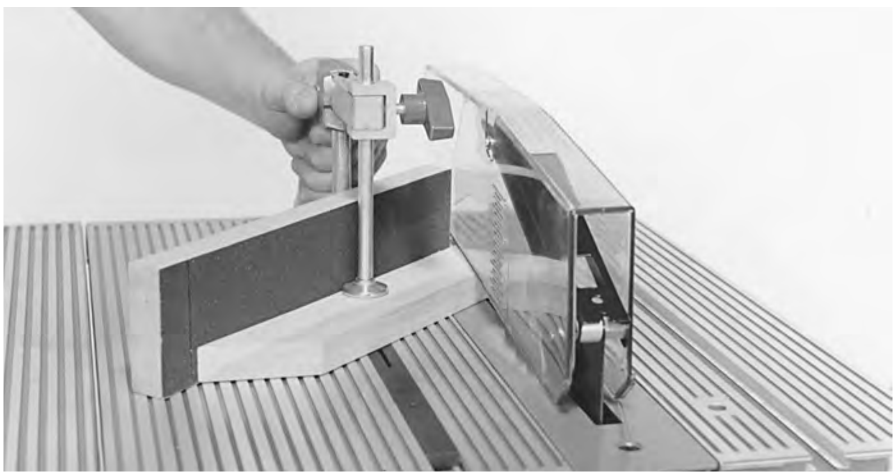


Figure 3-3. A fence extension that is faced with sandpaper provides a high friction surface that helps to keep the workpiece in place as you are sawing.

Here are some things that will cause inaccurate miter joints:

- Improper alignment of the machine.
- Dull saw blade or incorrectly set teeth.
- Stock warped or otherwise imperfect to begin with.
- Stock allowed to drift.
- Pass made too fast.

Mitered segments must be perfectly matched in size and shape if they are to join together in a perfect union. Use this formula to determine the segment length:

Frame width − rabbet width × 2 + picture length = frame length

Example for 8″ long picture:

2″ − 3/8″ = 1-5/8″ × 2 = 3-1/4″ + 8 = 11-1/4″

The miter gauge stop rod can be used as shown in Figure 3-4 to gauge the length of the segments. Square a piece of stock to this length. Set the miter gauge to the angle needed, and miter both ends of the segment. Then use it to set the miter gauge stop rod. ***Warning: Never position the miter gauge stop rod so that it crosses in front of the blade.*** Other segments are cut from one length of stock by mitering it at one end, then holding the mitered end against the stop rod. Be sure that you turn the stock over for each new pass.

A miter gauge extension with an adjustable stop can be used to cut miters on wide stock (Figure 3-5).

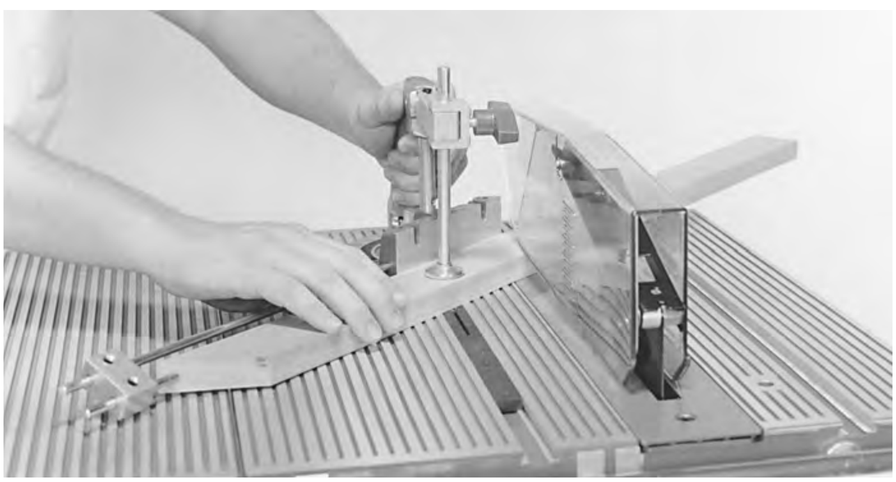
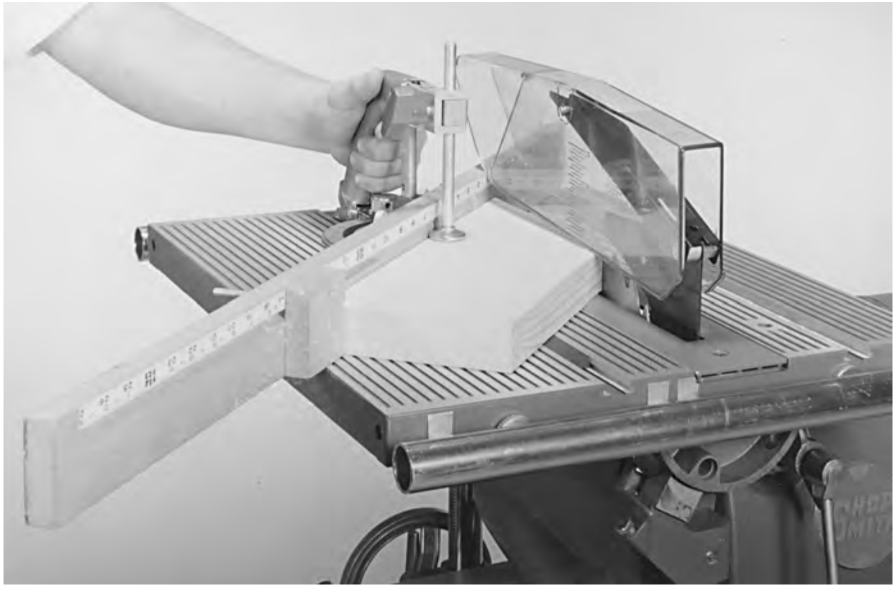


Figure 3-4. The miter gauge stop rod can be used to gauge the length of the segments.

Miter Cuts with a Fixture

Cutting close, tight miters is much easier when you use a sliding table



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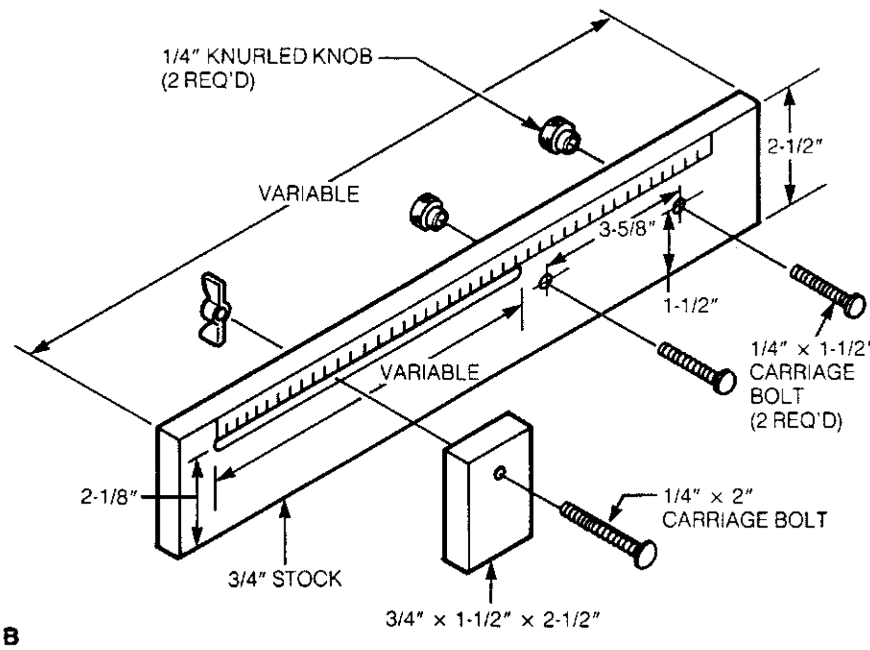


B

Figure 3-5. *(A) A miter gauge extension with an adjustable stop can be used to cut miters on wide stock. (B) Construction details of the miter gauge extension.*

fixture (Figure 3-6). The fixture is easy to make and is well worth your time and effort, because a fixture that is well built and set up accurately will enable you to cut perfect 45° miters every time. The strips that slide in the miter gauge slots are cut to fit from hardwood. Use screws to secure the strips to the base; then cut a 12" long saw kerf into the fixture.

Miter one end of each hardwood fence at 45°. Use glue and screws to secure one of the fences into place at 45° to the saw kerf. Once the glue on this fence has dried, use an accurate square to position the other one; secure it with glue and screws. So that the stock will have less tendency to drift while being cut, attach fine grit sandpaper onto the fixture with rubber cement.

When using this fixture, always cut matching miters. This is done by cutting the first corner of the stock on the right side of the fixture and the second corner on the left side.

Remember that all fixtures, in addition to being carefully made, should be protected so they will maintain accuracy. Carefully sand all parts before assembly. Use glue and screws to join components. After assembly, apply several coats of penetrating sealer with a light sanding between coats and another light sanding when the final coat is dry. Wax and buff those surfaces that make contact with the machine.

BEVEL CUTS

Bevel cuts are made with the worktable positioned at an angle other than 90° to the blade. Slide the carriage and the power plant all the way to the right. This will allow you to move the workpiece freely across the table without interfering with the way tubes. The angle considerations that apply to miters also apply to cross miters and bevels (Figure 3-7). The cut angle is always one-half of the joint angle.

Crosscut Bevels

To make a crosscut bevel, set the worktable at the desired angle and use the miter gauge to guide the workpiece (Figure 3-8). Mount the miter gauge on the downside of the table only. This will provide better support for the workpiece, help eliminate kickbacks, keep the miter gauge from hitting the blade, and keep your hands out of danger.

Rip Bevels

A rip bevel is made with the table tilted, the workpiece usually riding against the rip fence (Figure 3-9). ***Warning: Mount the rip fence on the downside of the table to provide better support for the workpiece, help eliminate kick back, and keep your hands out of danger.*** On the Model 500 there

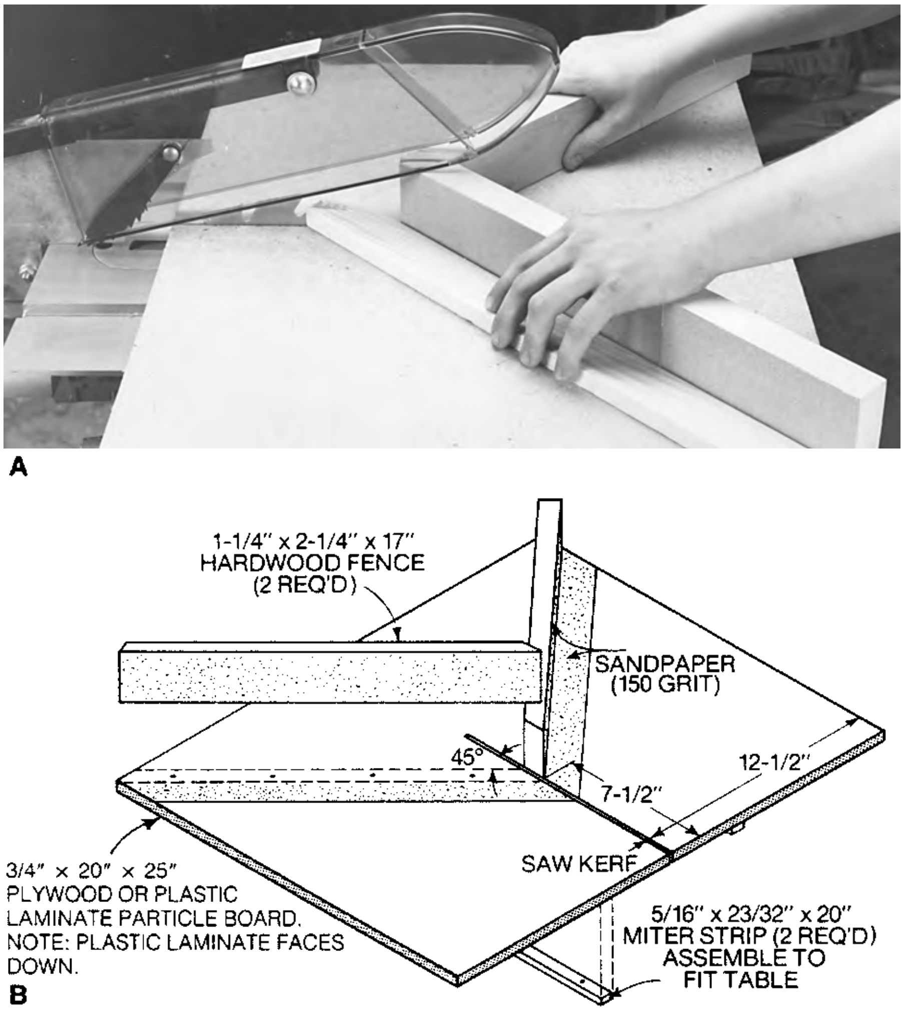


Figure 3-6. *(A) The sliding table fixture can be used to make close, accurate miters with ease. (B) Construction details of the sliding table fixture.*

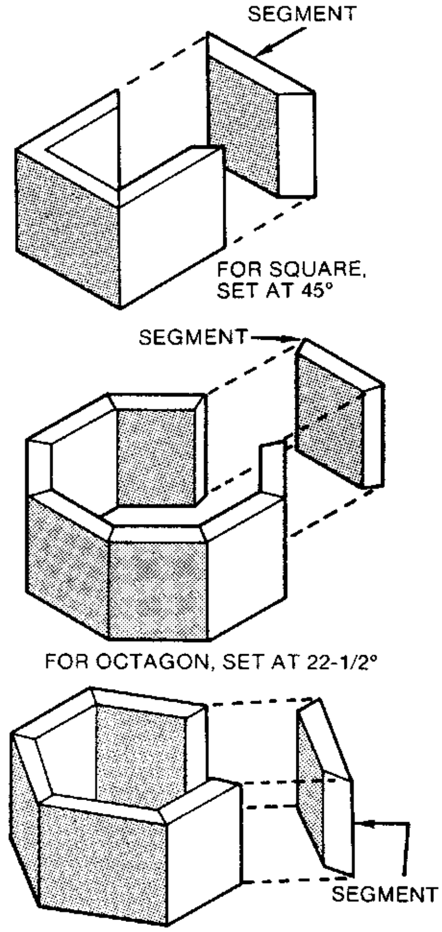


Figure 3-7. *The relationship between the joint angle and cut angle that was explained for simple miters also applies to cross miters and bevels.*

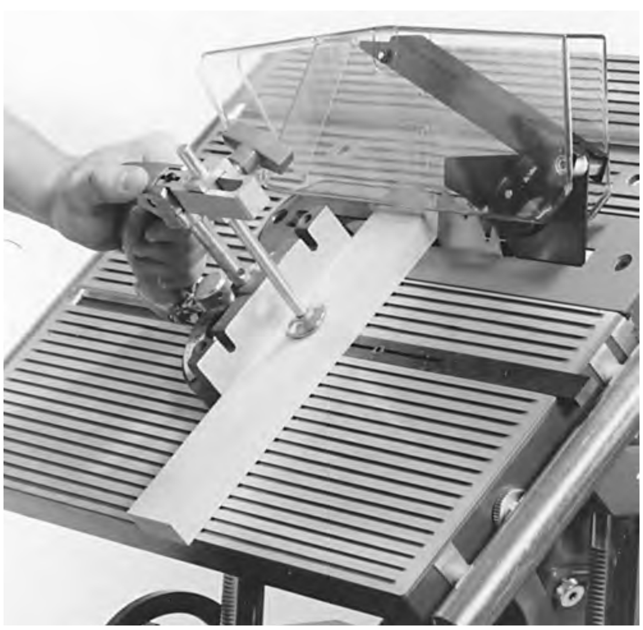


Figure 3-8. *Crosscut bevels are cut with the miter gauge at 90° and with the table tilted.*

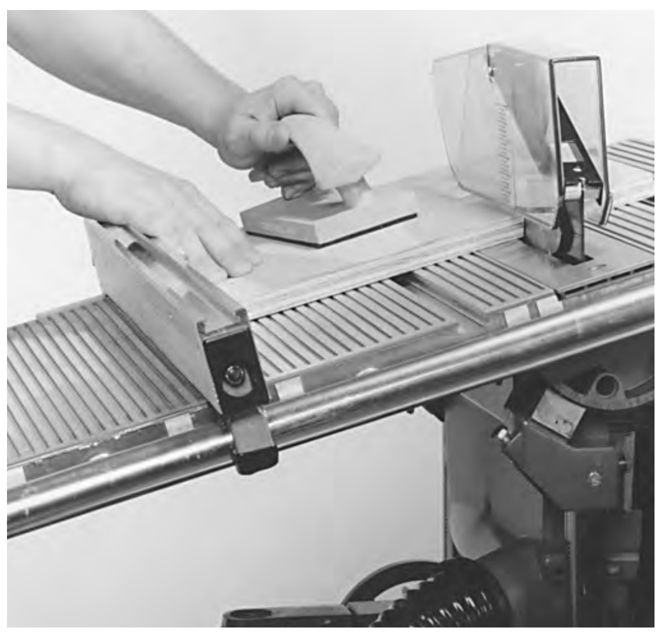


Figure 3-9. *Rip bevels are made with the table tilted and the workpiece usually riding against the rip fence.*

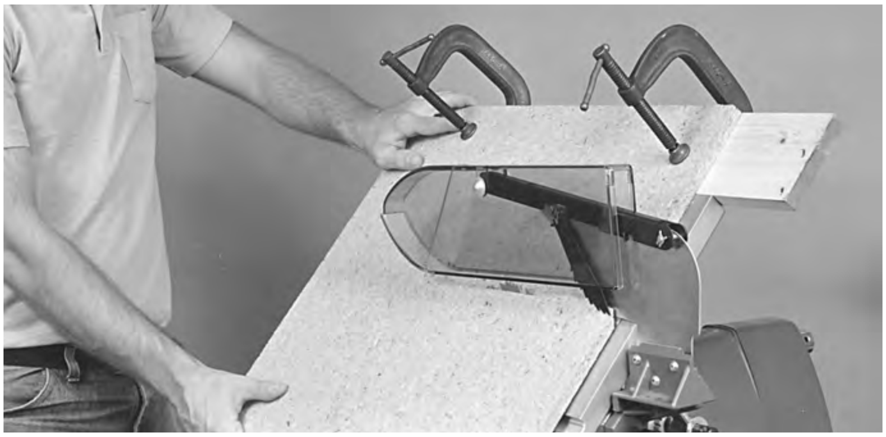


Figure 3-10. *To rip a bevel in a wide board, clamp a long, straight board to the underside of the workpiece. Hook this board over the upper edge of the table and use it as a guide.*

Figure 3-11. *When ripping a bevel in wide stock, use the rip fence and the extension table system (Model 510) to support the stock.*

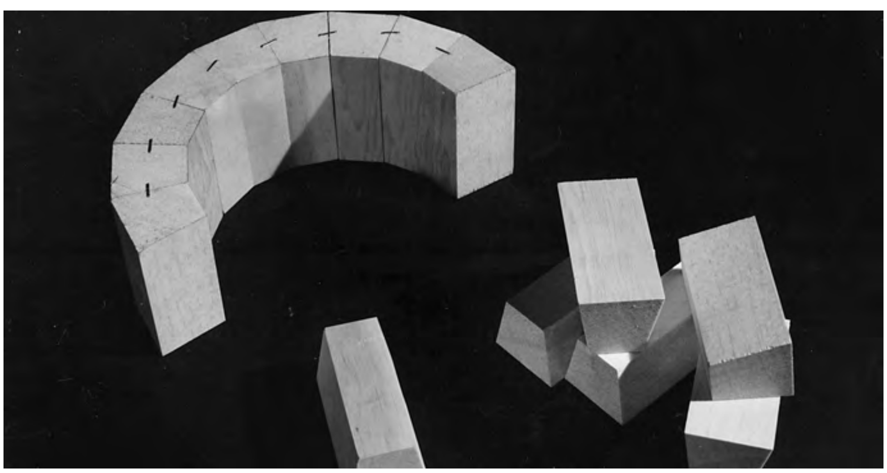


Figure 3-12. *Small segments can be assembled this way, using glue and a stapling gun. A band clamp or rubber bands can be used to hold the pieces until the glue dries.*

will be times when the width of a workpiece will prevent you from using the rip fence. If this is the case, clamp a long, straight board to the underside of the workpiece and rest this board over the upper edge of the table (Figure 3-10). If properly positioned, the board will guide the workpiece as accurately as a rip fence. If you have a Model 510, use the rip fence and the extension table system to support wide stock (Figure 3-11).

Small, cross beveled or rip beveled segments are easy to assemble if you work as shown in Figure 3-12. Coat mating surfaces with glue and hold them tightly together as you drive staples to serve as "clamps." Use a band clamp or rubber bands after the assembly is complete to hold the pieces together until the glue is dry.

A convenient way to cut beveled segments is shown in Figure 3-13. First cut the segments to the length and width you need. Set the table to the correct tilt and the fence to control the width of cut. Cut the bevel on one edge of the stock and then, without changing the setting, turn the stock end-for-end and bevel the second edge.

Figure 3-13. *Segments can be precut with straight sides and then beveled like this. Cut one side, turn stock end-for-end, and cut second side. The fence position is not changed.*

V-Cuts

V-shapes are formed by opposing bevel cuts that do not go through the stock and which meet to form an angle. Work as shown in Figure 3-14 when the "V" must be down the center of the stock. Set the saw blade's projection to the depth of the "V" needed. Set the rip fence so the center of the workpiece will match the topmost point of the saw blade. Make one pass and, after turning the stock end-for-end, make a second pass. ***Warning: Be sure to stand to one side when you make the second pass because the V-shaped waste piece might be kicked back toward the front of the table by the action of the saw blade.***

V-cuts that are not centered are done almost the same way. The difference is that the rip fence must be relocated to position the workpiece for the second pass.

COMPOUND ANGLES

While a miter cut requires a miter gauge setting and a bevel calls for a table tilt, a compound angle cut is done with a combination of both settings.

Any frame or open structure that has sloping sides requires a compound miter (Figure 3-15). Typical examples of projects that have compound-angle miter joints include: a peaked figure with any number of sides such as you might require for a fencepost top or the roof of a birdhouse or dollhouse, a plant container with sloping sides, and a picture frame with sides that slope toward or away from the wall.

Of all table saw operations, compound angle cuts are probably the hardest to do, not because of how they relate to sawing, but because the accuracy of the cut is so critical. Work slowly; be sure of each setting before you cut into good stock. Here is a good procedure to follow: Adjust the miter gauge to the angle you need and make a test cut with the table set at "0". Check to see if the cut is correct. Tilt the table to the angle required and make a test bevel cut. Check to see if that cut is correct.

Compound cutting sometimes requires alternating the miter gauge in the table slots, which means the miter gauge setting must be changed each time. Check each setting carefully before making the pass. Some woodworkers have an extra miter gauge on hand for just such times.

Take a stance that keeps you out of the line of cut and make a test pass without the workpiece and with the power off, so you can preview the best way to handle the operation.

Here is a typical procedure, based on a four-sided frame and using the popular 60° work angle, which may be followed when doing compound angle work. *Note:* The work angle is the angle measured between your line of sight and the flat face of the frame. First decide the overall size of the frame and from this determine the lengths of the four pieces required. Cut and square these pieces to exact length as if it were a simple frame.

By referring to Table 3-1, you will discover that the 60° work angle requires a table tilt of 20-3/4° and a miter gauge setting of 49°. Set the miter gauge and the table exactly at these settings. If you are off even a fraction of a degree, you won't get a good joint. To gauge the amount of cutoff, you can clamp a stop block to the table or

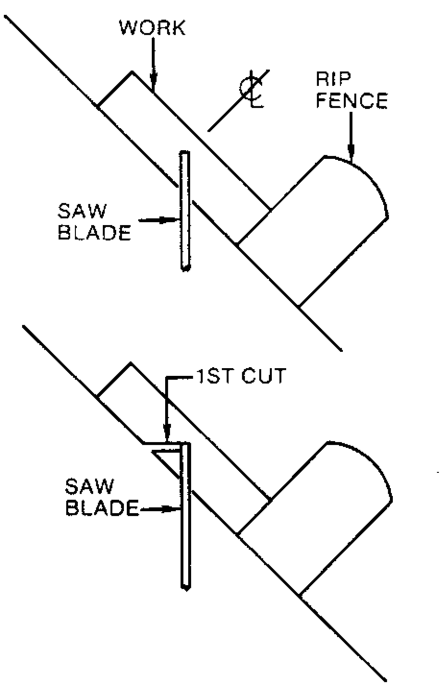


Figure 3-14. *V-cuts are done in this manner. The cuts must meet at the bottom of the "V." The waste stock may be kicked back, so stand on either side of the blade.*

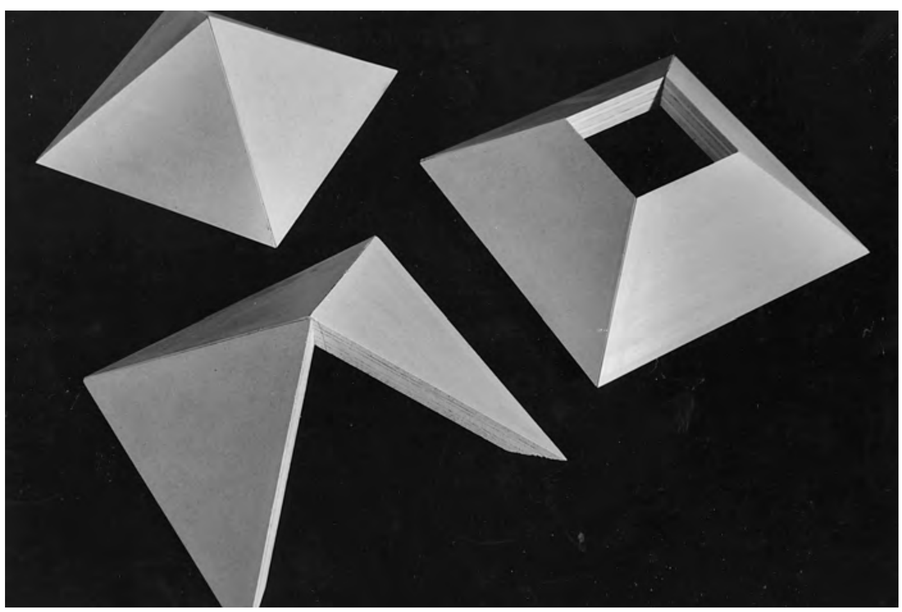
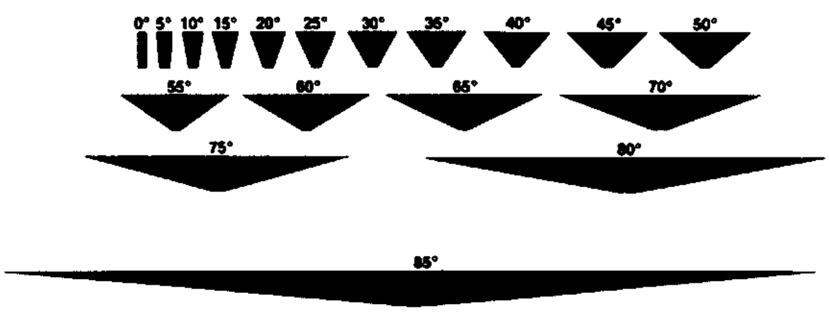


Figure 3-15. *Examples of assemblies done with compound miter joints.*

Table 3-1: Miter Gauge and Table Tilt Settings for Compound Angles

Work Angle	3 Sides		4 Sides		5 Sides		6 Sides		7 Sides		8 Sides	
	Miter Gauge	Table Tilt	Miter Gauge	Table Tilt	Miter Gauge	Table Tilt	Miter Gauge	Table Tilt	Miter Gauge	Table Tilt	Miter Gauge	Table Tilt
0°	90	60	90	45	90	36	90	30	90	25-3/4	90	22-1/2
5°	81-1/2	59-1/2	85	44-3/4	86-1/2	35-3/4	87-1/4	29-3/4	87-1/2	25-1/2	88	22-1/2
10°	73-1/4	58-1/2	80-1/4	44-1/4	82-3/4	35-1/4	84-1/4	29-1/2	85-1/4	25-1/4	86	22-1/4
15°	65-3/4	56-3/4	75-1/2	43-1/4	79-1/4	34-1/2	81-1/2	29	83	24-3/4	84	21-3/4
20°	59-1/4	54-1/2	71-1/4	41-3/4	76-3/4	33-1/2	78-3/4	28	80-3/4	24	82	21
25°	53-3/4	51-3/4	67	39-3/4	73	32-1/4	76-1/4	27	78-1/2	23-1/4	80	20-1/4
30°	49	48-1/2	63-1/2	37-3/4	70	30-1/2	74	25-3/4	76-1/2	22	78-1/4	19-1/4
35°	45-1/4	45-1/4	60-1/4	35-1/2	67-1/2	28-3/4	71-3/4	24-1/4	74-1/2	20-3/4	76-3/4	18-1/4
40°	42	41-1/2	57-1/4	23-3/4	65	26-3/4	69-3/4	22-1/2	72-3/4	19-1/2	75	17
45°	39-1/4	37-3/4	54-3/4	30	62-3/4	24-1/2	67-3/4	20-3/4	71-1/4	17-3/4	73-3/4	15-3/4
50°	37	33-3/4	52-1/2	27	61	22-1/4	66-1/4	18-3/4	69-3/4	16-3/4	72-1/2	14-1/4
55°	35-1/4	29-3/4	50-3/4	24	59-1/4	19-3/4	64-3/4	16-3/4	68-1/2	14-1/2	71-1/4	12-3/4
60°	33-3/4	25-3/4	49	20-3/4	57-3/4	17	63-1/2	14-1/2	67-1/2	12-1/2	70-1/2	11
65°	32-1/2	21-1/2	47-3/4	17-1/2	56-3/4	14-1/2	62-1/2	12-1/4	66-1/2	10-1/2	69-1/2	9-1/4
70°	31-1/2	17-1/4	46-3/4	14	55-3/4	11-1/2	61-1/2	19-3/4	65-3/4	8-1/2	68-3/4	7-1/2
75°	30-3/4	13	46	10-1/2	55	8-3/4	60-3/4	7-1/2	65	6-1/2	68-1/4	5-3/4
80°	30-1/2	8-3/4	45-1/2	7	54-1/2	5-3/4	60-1/2	5	64-3/4	7-1/4	68	3-3/4
85°	30-1/4	4-1/4	45-1/4	3-1/2	55-1/4	3	60-1/4	2-1/2	64-1/2	2-1/4	67-3/4	2
90°	60	90	45	90	36	90	30	90	25-3/4	90	22-1/2	90



use a miter gauge stop rod so the work can be positioned correctly before making contact with the blade. Hold the workpiece very firmly by using the miter gauge safety grip and make the pass very slowly (Figure 3-16). The four parts should fit together snugly, while forming a perfect right angle at each corner.

This method does involve wasting some wood, but attempting to cut each part of the frame consecutively from one long board or calculating the exact length is extremely difficult. Cutting the four pieces to exact length beforehand, as suggested, pays off in accuracy and convenience.

Work with the taper guide when you need to cut a compound angle on a wide piece of stock (Figure 3-17). In effect, the taper guide is a substitute for the miter gauge. The difference between this operation and normal taper cuts is that, here, you work with the table at a tilt angle.

Figure 3-16. *Hold the work firmly throughout the pass; cut slowly.*

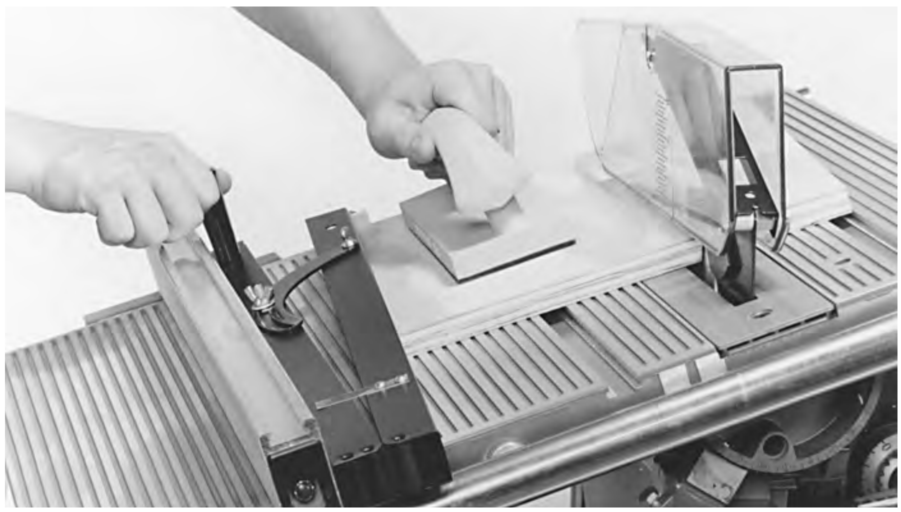


Figure 3-17. *Compound bevel cuts are done with the taper guide at one setting and the table tilt at another.*

DADO ACCESSORY JOINERY

In joinery and some other special applications, it is often necessary to make a cut considerably wider than the saw kerf. For this type of work, a dado accessory is usually used.

A dado accessory (Figure 3-18) consists of two outside blades, four 1/8″ and one 1/16″ chippers that are used between the blades. Width of cut, which can range from 1/8″ to 13/16″, is controlled by the number of components that you mount. A single outside blade will cut a 1/8″ kerf; if you mount the two blades, the cut will increase to 1/4″. You must add chippers to go beyond 1/4″. For example, for a 1/2″ cut, use both outside blades and two 1/8″ chippers. To increase the kerf to 9/16″ wide, add the 1/16″ chipper. Since there can be some minute variation in nominal wood and even plywood thicknesses, paper washers are supplied for mounting on the arbor between the components; thus you can make slight adjustments in width of cut.

The dado accessory is mounted on a 5/8″ molder/dado arbor which locks on the Mark V's main spindle (Figure 3-19). ***Warning: Be sure the tongue washer is used under the hex nut and the threaded shaft of the arbor is flush or extends past the end of the hex nut. Never use chippers alone or mount chippers with only one outside blade, because a kickback hazard is created.*** Arrange chippers so they are evenly dis-

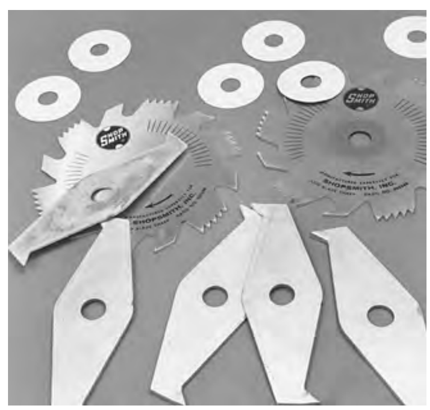


Figure 3-18. *The dado accessory consists of two outside blades and an assortment of chippers. The paper washers are for slight adjustments to compensate for variations in material thicknesses.*

Figure 3-19. *The dado accessory mounts on the 5/8" molder/dado arbor which is then locked to the Mark V's main spindle.*

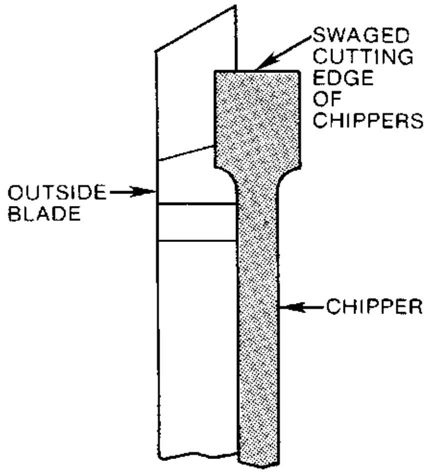


Figure 3-20. *Chippers are always used between outside blades. Situate the chippers so the swaged cutting edges are in the gullets of the outside blades.*

Figure 3-21. *Use the special dado table insert with the dado accessory. The Model 500 insert is shown.*

tributed and so their swaged cutting edges align in the gullets of the outside blades (Figure 3-20).

Because the dado accessory makes extra-wide cuts, you must use a special table insert that accommodates it (Figure 3-21). ***Warning: Be sure that the dado accessory has clearance in the slot. Rotate it by hand, using the auxiliary spindle, before turning on the power.***

The projection of the dado accessory is always less than the thickness of the stock. You can set projection by using a measuring scale or a step gauge (Figure 3-22).

You work with a dado accessory in much the same way as you do a saw blade, but since the tool will be removing much more material, the pass should be made very slowly to give the blades a chance to work without clogging. Form extra-deep cuts by making more than one pass. For example, if you need a cut that is 1-1/4" deep, make one pass with the cutter's projection at about 5/8". Make a second pass after adjusting the saw table for the full 1-1/4" deep cut. This procedure is especially applicable if you are working with a hardwood like oak or maple. ***Warning: The dado accessory is used without the upper saw guard in place. Whenever you remove the upper guard, keep the lower guard in place and make sure the lock knob is secured. Use a push stick, push blocks and safety devices. Work with extreme caution.***

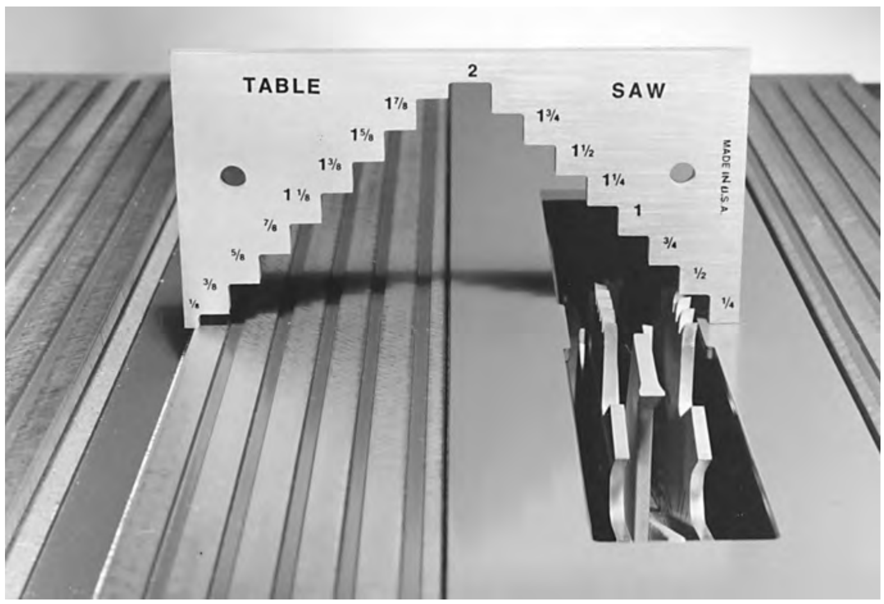


Figure 3-22. *The projection of the dado accessory can be set by using a step gauge.*

Guard Spacer (Mark V with Metal Lower Saw Guard Only)— Because the dado accessory can be used for extra-wide cuts, you must place a spacer (offered free through Customer Service) between the two halves of the lower saw guard. If you want to make a spacer, remove the cover from the guard and trace its contour on a piece of 1-1/4" stock that measures 3-1/2" wide by 10" long. Mark the location of the bolt holes and then draw another line parallel to the first one but about 1/4" smaller. Cut the stock on a bandsaw or scroll saw, and drill 9/32" holes for the attachment bolts. When you are finished, the spacer should look like the one shown in Figure 3-23. Secure the spacer between the two halves of the lower saw guard with 1/4"-20 × 1-3/4" bolts.

Figure 3-23. Because the dado accessory is designed for wide cuts, the metal lower saw guard must be modified by using a spacer between the main part of the guard and its cover.

Dadoes

A dado is a U-shaped square cornered cut in the surface of a board that is made across the grain. Use the miter gauge and the safety grip as you would for any crosscutting operation. When you need the same dado on more than one piece of stock, you can work with the miter gauge stop rod (Figure 3-24) or the miter gauge extension with the sliding stop (Figure 2-28) to position the workpiece so the cuts will be the same on all pieces. ***Warning: Never position the miter gauge stop rod so that it crosses in front of the blade.***

Extra-Wide Dadoes—When you need a dado that is wider than can be accomplished with the dado accessory at maximum width, proceed as follows: Place a spacer on the rip fence near the front of the table and lock the fence so the distance from the spacer to the dado will be the edge distance of the cut you need. Butt the end of the work against the spacer and make the first cut (Figure 3-25).

Next, move the rip fence so the distance from the spacer and the outside surface of the dado accessory will be the width of the cut you need. Make a second cut (Figure 3-26). Then just keep making overlapping passes until the waste stock between the first two cuts has been cleared away (Figure 3-27).

Matching Dado Sets—These dadoes, might be required, for example, when building a bookcase with shelves that are supported on both sides by a midpoint partition.

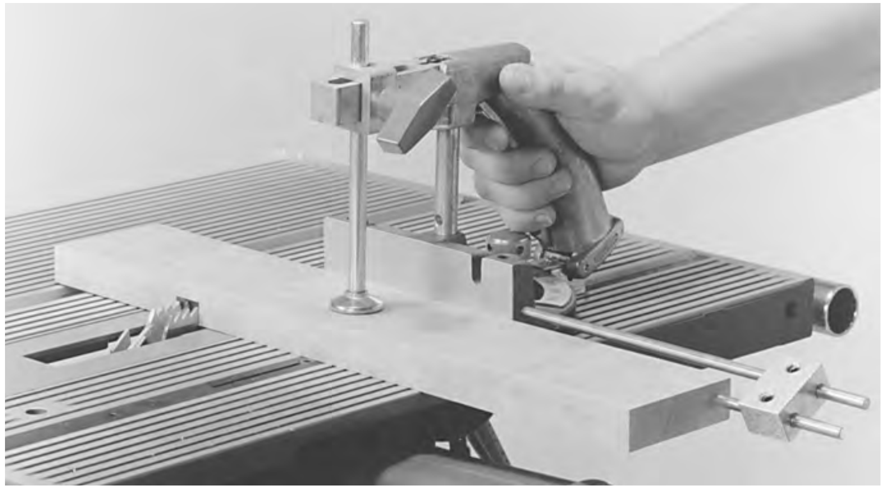


Figure 3-24. *A dado is a U-shaped cut made across the grain. Use the miter gauge stop rod when you need the same cut on more than one piece.*

Figure 3-25. *This is the first cut you make when you need an extra-wide dado. When more than one piece is involved, make this same cut on all pieces before changing the setting.*

Figure 3-26. *The second cut for an extra-wide dado is shown here. The fence position has been changed so the spacer can gauge the work's position for the total cut width.*

Figure 3-27. The final step is to clean out the waste by making repeat passes.

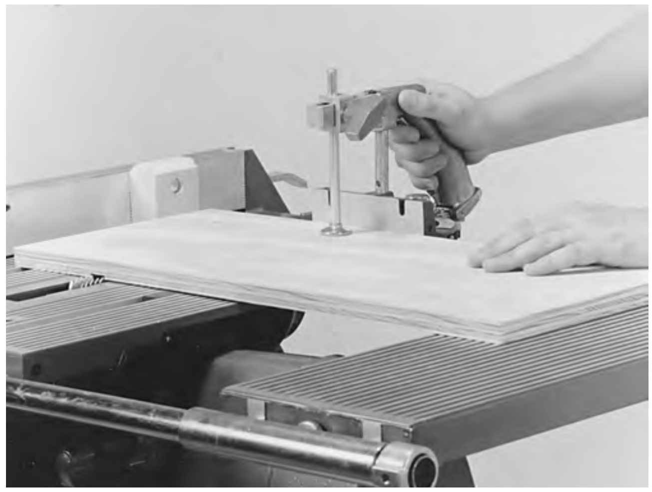


Figure 3-28. This is the first cut for a matching dado cut. Use the extension table for more support if needed.

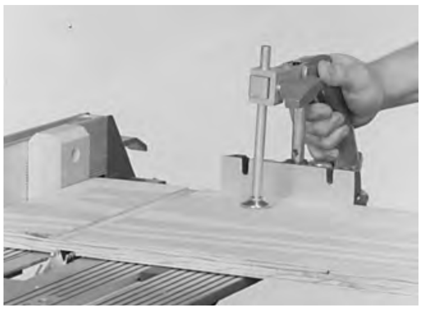


Figure 3-29. Make a second pass the same way after you have flipped the work. The two cuts will line up perfectly.

Place a spacer on the rip fence near the front of the table and lock the fence so the distance from the spacer to the dado will be the edge distance of the cut you need. Make the first cut (Figure 3-28). Be sure to keep the workpiece level. After the first cut, the work is flipped over and a second pass is made (Figure 3-29). You know that the two dadoes will be perfectly aligned. The cuts must be shallow enough to leave at least 1/3 the stock thickness uncut.

Grooves

Grooves are U-shaped cuts that are made with the grain of the wood. They are made much like rip cuts, with the fence positioned to gauge the distance between the cut and the edge of the stock. Figure 3-30 shows a groove being cut

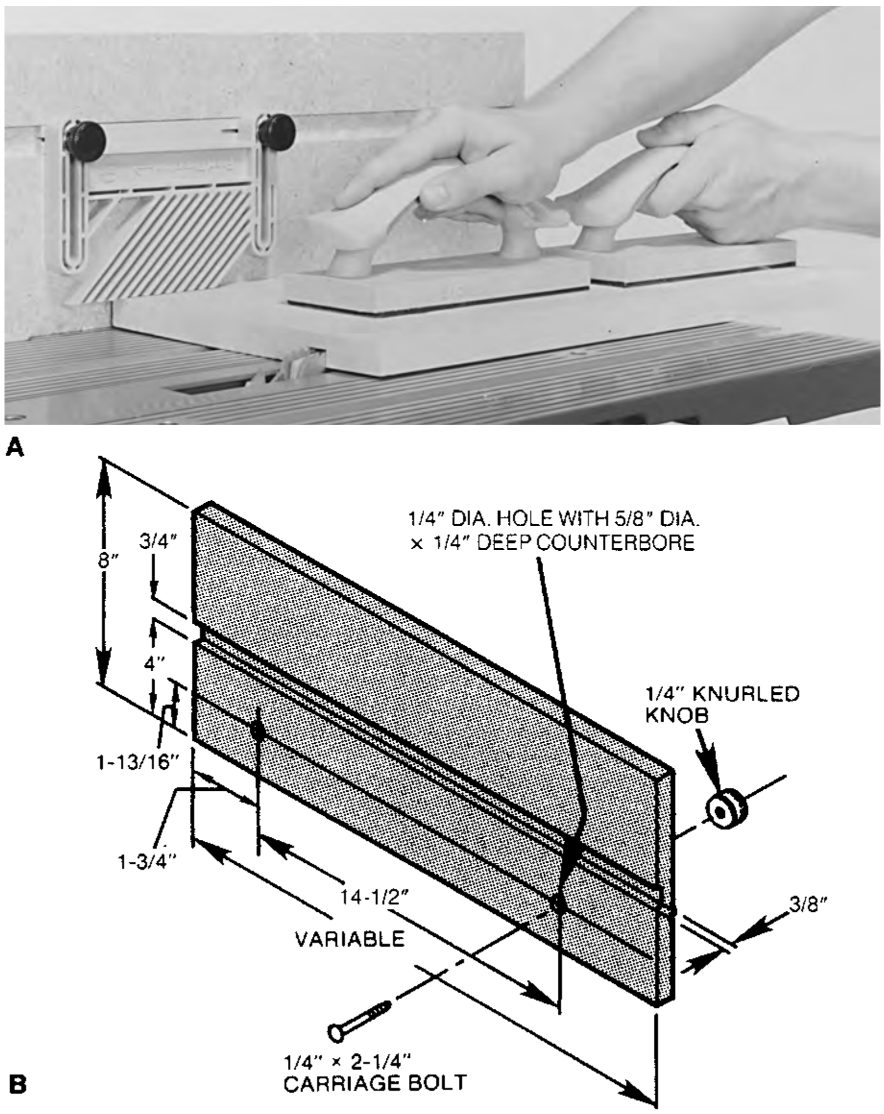


Figure 3-30. (A) Grooves are formed by using a rip fence extension to guide the workpiece, just as if you were doing a ripping operation. (B) Construction details of a rip fence extension.

Figure 3-31. A feather board keeps the workpiece against the fence so a groove can be cut in the edge.

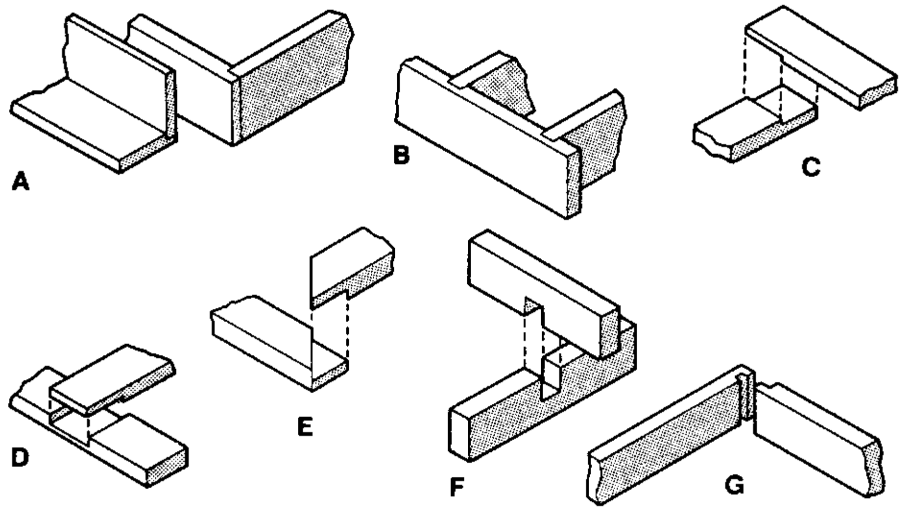


Figure 3-32. Some of the joints you can form by working with a dado accessory: (A) rabbet, (B) dado, (C) end lap, (D) middle lap, (E) lapped miter, (F) notched, and (G) combination dado and rabbet (good for box corners).

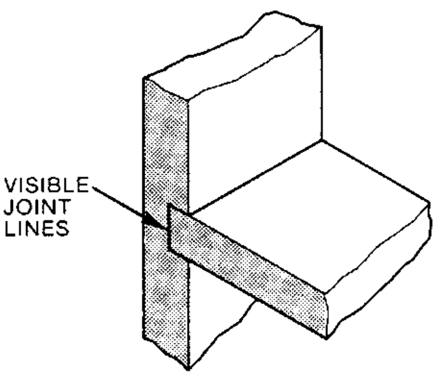


Figure 3-33. A disadvantage of the dado joint is that its joint line is visible.

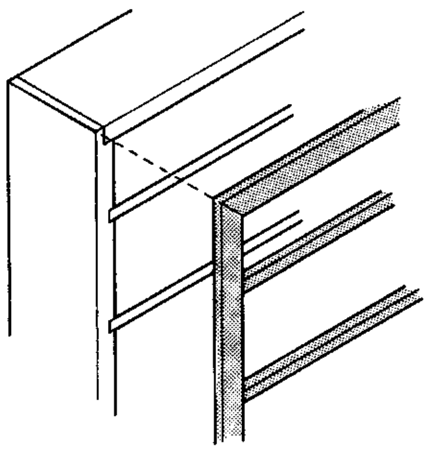


Figure 3-34. The joint lines are hidden if the project calls for facing strips or a front frame.

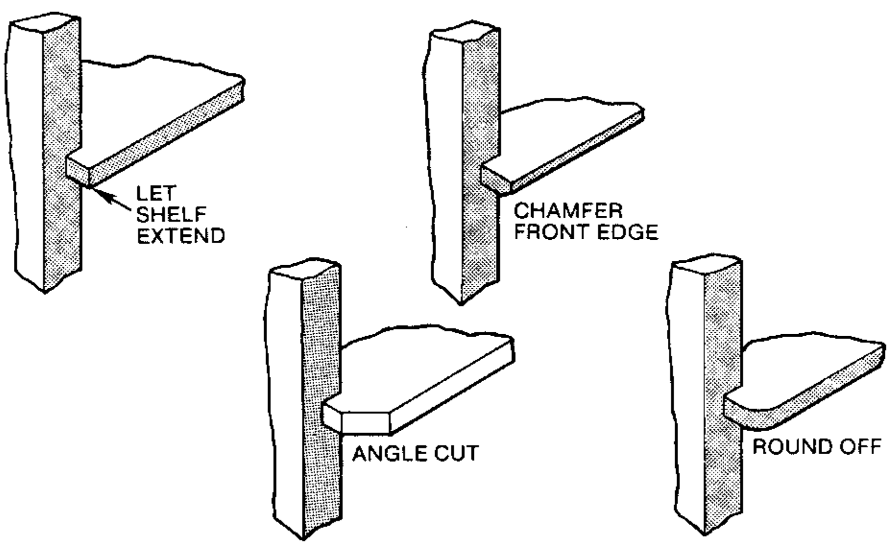


Figure 3-35. The joint lines will not be so noticeable if you design shelves like this.

in the surface of a workpiece. A feather board mounted on a rip fence extension helps to keep the workpiece down against the table.

To cut grooves in the edge of a workpiece, position a feather board in front of the dado accessory. Use a push block to move the stock (Figure 3-31).

Other Dado Accessory Joinery

All of the joints that are shown in Figure 3-32 can be cut by using a dado accessory. A problem with the simple dado joint is that it leaves a visible joint that is not attractive (Figure 3-33). The lines are hidden when the project is designed with facing strips or a front frame (Figure 3-34). To create a more acceptable appearance when the joint can't be hidden, you can install shelves that are wider than the sides of the case. As shown in Figure 3-35, the front edges of the shelves can be treated in various ways to contribute to visual appeal.

A very professional way to conceal dado joint lines is to work with stopped dadoes. This simply means that the dado cut is not continued completely across the stock. To control the length of the cut, you work with a stop block

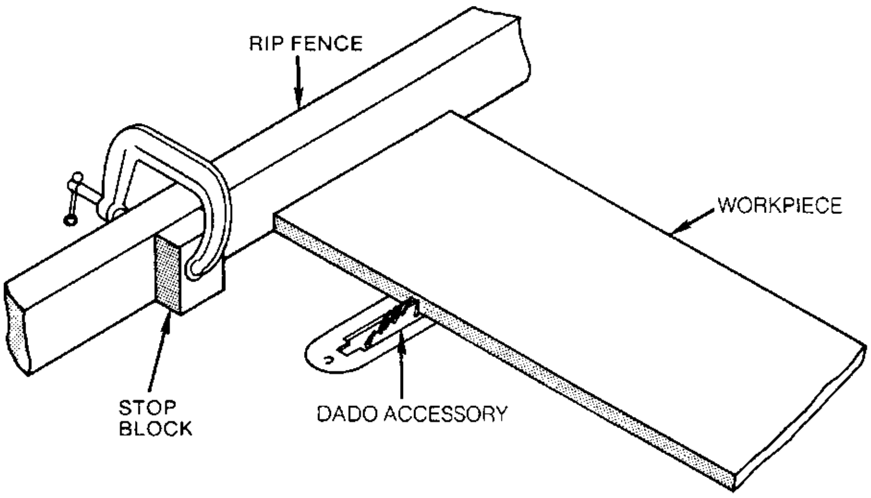


Figure 3-36. A stopped dado results when you do not cut entirely across the stock. A stop block can be used to control the length of cut.

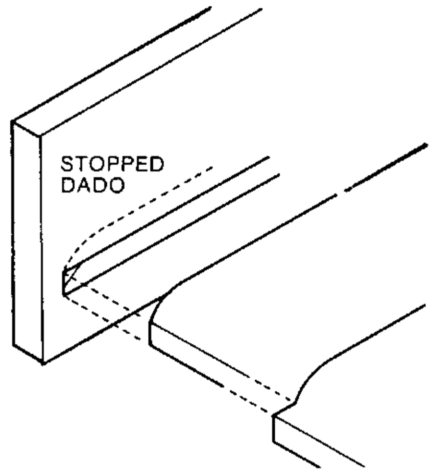


Figure 3-37. Shelves can be shaped this way to conform to the arc that is part of a stopped dado.

secured to the rip fence (Figure 3-36). This, of course, leaves an arc where the cut stops. The shelf, or whatever insert, can be shaped in one of the ways shown in Figure 3-37 to accommodate the arc. Another method is to use a small chisel to cut away the arc material so shelves can be inserted as shown in Figure 3-38.

Rabbet Cuts—A rabbet is an L-shaped cut made on the end of stock or along the edge. The width of the cut may be gauged with the miter gauge stop rod or by using a spacer on the rip fence. ***Warning: Never position the miter gauge stop rod so it crosses in front of the dado accessory.***

When rabbet cuts are needed along the length of stock (this may be called for when the back of a bookcase or other project is recessed into the frame), the rabbet is cut with the stock sliding against the rip fence.

The size of the rabbet is determined by the piece that will be joined to it. For example, if you were recessing a 1/4" panel into the back of a bookcase frame made of 3/4" stock, the rabbet would have to be 1/4" deep (to accommodate the panel) by about 3/8" wide (to provide fastening area without loss of strength to the side).

While rabbets can be cut with a conventional saw blade as described later in this chapter, they are more easily formed with a dado accessory. To obtain the most accurate results, make a fence facing like the one shown in Figure 3-39. To form the relief arc that is needed in the facing, continue in this manner: Raise the table above the dado accessory and bolt the facing to the rip fence. Lock the fence so the dado accessory will cut about three-quarters of the facing's thickness; then very slowly lower the table until the arc's height is about 3/8" deep.

To form an edge rabbet, lock the rip fence so the distance from the fence facing to the outside of the dado accessory equals the width of the rabbet. Adjust the blade projection for the depth of the rabbet. Hold the workpiece snugly against the facing and make the pass as shown in Figure 3-40.

End rabbets may be cut in similar fashion but a spacer is mounted on the rip fence and the miter gauge with safety grip advances the work (Figure 3-41). The rip fence is locked so the distance from the spacer to the outside of the dado accessory equals the width of the rabbet; the blade's projection is set for the rabbet's depth.

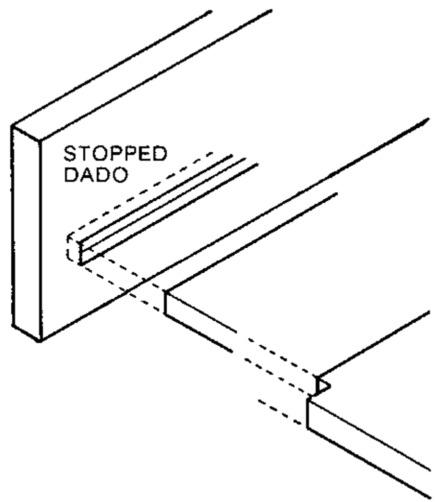
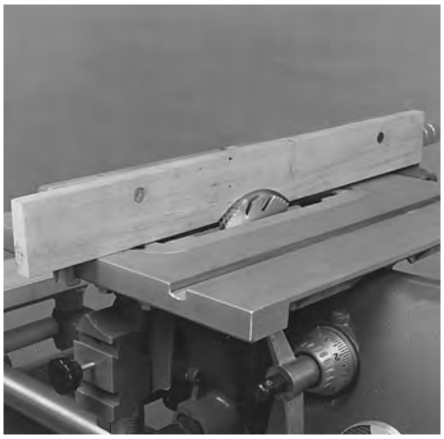


Figure 3-38. The arc area of the stopped dado can be cleared out with a chisel; the shelves can then be fitted this way.

Tongue-and-Groove Work—To perform tongue-and-groove work, assemble the dado accessory so you'll get the groove width you need. Set the projection for the depth of the groove; then make the pass as shown in Figure 3-42. Be sure that the stock has ample bearing surface against the insert. To ensure that the groove will be exactly centered, assemble the dado accessory parts to make the cut narrower than you need. Make one pass and then turn the stock end-for-end and make a second pass.



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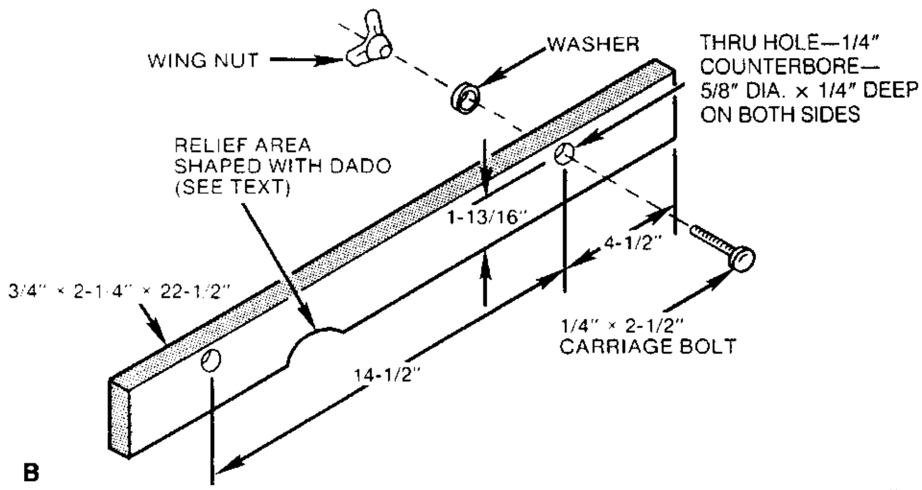


B

Figure 3-39. *(A) A fence facing, which you make, is a necessary accessory for many dadoing operations. (B) Construction details of the fence facing.*

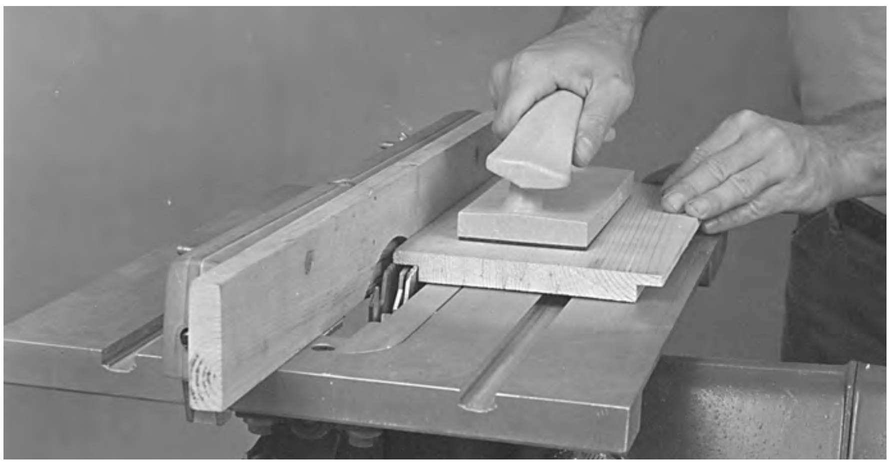


Figure 3-40. *Use a fence facing when cutting edge rabbets. It's much better to work this way than to move the workpiece between the fence and the dado accessory.*

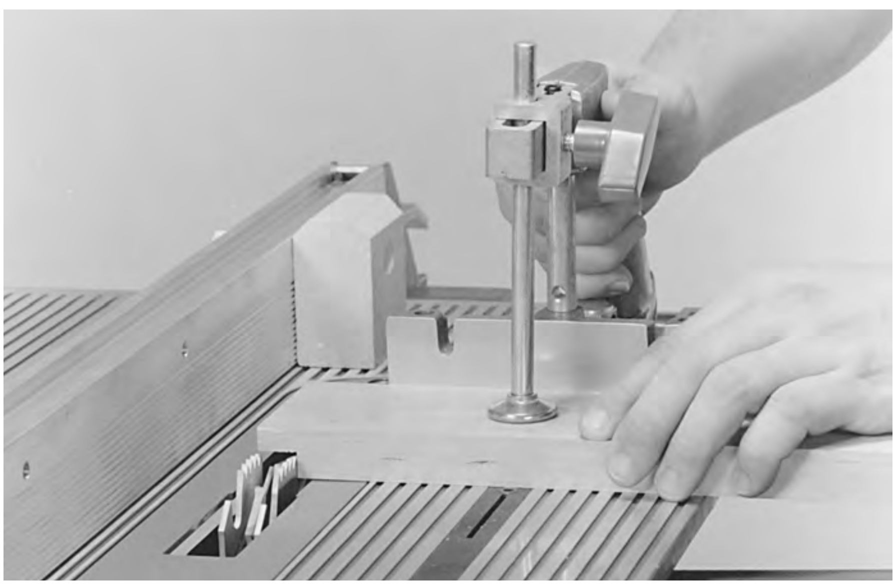


Figure 3-41. *A spacer on the rip fence can be used to gauge the cut width of an end rabbet. Position the spacer so it is well in front of the dado accessory.*

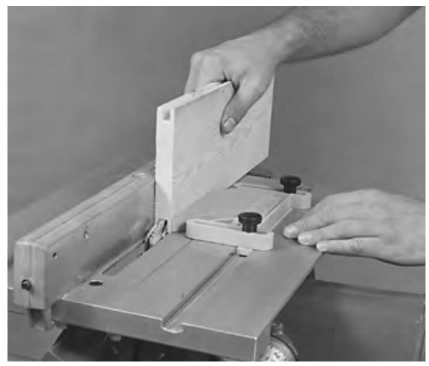


Figure 3-42. *Cutting a groove for a tongue and groove joint. Be sure the stock has ample bearing surface against the insert.*

The tongue is formed by making two opposing rabbet cuts on the stock's edge (Figure 3-43). Make a first cut with one side of the stock against the fence and make a second cut after turning the stock end-for-end. It's easier to make adjustments for the rabbet cuts that form the tongue, so always shape the grooves first and fit the tongue to the groove.

Forming a Tenon—A tenon can be formed by making two matching rabbet cuts, controlled by the setup shown in Figure 3-44. The distance from the spacer to the outside of the dado accessory equals the length of the tenon. The blade's projection equals one-half of the stock's thickness minus half the thickness of the tenon. Make repeat passes to clean away the

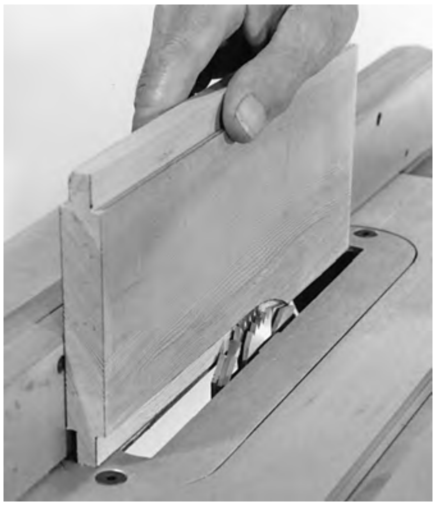


Figure 3-43. A tongue is formed by making matching rabbet cuts on opposite edges of the stock. Always cut the grooves first and then form the tongues to fit.

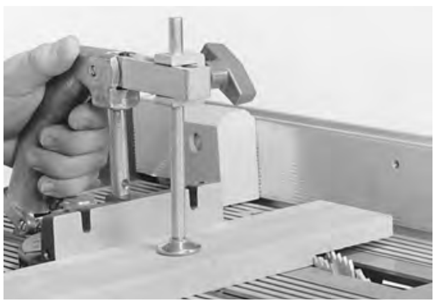


Figure 3-44. A tenon is formed by making two rabbet cuts. The spacer controls the total cut width. Clean out waste by making repeat passes.

Figure 3-45. To finish the tenon, turn the stock over and repeat the procedure.

waste stock; then turn the work over and repeat the procedure (Figure 3-45).

ADDITIONAL JOINERY

All of the joints shown in Figure 3-46 can be accomplished by working with either a saw blade or a

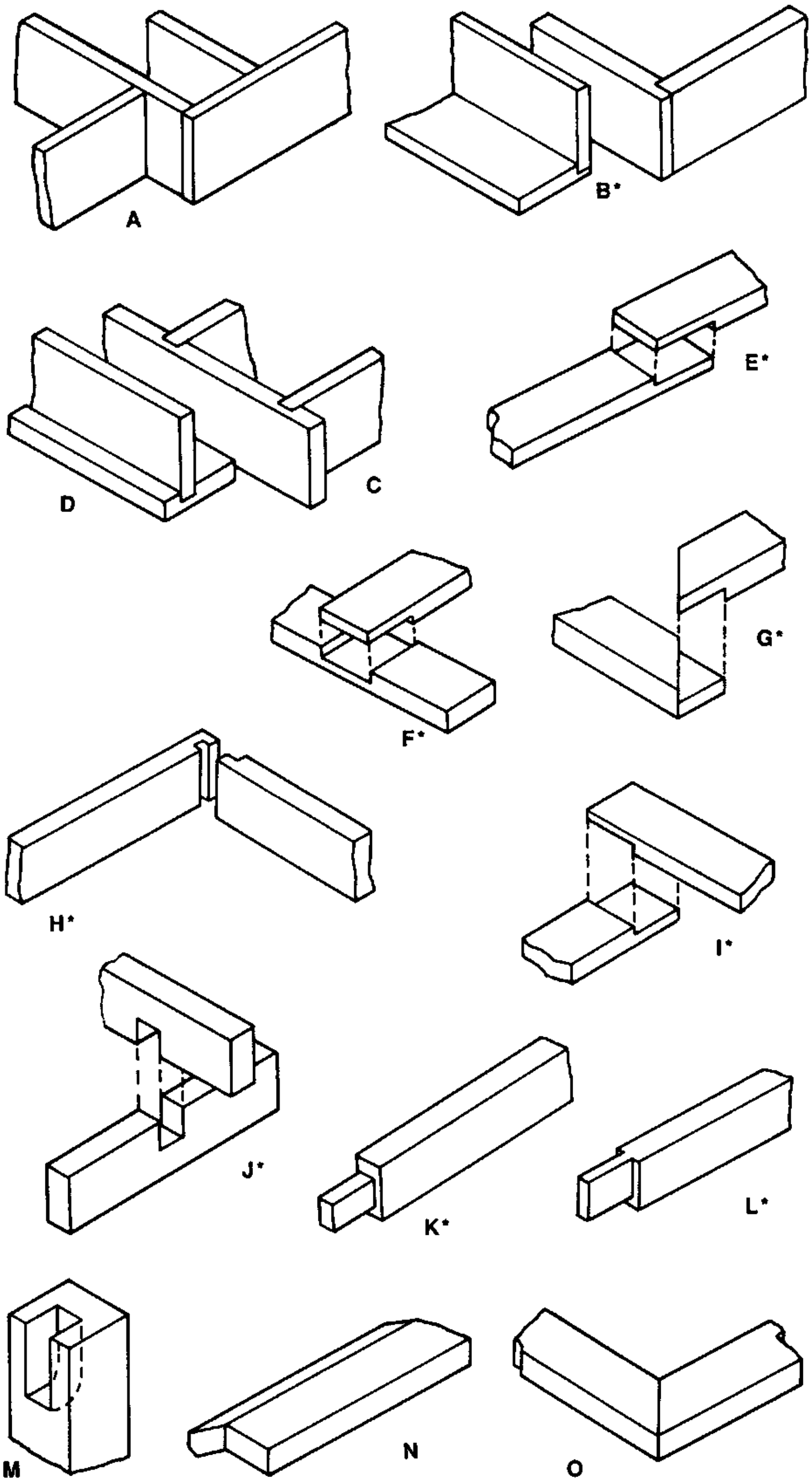


*Figure 3-46. All of these joints can be accomplished on the table saw using a saw blade or a dado accessory: (A) butt, (B) rabbet, (C) dado, (D) groove, (E) end lap (splice), (F) middle lap, (G) lapped miter, (H) combination dado and rabbet, (I) end lap, (J) notched, (K) true tenon, (L) stud tenon, (M) slot (for stud tenon), (N) beveled miter, and (O) simple miter. *All or part of these joints can be made using the Tenon Master™ Jig.*

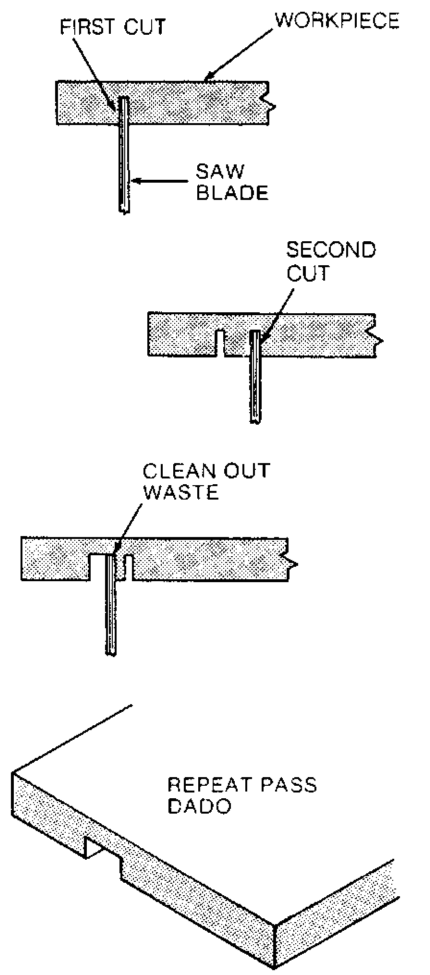


Figure 3-47. Dadoes can be formed by making repeat passes with a saw blade.

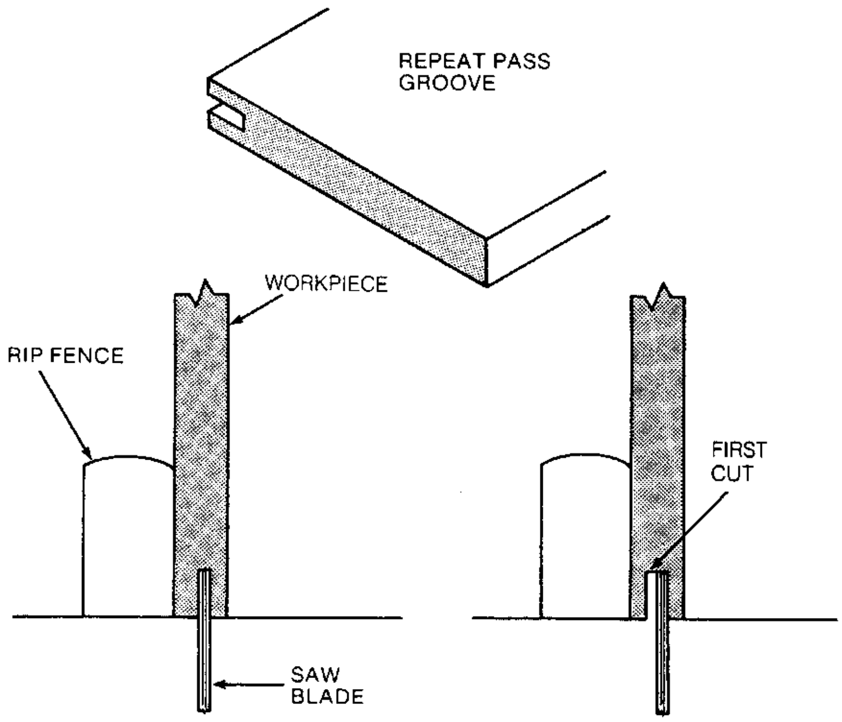


Figure 3-48. Repeat passes can also be used to form grooves in the edge of stock. When first and second cuts are made with opposite surfaces of the stock against the fence, the groove will be exactly centered. Use a rip fence extension and feather board for additional support.

dado accessory. Some of the joints can be made using the Tenon Master ™ Jig. It's a good idea to become familiar with these joints since they are used in many types of furniture and cabinetmaking and in drawer and case constructions.

Saw Blade Joinery

By making repeat passes with the saw blade you can form dadoes, grooves and rabbets.

Dadoes— Figure 3-47 shows how to form a dado by making repeat passes with a saw blade. The first and second cuts form the shoulders of the dado. The material between the two cuts is removed by making overlapping passes. When the same cut is required on more than one piece, gauge the first and second cuts by using a stop block on the rip fence and miter gauge extension or stop rod. ***Warning: Never position the miter gauge stop rod so it crosses in front of the blade.*** Do the cuts in sequence on all pieces; that is, make the first cut on all pieces and then the second cut. This will ensure that the cuts will be similar and correctly located on all the work.

Grooves—A repeat-pass groove is formed by working against the rip fence as diagrammed in Figure 3-48. Work this way to assure that the groove will be exactly centered. Mark the stock for the first cut; this will indicate the stock thickness that remains after the groove is formed. Set the fence so the outside of the blade will be on that line and make the first pass. Then, turn the stock end-for-end so the opposite surface will be against the fence, and make a second pass. If material remains between the two cuts you can clear it away by making additional passes. On jobs like this, and especially if the stock is thin, make a special insert (Figure 2-11) so there will be ample support area for the stock around the cut area. Use a rip fence extension and a feather board for additional support.

Rabbets—While rabbets can be formed with a dado accessory as described earlier in this chapter, they can also be made with a saw blade by following the two steps shown in Figure 3-49.

Use a rip fence extension and a feather board for both steps. Plans for making the rip fence extension can be found in Figure 5-10. ***Warning: Avoid getting the waste stock caught between the rip fence extension and the blade on the second cut; otherwise, the waste may kick back. Plan ahead carefully.***

Cut the surface of the workpiece first (Figure 3-50). Then turn off the Mark V and readjust the position of the fence if necessary. Turn the workpiece on edge and make your second cut so that the waste is on the opposite side of the blade from the rip fence (Figure 3-51).

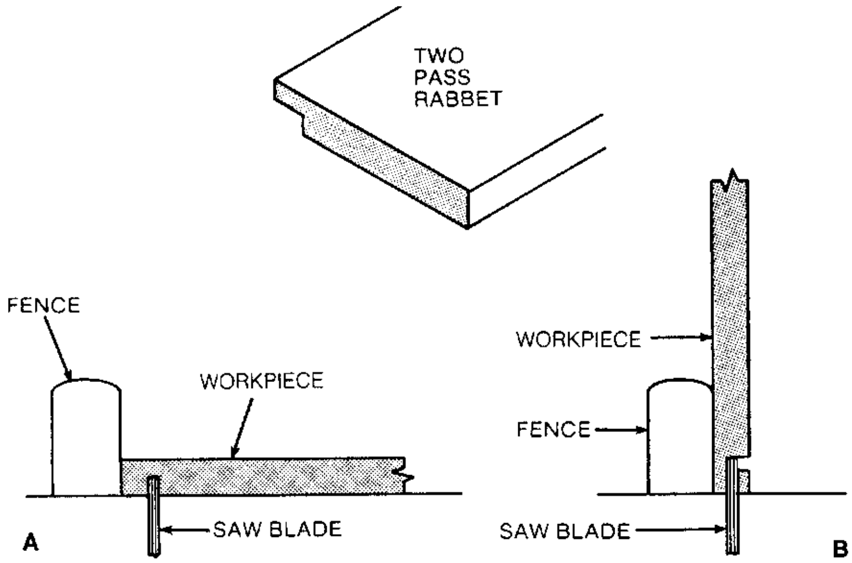


Figure 3-49. A rabbet can be formed by a saw blade in this manner: (A) first pass, (B) second pass. Use a rip fence extension and a feather board for additional support.

Notching

A notching cut is a dado that is cut across the thickness of the stock. When the cut is used to join pieces that cross each other and which must have even surfaces, the blade projection must be exactly one-half the stock's width. A typical application is the eggcrate-type construction shown in Figure 3-52. One way to work is to clamp together all the pieces you need and saw them as if they were a single block (Figure 3-53).

Mark the spacing between notches on the front piece; set the dado width to equal the thickness of the stock and the blade projection to equal one-half the stock's width.

***Figure 3-50.** When making a rabbet, first cut a kerf in the surface of the workpiece.*

***Figure 3-51.** Turn the workpiece on edge and make the second cut. It's important that the waste doesn't get caught between the saw blade and the extension fence.*

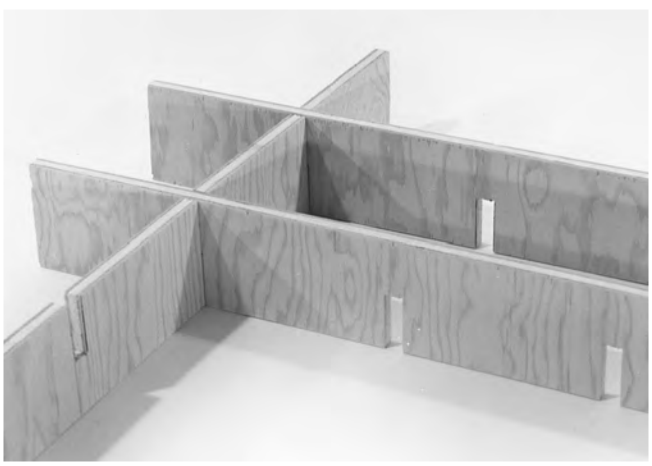


***Figure 3-52.** The familiar eggcrate pattern is easy to make.*

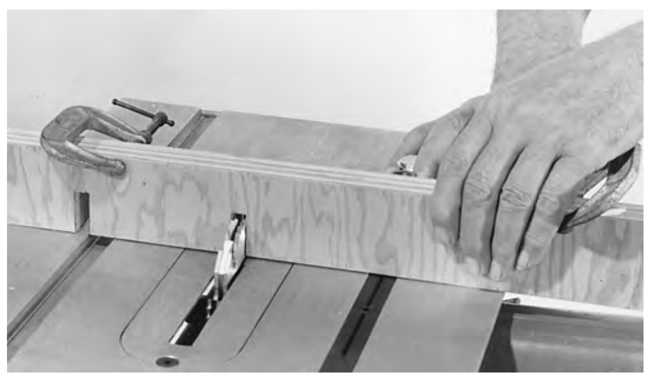


***Figure 3-53.** Clamp together as many pieces as you need so they can be cut like a solid block. Dado width equals the stock's thickness; blade projection equals one-half the stock's width.*

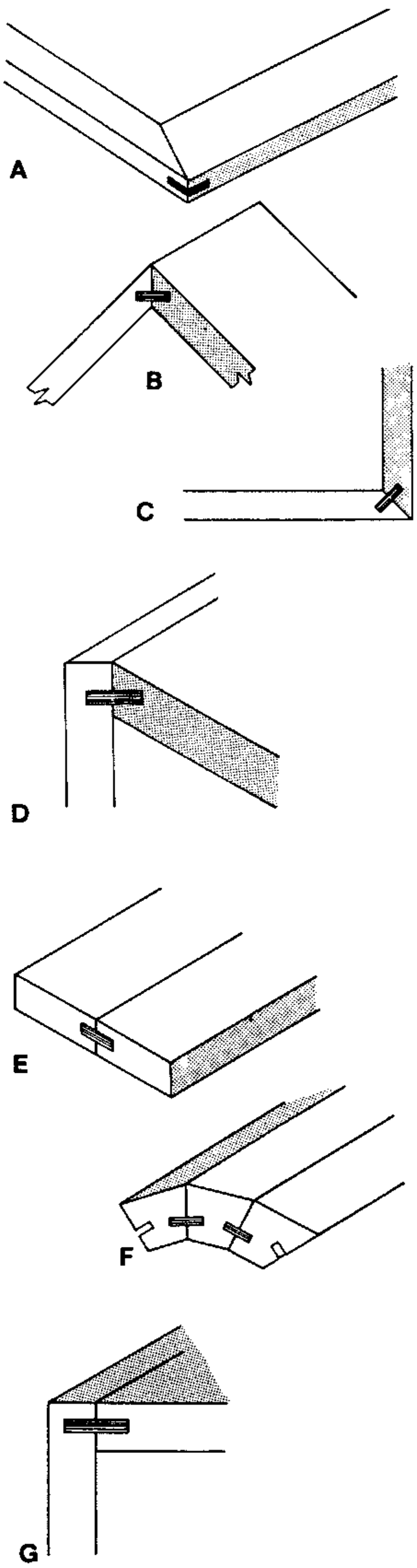


Figure 3-54. These are typical of the joints that are stronger when a spline is used: (A) simple miters; (B) cross miters; (C) bevel miters; (D) odd angle joints; (E) edge-to-edge joints; (F) segments; and (G) even butt joints.

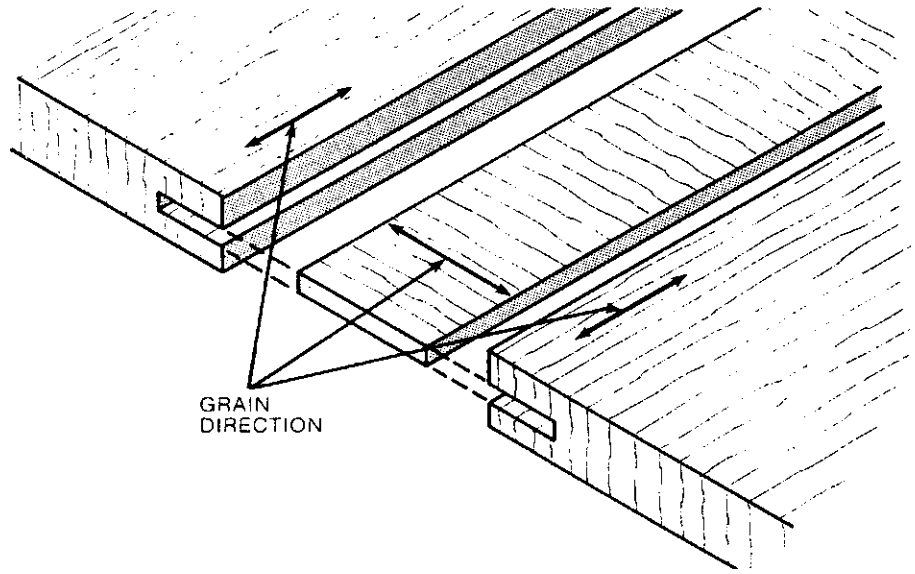
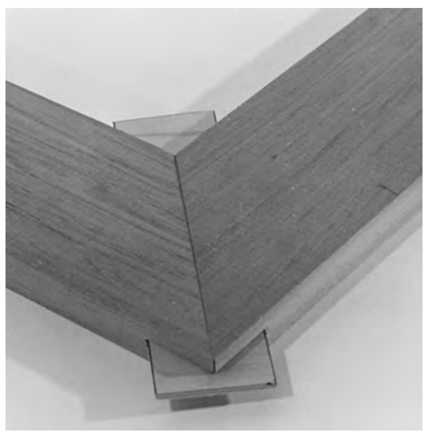


Figure 3-55. Be sure the grain direction of the spline is across its short dimension or at right angles to the mating pieces.



A

B

Figure 3-56. (A) A spline can be used in a simple miter regardless of the miter cut angle. (B) Splines can also be used to reinforce compound miter joints. Cut splines longer than necessary so you can trim and sand them smooth after assembly.

Splines and Keys for Reinforcement

It's always a good idea to reinforce a joint even though modern adhesives provide a strong bond. Splines, which can be used with many joint designs as shown in Figure 3-54, do an excellent job of providing the extra strength. A spline is simply a straight strip that is cut to fit grooves formed in the mating pieces (Figure 3-55). Since wood can split more easily along its grain than across its grain, splines should be designed so the grain is at right angles to the pieces to be joined.

Figure 3-56 demonstrates how splines are used to reinforce simple miter and compound miter joints.

Forming Splines—One way to form splines is to first cut grooves through the ends of a workpiece and then to cut off the ends by doing a crosscut as shown in Figure 3-57. The thickness of the splines will depend on how you set up for the initial groove cuts. The grooves must run across the stock so the splines will have correct grain direction.

Plywood is an excellent material for splines. It provides a lot of strength and you don't have to

Figure 3-57. After grooves are cut in the edge of stock, the splines are separated by making a crosscut.

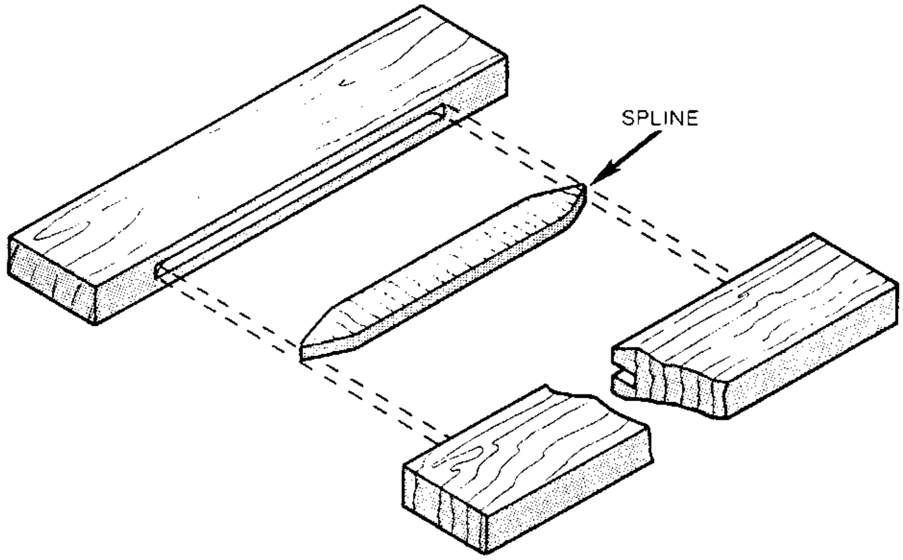


Figure 3-59. A blind spline can add much strength when pieces are joined edge-to-edge, and it can't be seen when it is installed this way. Cut the spline so the wood grain runs along the short dimension.

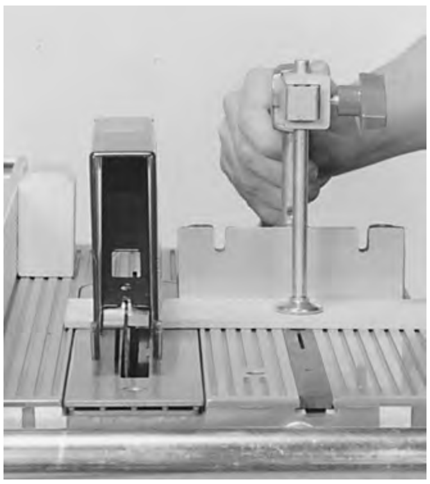


Figure 3-58. Plywood is a very good spline material. Use a spacer on the rip fence to gauge the width of the spline.

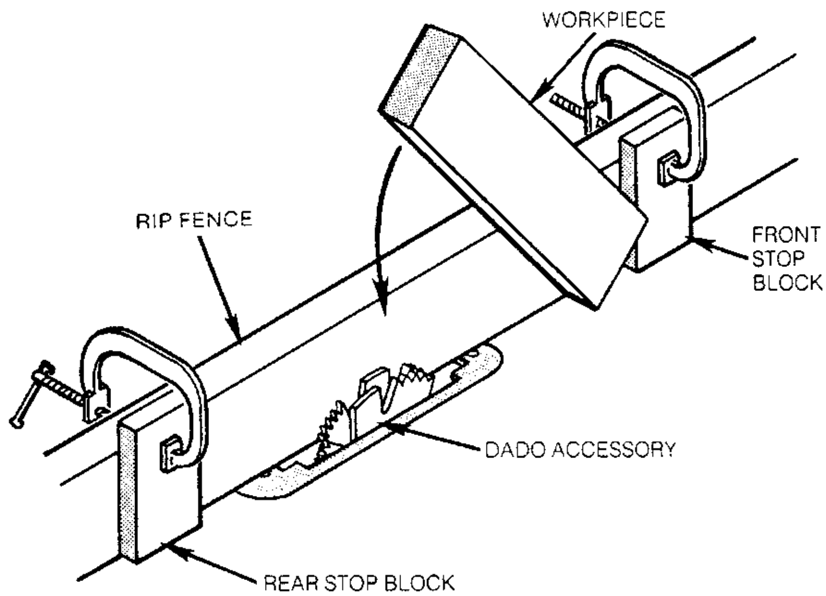


Figure 3-60. Stop blocks are used to control the length of the groove. Start the job by bracing the workpiece securely against the front stop block and then slowly lowering it to contact the dado accessory.

worry about grain direction. Cut the plywood to a width that equals the spline length you need and then simply cut off as many pieces as you need (Figure 3-58).

Blind Spline Joint—Simple butt joints are often used when boards are joined edge-to-edge, but a spline can aid in the alignment of the boards and add strength to the assembly. A blind spline can't be seen (Figure 3-59). ***Warning: The upper saw guard is removed for this operation so work with extreme caution.***

Cut the groove as shown in Figure 3-60. The stop blocks, clamped to the rip fence, control the length of the groove. Brace the workpiece against the front stop block, as shown in the illustration; then very slowly and carefully lower it until it contacts the dado accessory and rests securely on the table. Then move the workpiece forward until it contacts the rear stop block. Lift the work carefully when you remove it, picking the back end up first.

The splines, which are shaped to conform to the arcs left by the dado, should have grain running across the short dimension. Always cut the grooves first since it's no chore to form the splines to correct thickness. Don't size the splines so they must be forced into place. A slip-fit is best since it makes assembly easier and provides room for glue.

Spline Grooves in Compound Miters—One method of forming spline grooves in compound

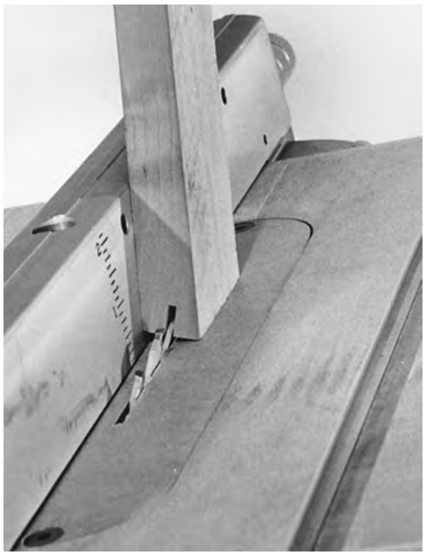


Figure 3-61. Spline grooves in miters, cross miters, and even compound miters can be cut this way, but extreme caution is required.

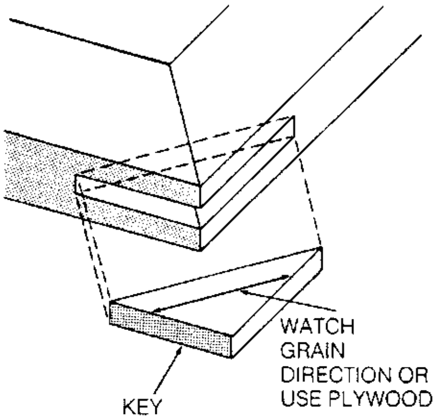


Figure 3-62. Keys are triangular pieces that fit into miter cuts like this.

Figure 3-63. The thin material you need to make the keys is cut this way.

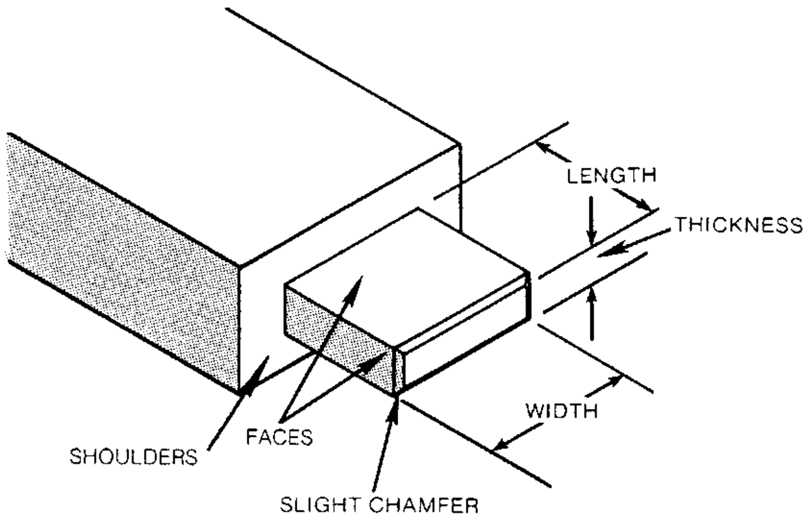


Figure 3-64. This is a true tenon. Its length should be 1/16" less than the depth of the mortise and its end should be chamfered to allow room for excess glue.

miters, with the table tilted to the correct angle and the rip fence used as a guide, is shown in Figure 3-61. The operator is responsible for holding the stock securely and maintaining its position throughout the pass. ***Warning: The upper saw guard is removed for this operation so work with extreme caution.*** An easier and more accurate method is to use the Tenon Master™ Jig.

When you are making splined joints, always form the groove first; then cut the reinforcement piece so it will be a nice, sliding fit.

Keys—Keys are triangular pieces that are often used in the manner shown in Figure 3-62 to reinforce miter joints. Notice the direction in which the grain should run. The thin stock you need to make the keys can be cut as shown in Figure 3-63. To keep small pieces of stock from falling through the table insert, position the blade as close to the left side of the insert as possible.

Always cut splines and keys so they are longer than you need. It's better to trim them and sand them to conform to project surfaces after they are installed and the glue is dry.

Tenons

The "true" tenon is shown in Figure 3-64. The tenon can be formed on the table saw with a dado accessory or by making multiple passes with a saw blade. *Note:* The "mortise," which is a rectangular cavity that receives the tenon, is cut with a mortising, routing or drilling accessory.

The four-pass procedure illustrated in Figure 3-65 is generally used to form tenons. (This method can also be used to cut tongues.) Set the rip fence to, in effect, gauge the thickness of the projection. Make the first pass, and then make a second one after turning the stock end-for-end. Remove the waste by working with the miter gauge. Since the last two cuts must match, gauge the stock's position by using a spacer block on the rip fence.

The open tenon has only two shoulders. It and the slot it needs can also be formed on the table saw (Figure 3-66).

When forming tenons, the stock must be held on edge and components that require the cuts are often narrow, so the easiest and most accurate way to form tenons is to work with the Tenon Master™ Jig.

Form tenons by using a dado accessory or saw blade and working as shown in Figure 3-67. Once the Tenon Master has been correctly positioned, its position does

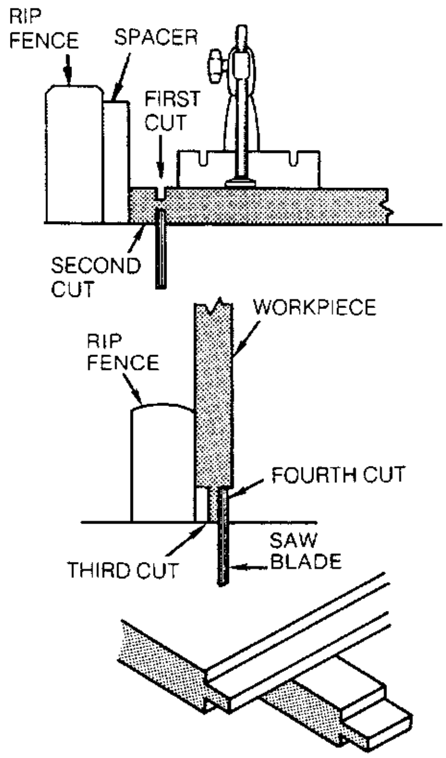


Figure 3-65. *You can produce a tenon with a saw blade if you make these four passes—two with the miter gauge and two against the fence.*

not have to be changed. Make the first pass, turn the work so its opposite surface is against the face, and make a second pass. The work will be most secure when clamped to the face of the Tenon Master.

Slots can be formed by using a dado accessory or by making repeat passes with a saw blade (Figure 3-68). This is also a good way to form the initial grooves in stock ends which will then be crosscut to produce splines. In addition, you can work this way for the first cut when doing a two-pass rabbet, the first cuts for tenons, and so on. When the cut or the size of the work requires it, make a special table insert and use it instead of the standard insert ("Special Table Inserts," Chapter 2).

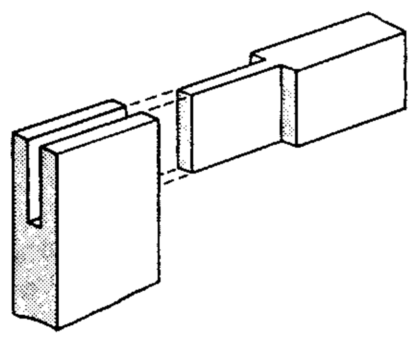


Figure 3-66. *The open tenon has only two shoulders. It and the slot it needs can be formed on the table saw.*

The Tenon Master can be used for operations like forming grooves in miter joints for splines or keys. It positions the workpiece at the correct angle and secures it so it can't move during the pass.

To accurately cut grooves for keys be sure the trunnion is positioned correctly. The mating pieces of the miter joint are set and locked in place as shown in Figure 3-69. When you work this way, it isn't necessary for the grooves to be exactly centered. This same setup can be used to cut grooves for splines (Figure 3-70).

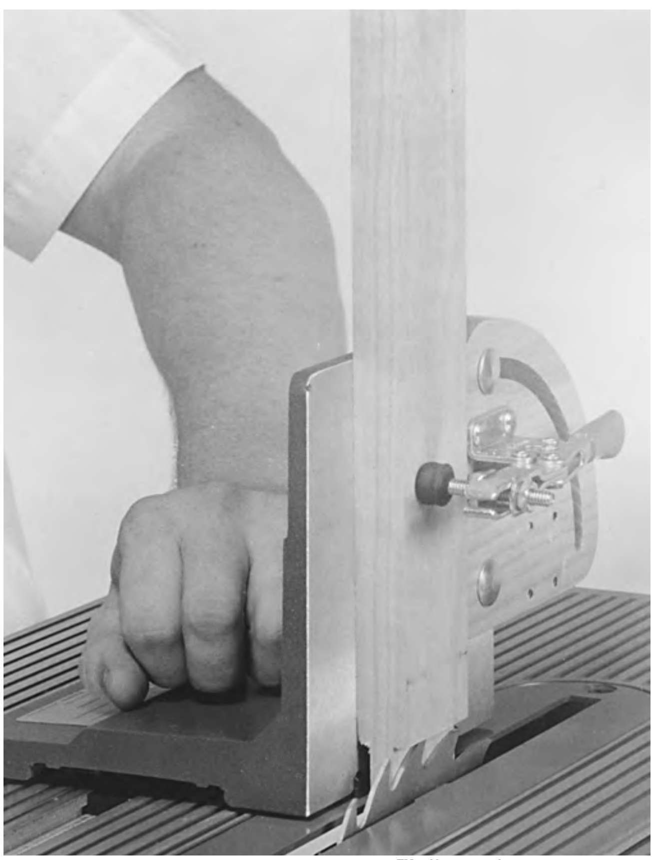


Figure 3-67. *Using the Tenon Master™ Jig to shape a tenon.*

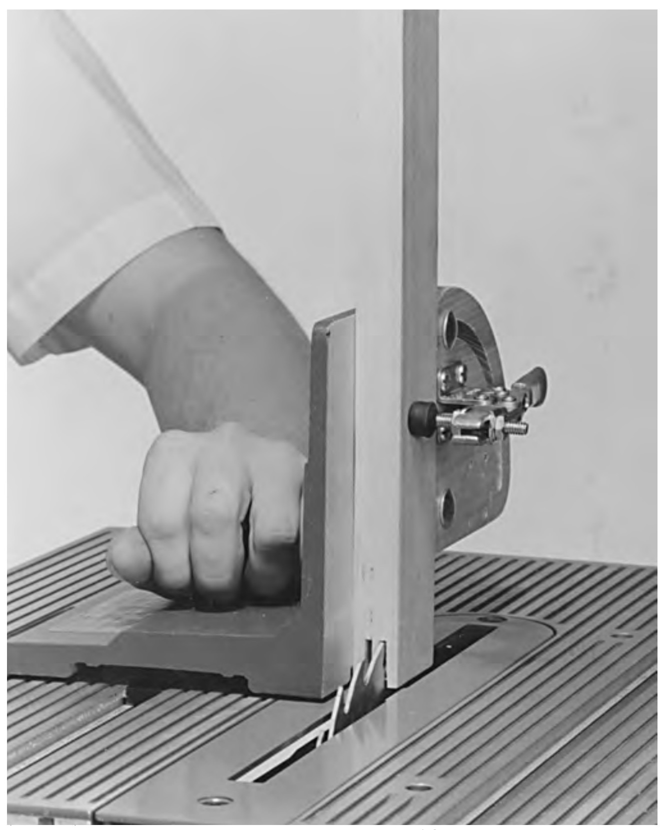


Figure 3-68. *You can form a slot by making repeat passes with a saw blade or by using a dado accessory.*

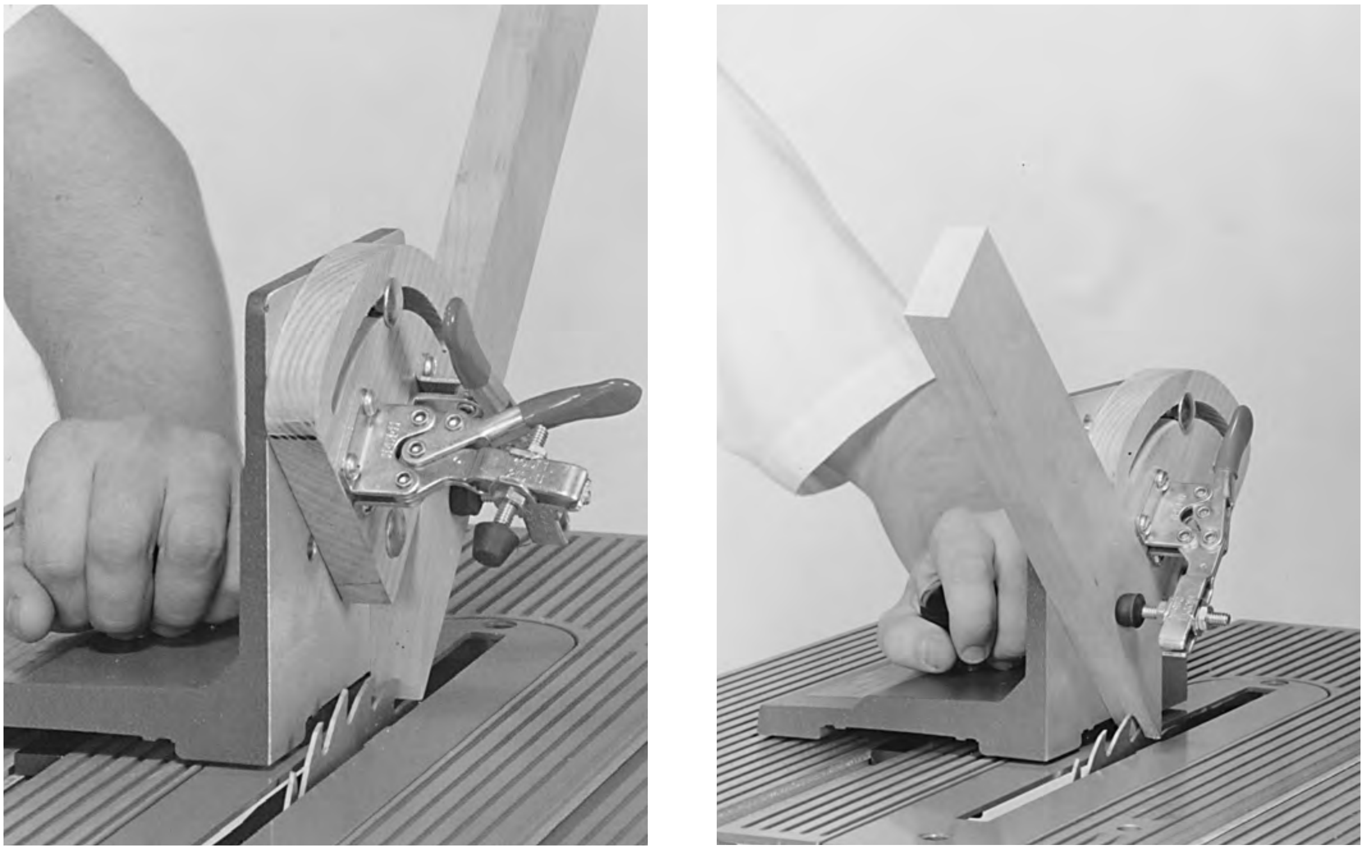


Figure 3-69. *The mating pieces are set and clamped in position like this to cut grooves for the keys.*

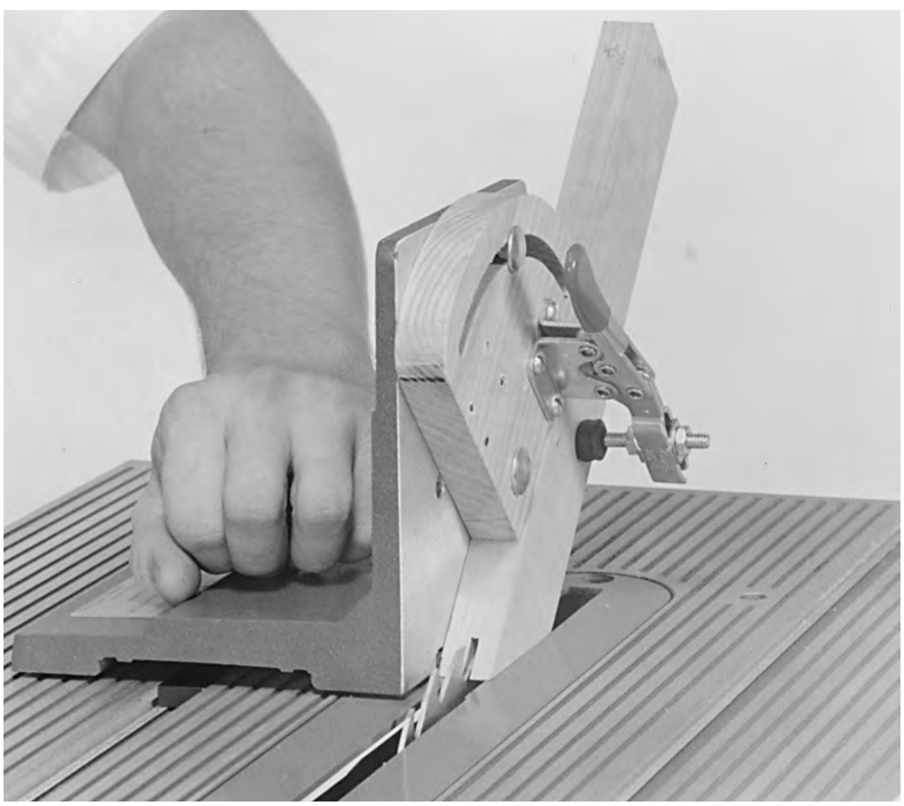


Figure 3-70. *As long as the width and thickness of the stock permits it to be placed along the guides, the attachment can also be used to form spline grooves.*

Finger Joints

The finger joint, like the dovetail, is often found on classic examples of furniture. It is sometimes hidden, but other times it is left exposed to denote craftmanship and display the interlocking fingers which form interesting patterns (Figure 3-71). Structurally, it is an impressive joint because it has an unusual amount of gluing surfaces. It is often called a "box joint" which doesn't exactly seem correct since the term connotes unimaginative applications. Actually it can be used on drawers, jewelry boxes, carcass constructions, and so on.

Generally, the width of the fingers should be about equal to the thickness of the stock. However, on a shallow project made of 1/2" or thicker material, such heavy fingers would not be visually appealing. In many cases, even on deep projects made of thick material, thin fingers look more impressive. A good, practical finger

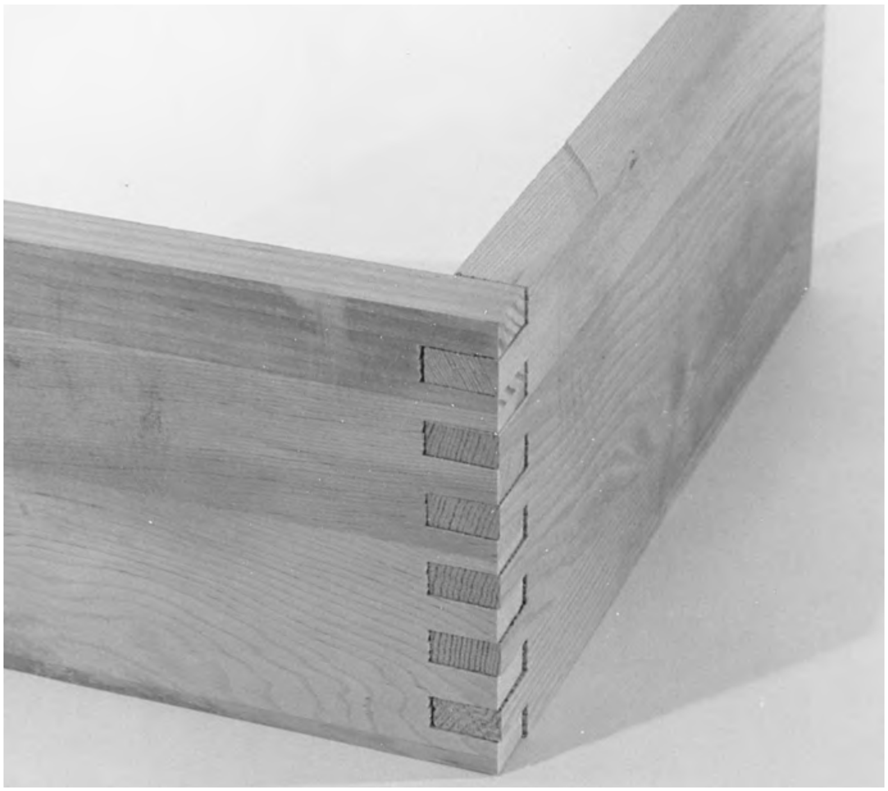


Figure 3-71. The finger joint is attractive and has a great deal of strength because of its abundant glue area.

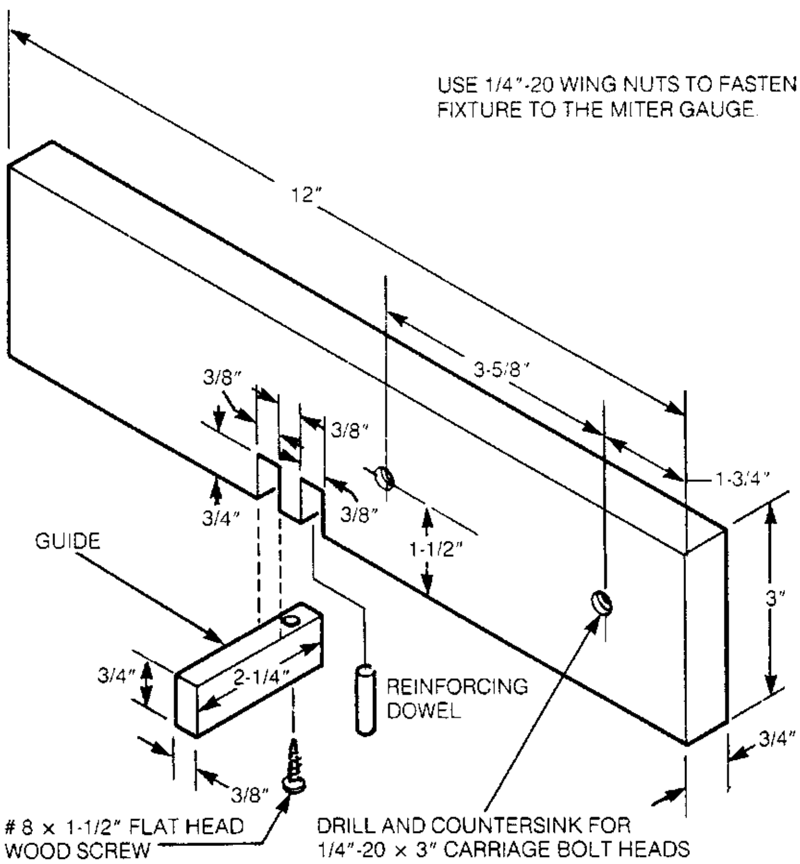


Figure 3-72. Construction details of a finger joint fixture.

width is 3/8". This will look good on material thickness ranging from 3/8" to 1".

Finger joints look complicated. But when you make a simple fixture, like the one shown in Figure 3-72, you can cut mating pieces of the joint at the same time and with ensured accuracy. So that the mating pieces of the joint will fit snugly together, be very careful with measurements and cuts when you are making the fixture. *Note:* The fixture is for 3/8" wide fingers only. For different size joints, the 3/8" dimensions need to be changed to the sizes desired. ***Warning: The upper saw guard is removed so work with extreme caution.***

To cut the notches in the fixture, set the dado accessory for a cut that is exactly 3/8" wide. Set the dado blade's projection to match the thickness of the stock or just a fraction more. Mount the fixture to the miter gauge and make the pass that cuts the first notch. Make a second notch exactly 3/8" away from the first one. The guide must be exactly the width of the cut and be secured in the second notch with a screw.

Figure 3-73 shows the fixture mounted to the miter gauge and ready to use. Place the spacer against the guide in the fixture and butt one piece of the workpiece (part one) against it. Make the first pass (Figure 3-74A). This first cut, which will be L-shaped, is then butted against the guide. The mating workpiece (part two) is put over top of part one. The uncut edge is butted against the guide (Figure 3-74B). Subsequent cuts are accurately spaced by fitting the preceding cut over the guide (Figure 3-75).

The finger joint fixture that we have demonstrated will continue to serve anytime the joint will have the same finger widths for which the fixture is designed. However, you can make another fixture that allows multiple width fingers if you

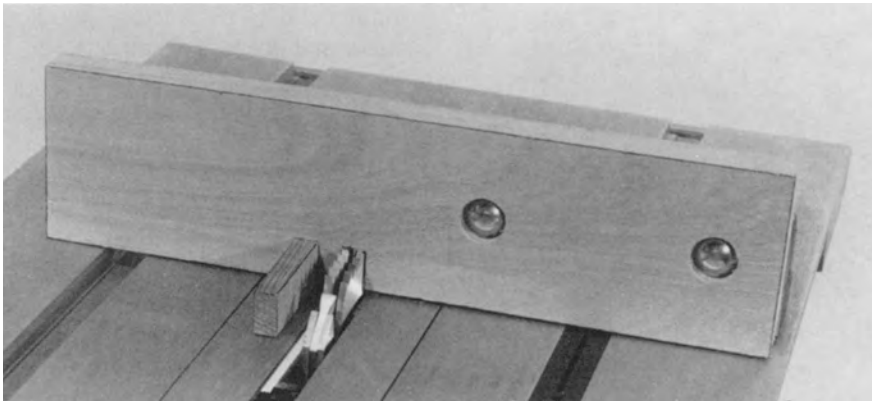


Figure 3-73. The fixture, ready for use, looks like this.

interchange multiple sizes of guides (Figure 3-76). Using this type of fixture will require more care, since the fixture must be accurately set for each job.

When using either fixture, any excess of finger length can be sanded off after project assembly.

Lock Corner Joints

Joints of this type are a challenge to do, but they hold together beautifully. Figure 3-77 shows the typi-

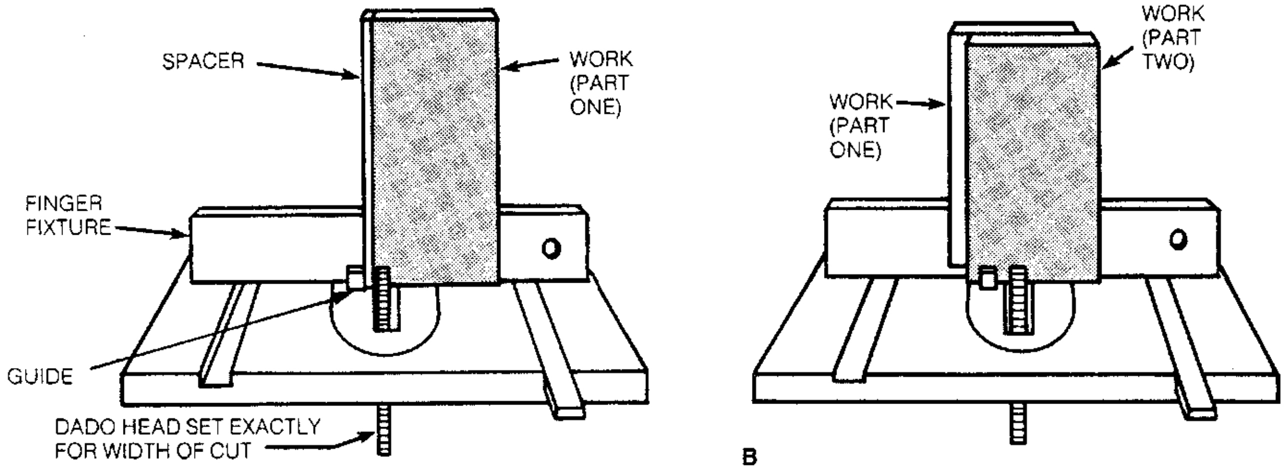


Figure 3-74. (A) Make the first cut with guide strip between the work and the guide block. (B) Make the next cut as shown.

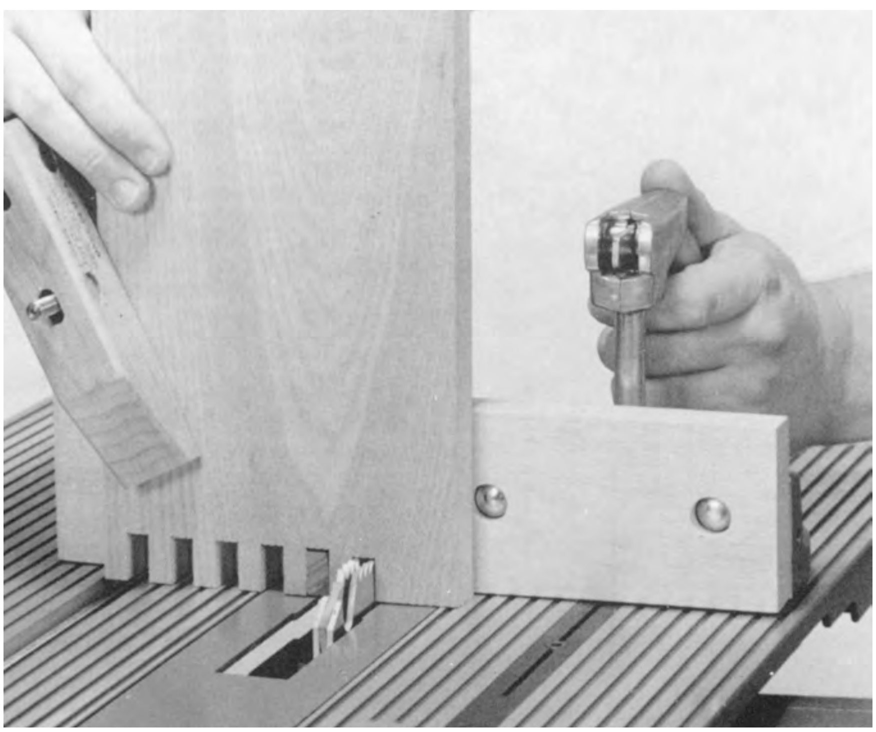


Figure 3-75. Make subsequent cuts by placing the preceding cut over the guide.

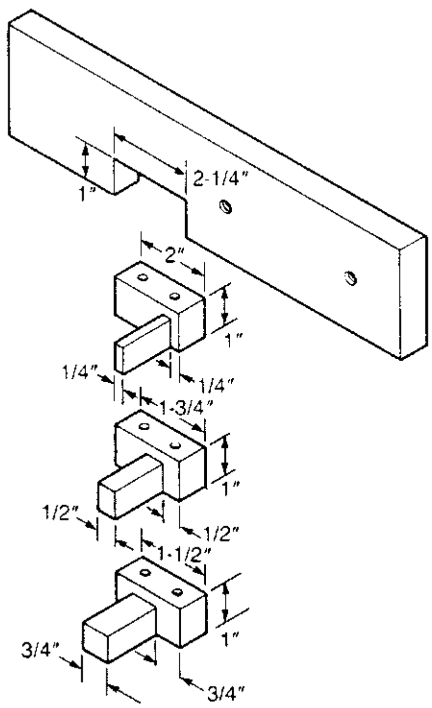


Figure 3-76. Construction details of a finger joint fixture for various widths of fingers.

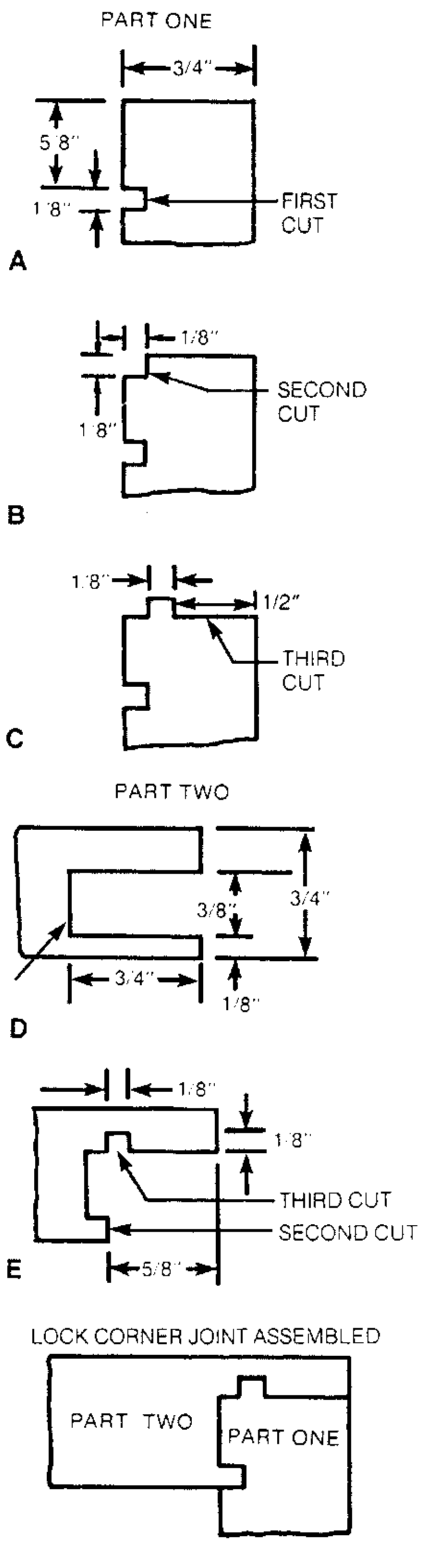


Figure 3-77. Procedure for making a lock corner joint on 3/4" stock. Accuracy is critical. (A) Cut a 1/8" × 1/8" dado, 5/8" from the edge. (B) Cut a 1/8" × 1/8" rabbet. (C) Cut a 1/8" × 1/2" rabbet to form the 1/8" × 1/8" tongue. (D) Form a slot 3/8" × 3/4". (E) Cut off one side of the slot and cut a 1/8" × 1/8" dado.

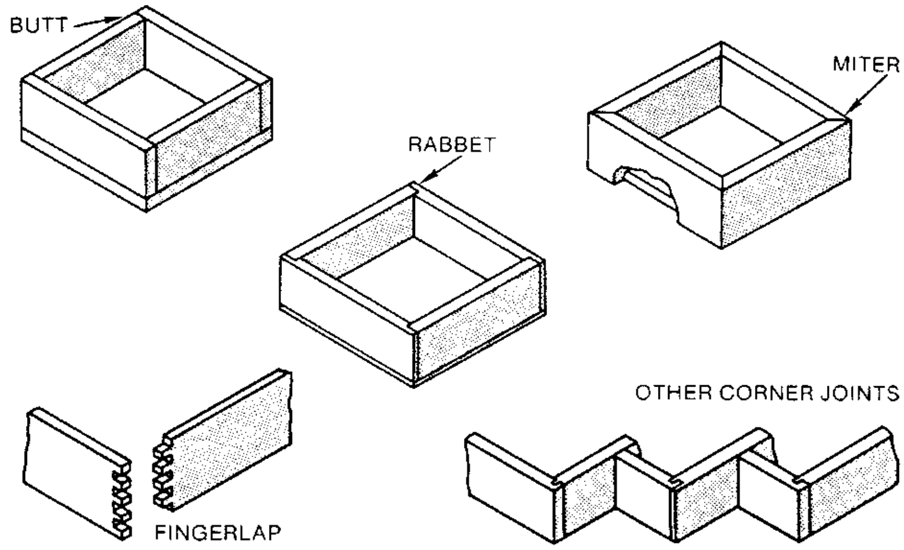


***Figure 3-78.** Various types of joints that can be used on box corners. Which you choose depends on how the project must appear. The mitered joint is the neatest, but is not much stronger than a butt unless you reinforce it with a spline.*

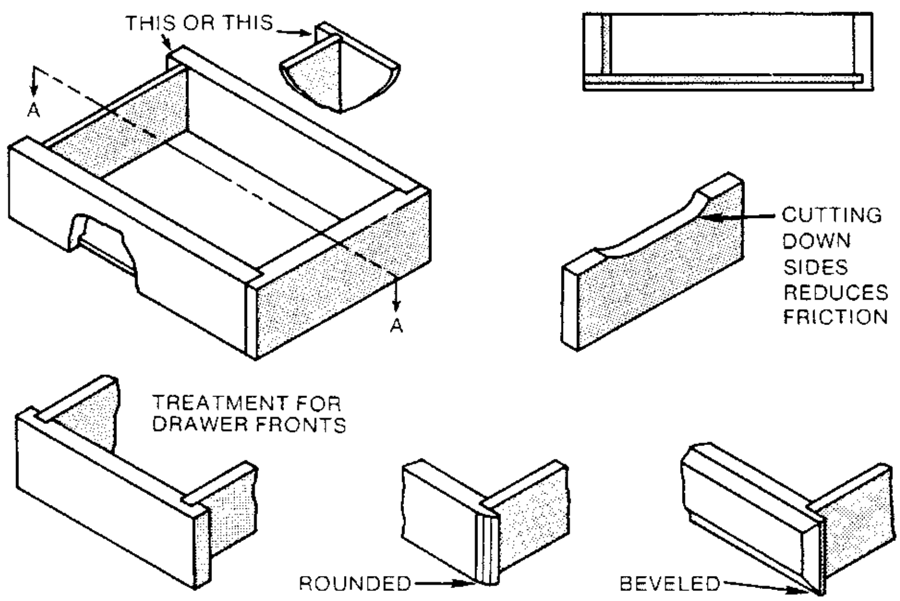


***Figure 3-79.** Typical drawer construction.*

cal procedure on 3/4" stock. Accuracy is critical.

Joint Applications

Joints are used to hold parts together. The joints can be simple or advanced, but all must be carefully cut if they are to look good and hold with maximum strength. Figures 3-78 through 3-81 illustrate some joint applications on typical woodworking projects.

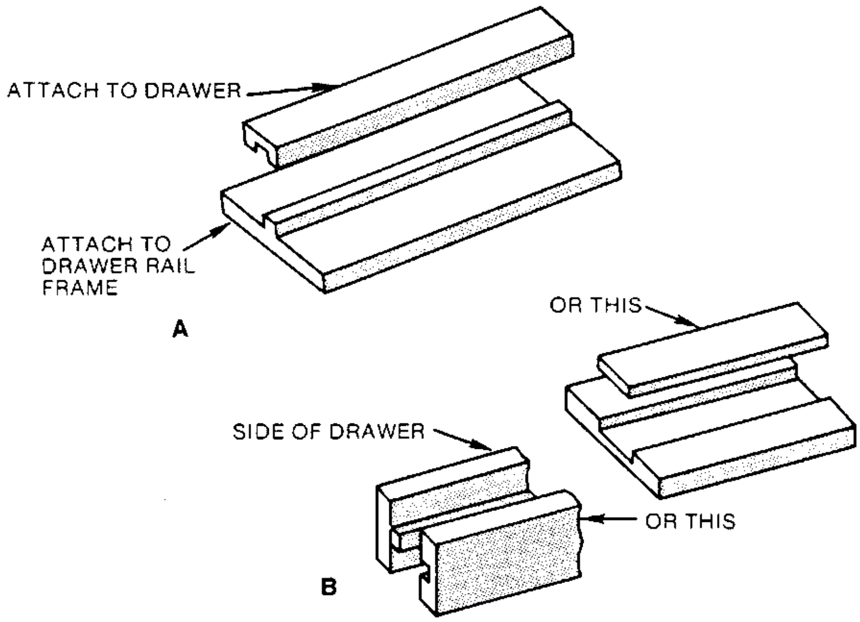


Figure 3-80. Some common drawer guide designs. (A) The centered guide is the most common. (B) The drawer side can be fitted with a cleat that rides a dado in the side of the case, or the opposite can be done.

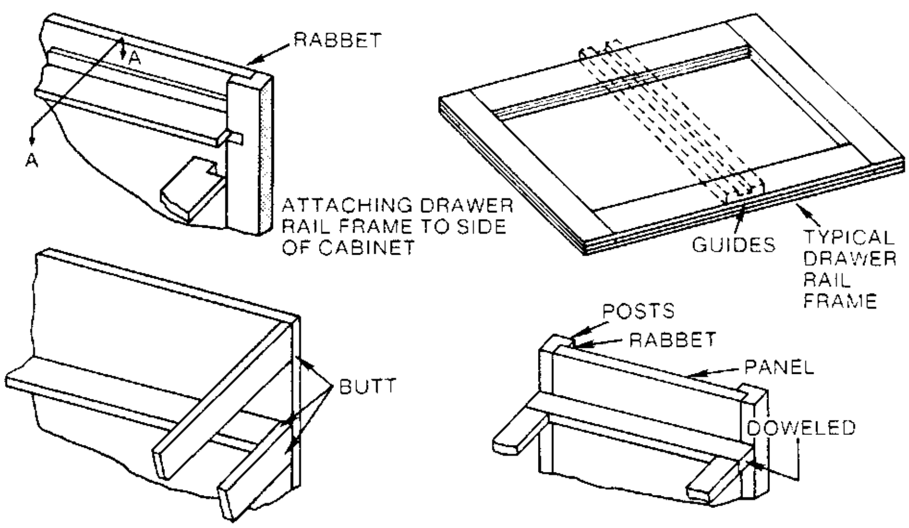


Figure 3-81. Drawer supports, or rail frames, are integral parts of case construction. Some typical assembly methods are shown here. Many rail frames are done with thin inset plywood panels so they serve as dust guards between drawer sections.

Chapter 4
Table Saw: Special Operations

In the table saw mode, the Mark V can perform a variety of operations. Kerfing, or thinning out, allows you to bend wood without steaming. Kerfing can also be used for a decorative effect. You can also cut coves, inlays, and raised or pierced panels.
Warning: Many of the special operations require the removal of the upper saw guard. Whenever the upper saw guard is removed, keep the lower saw guard in place and work with extreme caution.

BENDING WOOD

Whether in a home workshop or a commercial establishment, most woodworkers often find it necessary to bend wood to a particular shape. It may be needed on a furniture project—the apron on a drum table or round stool—or on other projects like a garden arbor with an arched top or a doorway with a semi-circular upper structure. Commercial establishments, of course, can bend wood to almost any shape by steaming it or using chemicals to make it flexible. In the home workshop, you don't usually have the special bending equipment, but you can still do an impressive amount of wood bending just by working on the table saw and using either the kerfing technique or a thinning out process. You *must* use straight grain lumber for any bending.

Kerfing

The most popular method of bending wood without steaming is by kerfing (Figure 4-1). What this method accomplishes is a reduction in stock thickness, while allowing room (between the cuts) so the wood can bend back on itself. The depth of the kerfs and their spacing are the important factors and are variable. Deep kerfs, closely spaced, allow the sharpest bends (Figure 4-2). To bend wood with minimum loss of strength, proper kerf depth and spacing should be determined using a simple test.

Make a sample kerf in a test piece of stock that you wish to bend (Figure 4-3). In 3/4″ stock try a kerf that is 5/8″ to 11/16″ deep. Position the test piece, kerf side up, on a flat surface and hold it in place with a clamp on the right side of the kerf. The distance from the kerf to the edge of the surface on which you have placed the work should equal the radius of the bend you need. Lift the stock at its free end until the kerf closes and then measure the amount of lift at the edge of the table. This tells you the distance required between kerfs.

Since work like this calls for a considerable number of kerfs correctly spaced, you should work with a kerf spacing guide like the one shown in Figure 4-4. After you have secured the guide to the miter gauge, cut a saw slot through it and then drill a hole for a nail to serve as the guide pin, spacing it away from the slot a distance equal to the required kerf spacing. Make the first kerf with the workpiece butted against the guide pin. The distance between the remain-

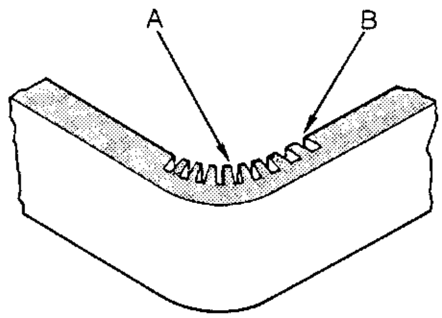


Figure 4-2. *The kerf spacing can be varied, depending on the sharpness of the bend. (A) The kerfs should be more closely spaced in the sharpest bend area. (B) Greater spacing is sufficient where bend begins to straighten.*

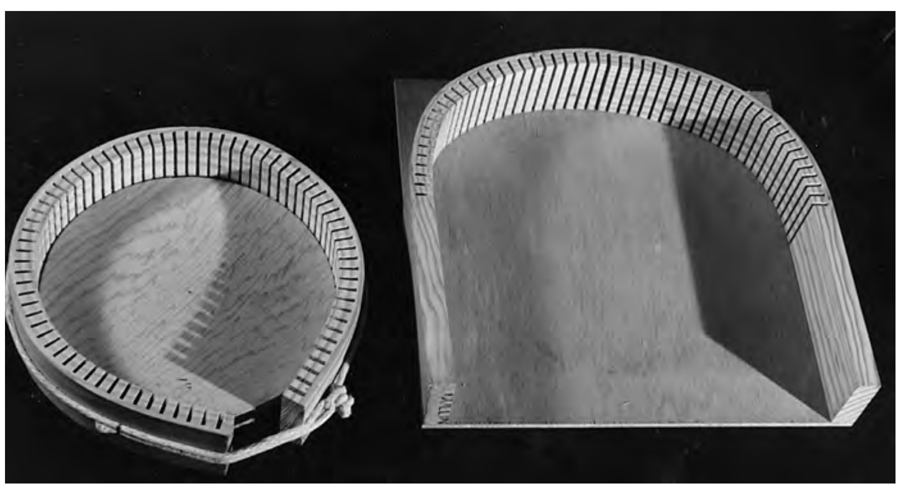


Figure 4-1. *A good amount of wood bending can be done by using the kerfing technique. Kerfs can extend the full length of the workpiece or be confined to an area.*

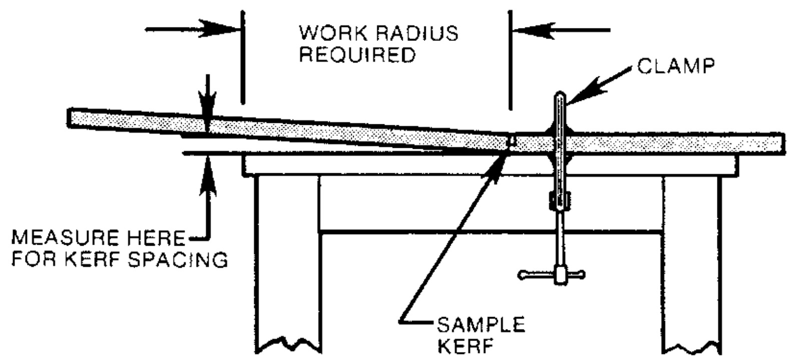


Figure 4-3. *Make this test to determine, at least as a start, the kerf depth and the spacing you need to make a particular bend.*

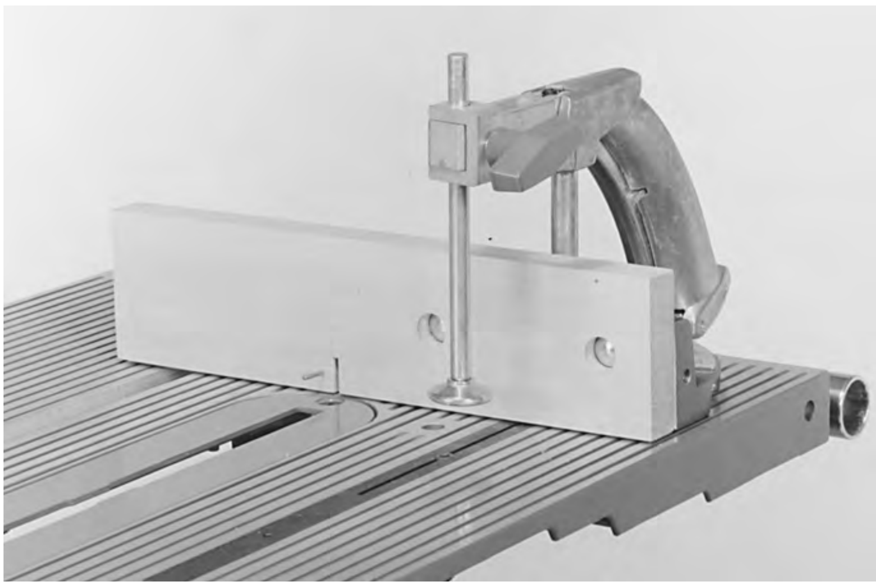


Figure 4-4. *Use a miter gauge extension to make a kerf spacing guide. The distance from the pin (8d nail) to the slot automatically spaces the kerfs.*

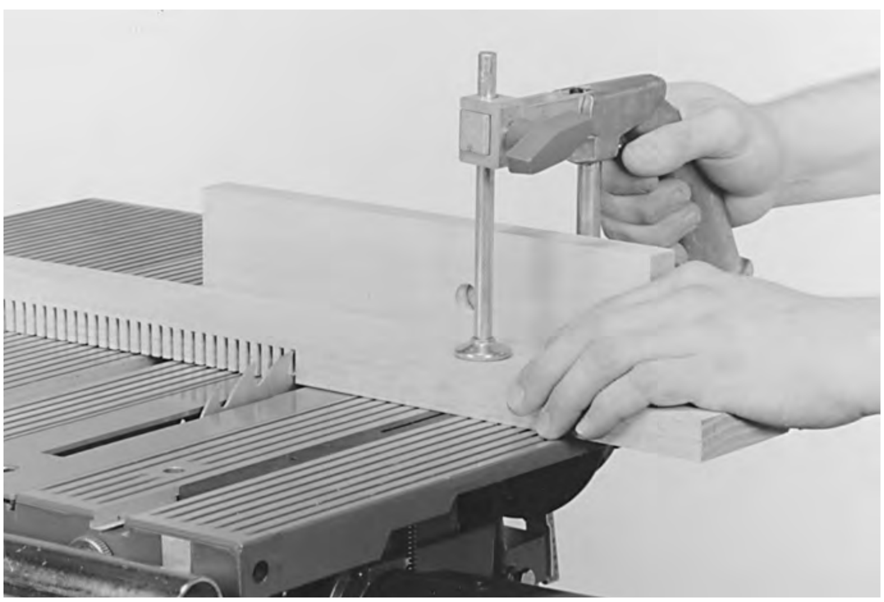


Figure 4-5. *By placing the last kerf over the guide pin, the work is accurately positioned for the next cut.*

ing cuts is automatically gauged by placing the last kerf over the guide pin (Figure 4-5). When the kerfs must be cut in a central area of the stock, make the first cut without using the guide.

To calculate the number of cuts, first find the circumference of the circle that will form the corner of the project. Divide this number by the total number of corners on the project. This will be the length of one corner. Divide the length of the corner by the total width of the saw kerf plus the spacing between the kerfs. This will give you the number of cuts you'll need to make. The formula for this is:

Circumference = πd
Circumference ÷ Number of Corners = Corner Length
Corner Length ÷ (Kerf Width + Kerf Spacing) = Number of Cuts

Example: Calculating the number of cuts for a 12″ dia. circle, used on a four corner project, with a saw kerf of 1/8″, and kerf spacing of 3/4″.

Circumference = 3.14 × 12″ = 37.68″
37.68″ ÷ 4 = 9.42″
9.42″ ÷ (1/8″ + 3/4″) = 9.42″ ÷ 7/8″ (.875) = 10.77 or 11 cuts

When kerfing is complete, bend the wood slowly until the curve you need is achieved. Wetting the wood with hot water (even if you must soak it awhile) will help the bending process. Also, use a tie strip, tack-nailed in place, to hold the part's shape until it is permanently attached on an assembly.

You can form irregular curves if you do the kerfing on both sides of the stock and/or vary the kerf spacing. When the kerfing is exposed, veneers may be glued in place to conceal the cuts. If you're working on an outdoor project, coat the kerfs with waterproof glue before making the bend. Wood dough or putty can be used to fill the crevices. When the work has been correctly sanded and finished, it will require a close exam-

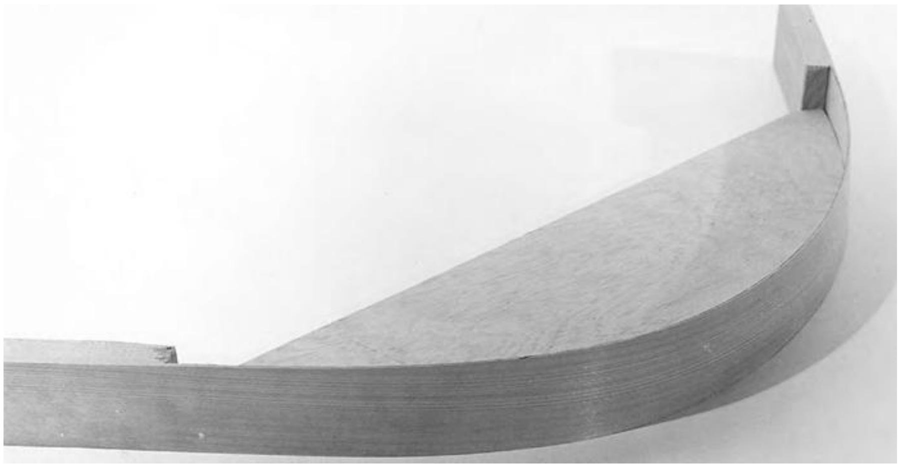


Figure 4-6. Wood can easily be bent when you reduce its thickness in the bend area. This is the "thinning out" technique.

ination to reveal the method used to make the bend.

Thinning Out

When thinning out, the stock's thickness is reduced the full length of the bend area (Figure 4-6). In effect, you are producing a length of veneer which is an integral part of the wood. The thinning out can be done with the dado or molder head. It can also be done by resawing the stock on the bandsaw (see Chapter 14). This method permits very sharp bends; but, since the veneer area won't have much rigidity or strength, corner blocks should be used to provide structural strength (Figure 4-7). Thinned out sections that have the wood grain running lengthwise will be stronger than those where the grain runs crosswise.

COVING

Coving is a unique table saw operation in that the work is fed obliquely across the blade (Figure 4-8) It is a lengthy process because the shape is achieved by making numerous passes with the saw blade's projection increased by no more than 1/16" each pass. Coving can be done with the table set at 90° to cut a circular cove or with the table tilted to cut an elliptical cove. If a narrow edge cove is needed, either cut it on a wide piece of stock and cut away the scrap when coving is complete or cut the edge cove from a center cove. ***Warning: The cutting action is essentially a scraping one, so trying to rush by using more than 1/16" blade projection is not safe.*** The blade will tend to cut rather than scrape and the action will cause the workpiece to move away from the guide strip and kick back. The first thing to do is make the parallel rule fixture that is diagrammed in Figure 4-9. The angle of the cut determines the width of the cove. Set the distance between the fixture's long legs to equal the width of the arch you want (Figure

Figure 4-8. Coves can be produced on the table saw by passing the work obliquely across the saw blade. It requires many passes and the cutting should be done with a combination blade that has set teeth.

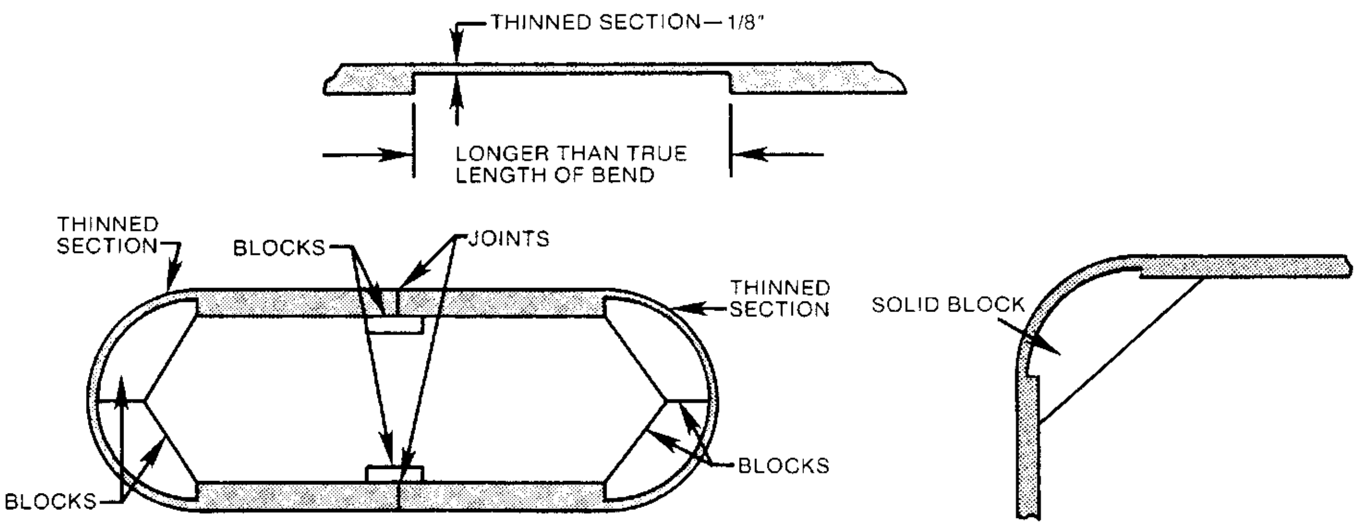


Figure 4-7. Thinned out areas, even kerfed areas, can be reinforced by using corner blocks.

4-10). Next, set the saw blade's projection to equal the depth of the cove and then place the fixture so its long inside edges just touch at the front and rear of the blade. With the parallel rule so positioned, clamp a guide strip to the worktable at the angle determined by the rule (Figure 4-11). The guide strip *must* be positioned on the infeed side of the blade only so the cutting action forces the stock into the guide strip. The distance between the guide strip and the saw blade will determine whether the cut will be centered, off center, or on an edge of the stock.

Start the work by setting the blade's projection to no more than 1/16". Use a push block to hold the workpiece firmly against the guide strip and make the pass very slowly. Pay special attention to how you place and use your hands. ***Warning: Coving is done without the upper saw guard in place so work with extreme caution. Use a feather board and push block to support and guide the workpiece. Never cut edge coves that will be wider than half the stock width. Avoid placing your hands over the blade or in line with the cut.*** After the first pass, increase the blade's projection another 1/16" and make a second pass. Continue in this manner until you have arrived at the arch's depth.

This kind of cut can be made on stock edges (Figure 4-12), but be sure of hand position and that the cove is no wider than half the stock width. With all coving operations, you can clamp a second guide strip to the table parallel to the first one. The distance between the strips equals the width of the stock. Thus you have a "road" along which you move the stock. If you wish to speed up the operation, you can do so by cutting kerfs to remove the bulk of the waste material (Figure 4-13).

Coving is a useful technique because it can be used to produce

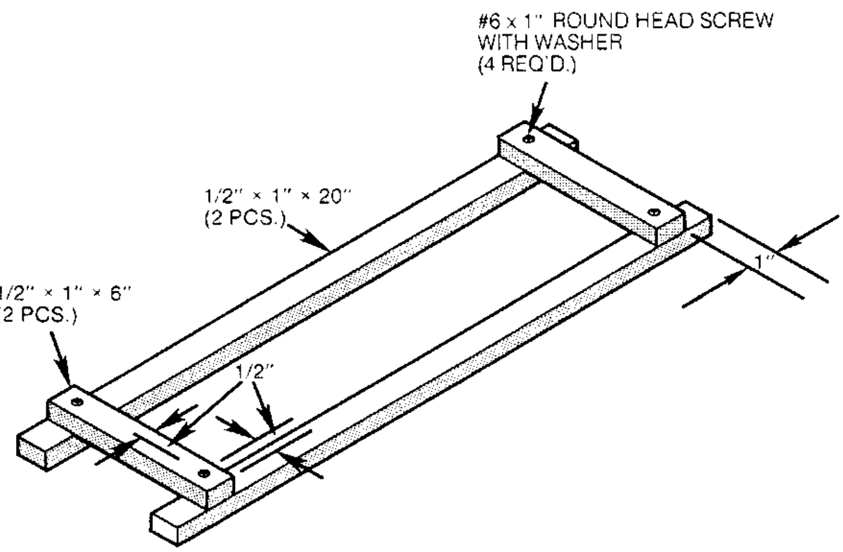


Figure 4-9. *Construction details of a parallel rule that will be used to determine the position of the guide strip.*

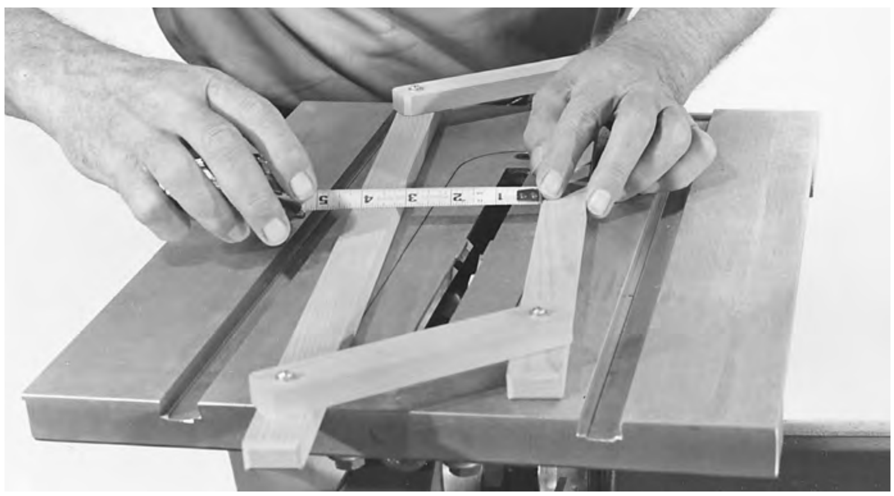


Figure 4-10. *The distance between the long legs of the fixture should equal the width of the arch.*

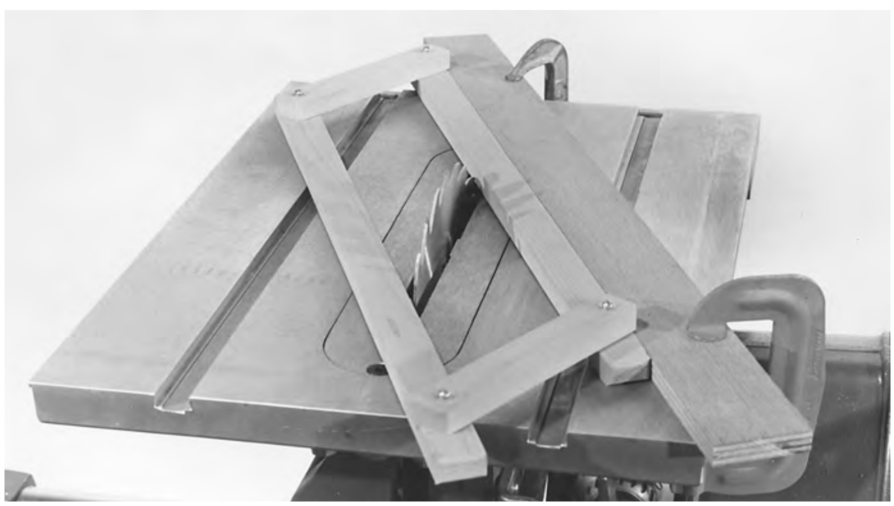


Figure 4-11. *The saw blade's projection should equal the depth of the cove. The guide strip's position is gauged by the parallel rule.*

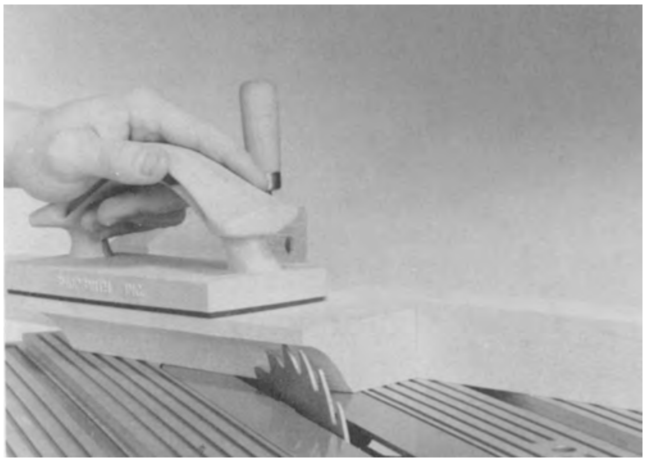


Figure 4-12. Edge coves are also possible. Make the passes very, very slowly.

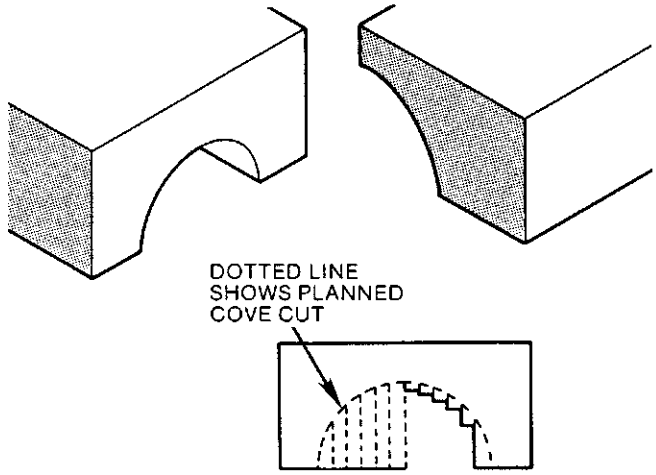


Figure 4-13. The bulk of the waste removal can be accomplished by making repeat passes with a saw blade.

components like those shown in Figure 4-14. Shapes like those in Figure 4-15 are possible if the coving is done on pieces that have first been lathe-turned. The coves that are formed are not true semicircles; this could only occur if the work were fed across the blade at right angles to it. However, some work with a drum sander or hand sanding is usually sufficient to true up the arch.

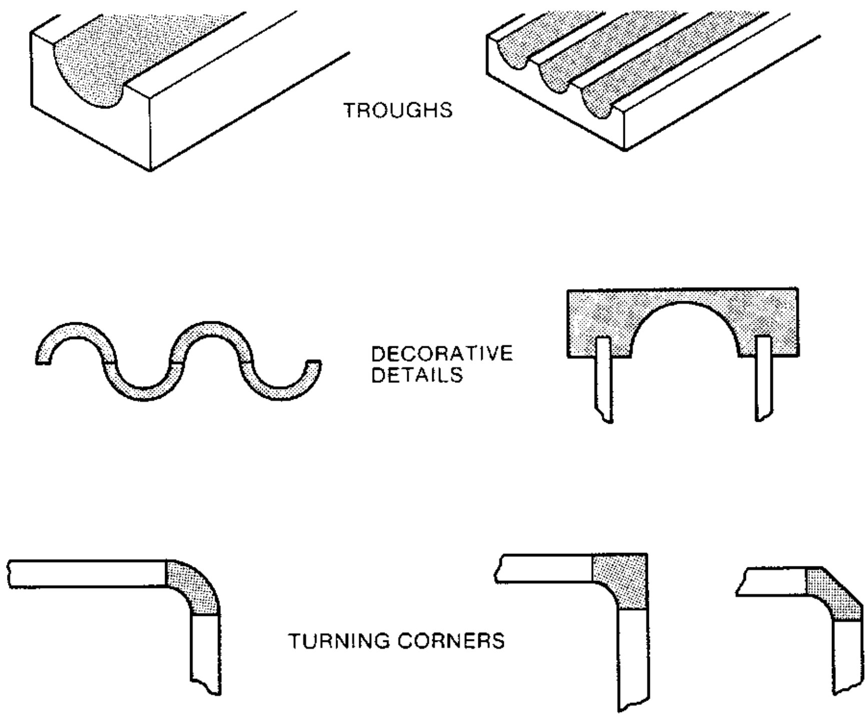


Figure 4-14. Some of the applications for workpieces that were formed by cove cutting.

KERFED MOLDINGS

One way to individualize your work is with original molding designs like those in Figure 4-16. Most of these are done by using the kerfing method described for wood bending or variations of it. Thus, the kerf spacing guide used for bending kerfs can also be used for moldings. Instead of making the kerfs on only one face of the stock, the work is turned over for each new cut (Figure 4-17). A fixture (Figure 3-72) that is used for finger joints may also be used should you wish to produce wide notches using the dado head. Another way to produce exclusive moldings is to strip-cut pieces from stock that has been surface-contoured with the molder.

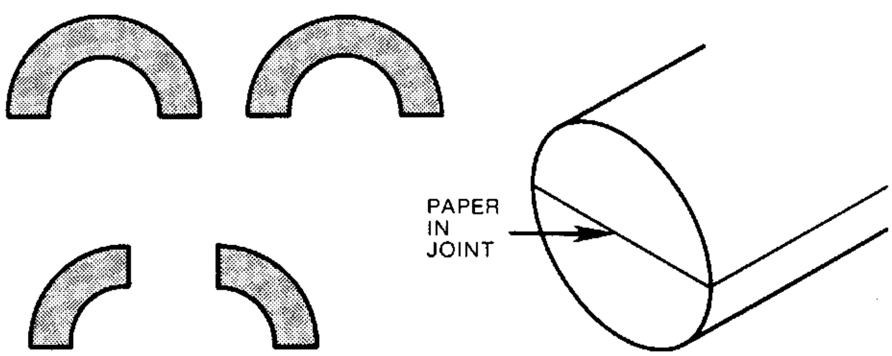


Figure 4-15. Shapes like this are possible by cove cutting after the workpiece has been turned to a cylinder on the lathe.

PIERCING

Piercing is done on the table saw by running intersecting cuts on

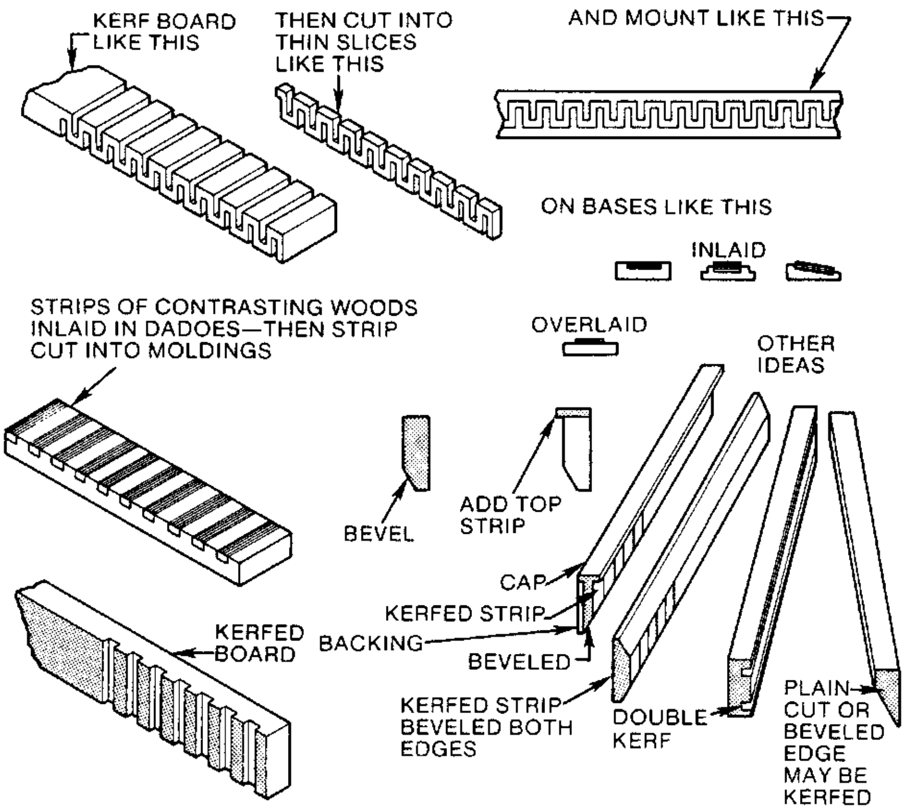


Figure 4-16. Here are some kerfed molding designs.

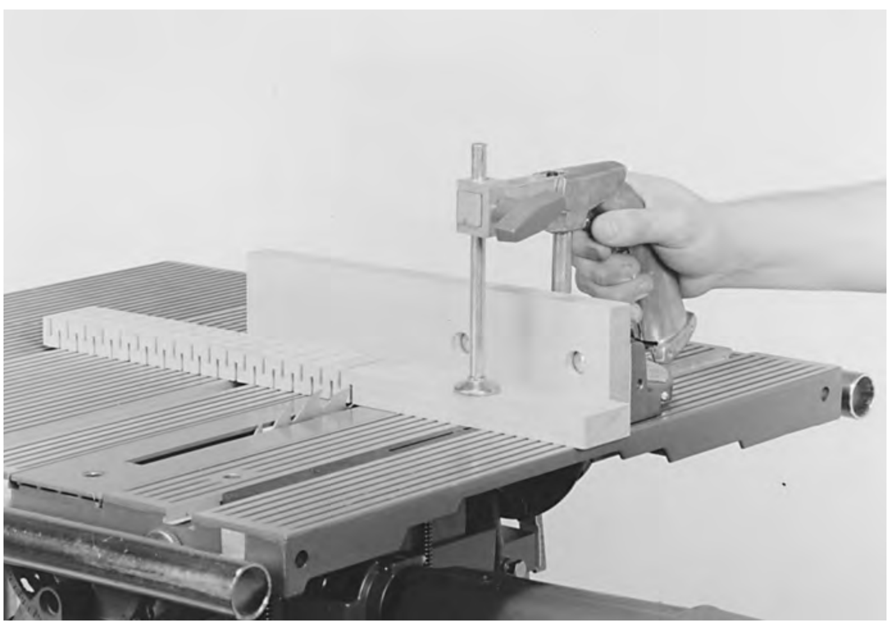


Figure 4-17. Kerfs for moldings can be done using the kerf spacing guide used for kerf bending. Invert the stock and turn it end-for-end for each cut.

opposite surfaces of the stock. When the projection of the saw blade is a bit more than half the stock's thickness, openings in the work result where the cuts cross (Figure 4-18). The overall pattern is affected by the kerfs as well as the openings, so it is important to visualize the results before doing the cutting. It's wise to go through the procedure on scrap material. By using a simple guide like the one shown in use in Figure 4-19, the kerfing can be done at an angle, which adds another dimension to the technique. Piercing can be done with a regular saw blade or with a dado head for wider cuts. ***Warning: Piercing is done without the upper saw guard in place so work with extreme caution.***

FORMING SIMPLE INLAYS

The idea in forming simple inlays is to cut kerfs (Figure 4-20), with a saw blade or dado head, and then fill the grooves with a contrasting wood (Figure 4-21) that is cut to fit. Working in this manner, you'll have a tight, professional looking fit when the inlaid strips cross each other. ***Warning: Inlays are formed without the upper saw guard in place so work with extreme caution.***

Cut all the kerfs that run in one direction and inlay the strips. Then cut the crossing kerfs. The second set of inlay strips will form perfect joints where they cross the first ones. Always cut the inlay strips so they are a bit thicker than necessary. You can sand them, after installation, so they will be flush with adjacent surfaces.

RAISED PANELS

Making raised panels for room doors, cabinet doors, or wall paneling will be easy with a fixture that you can use with your table saw.

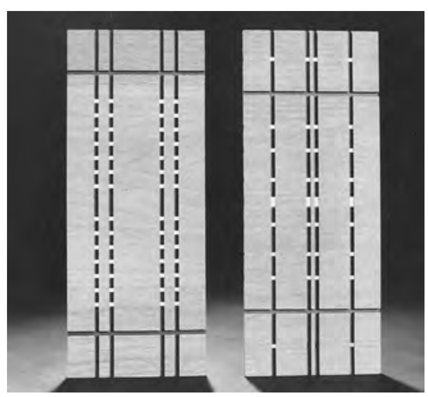


Figure 4-18. Examples of pierced panels. The openings are the result of intersecting cuts that are made on opposite surfaces of the stock.

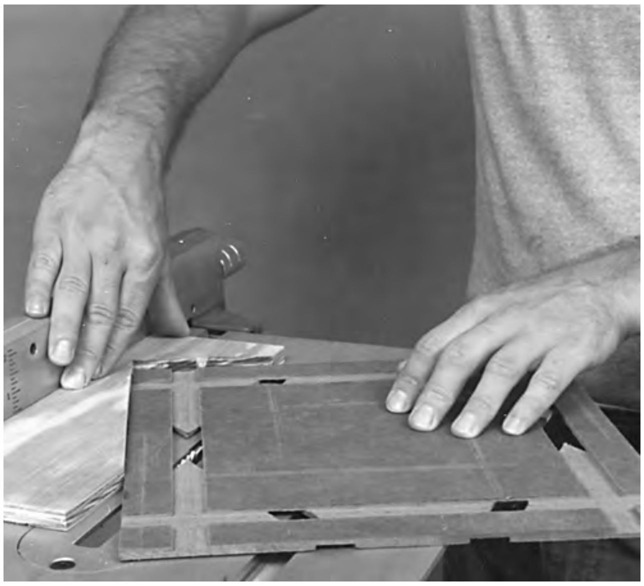


Figure 4-19. Piercing can also be done by making angular cuts. Since most work of this type is too large to be handled with a miter gauge, it is necessary to make a special notched guide so the passes can be made safely and accurately.

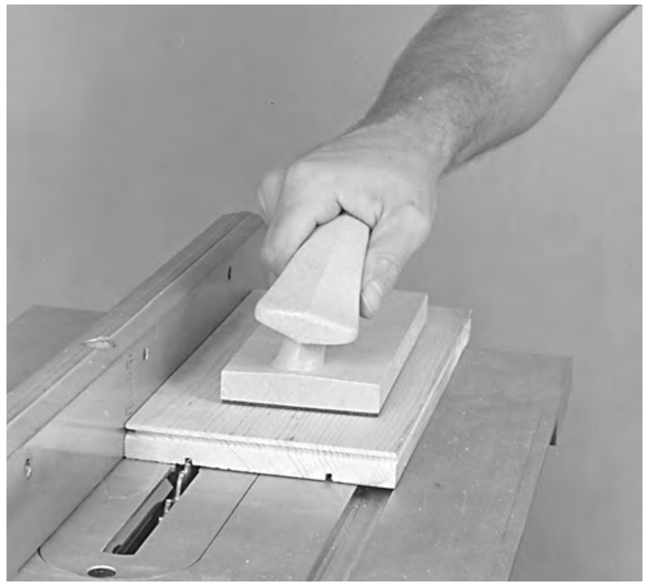


Figure 4-20. Some simple inlay work can be done by cutting surface kerfs and then filling the cuts with strips of contrasting wood.

The fixture straddles the rip fence and will hold your stock securely as you cut the bevels for your panel.

Make the fixture (Figure 4-22) by first cutting all parts to size. Drill the adjustable clamp holes where shown 2″ apart. Use glue and screws to assemble all parts except the clamping strip. Glue fine-grit sandpaper onto the face of the fixture. *Note:* This fixture can double as a tenoning fixture. Insert the workpiece against the back-up strip and cut a tenon on the end of the workpiece.

To use the fixture, tilt the table 5° to 15°—the greater the tilt, the narrower the bevel. Use a carbide-tipped blade for a smoother cut. Place your stock in the fixture, put the clamping bolts as close to the panel as possible, and tighten the wing nuts. The sandpaper will also help keep the panel in place. Position the rip fence on the right side of the blade. Set table height so the inside edge of the blade penetrates through the stock (Figure 4-23). Turn off the machine after each pass and reset the panel in the fixture to cut each side of the panel.

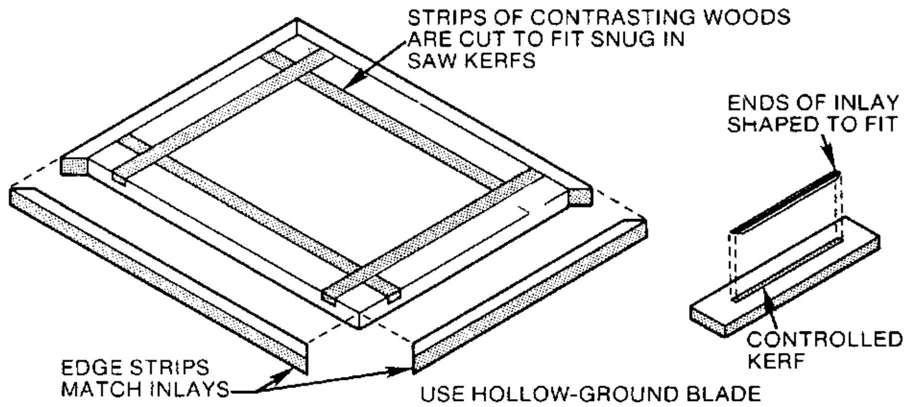


Figure 4-21. You can inlay wider strips if you do the kerfing with the dado accessory.

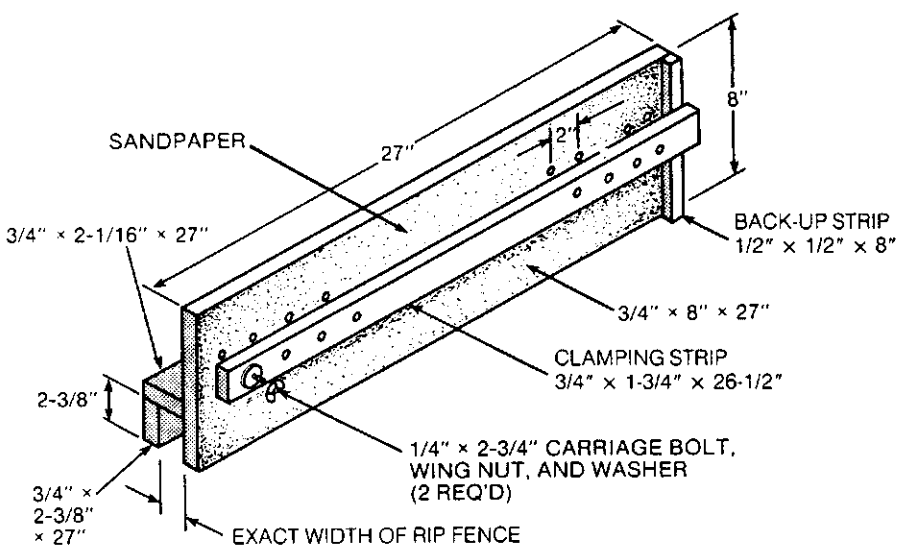


Figure 4-22. Construction details of the raised panel fixture.

Figure 4-23. *To use the raised panel fixture, tilt the table 5° to 15°. Place your stock in the fixture, secure the mounting screws as close to the panel as possible.*

Chapter 5
Table Saw: Molding

Molding operations are performed with the Mark V in the table saw mode. The molder head accessory enables you to add professional detail to almost any project. With it you can shape edges and surfaces, form cabinet door lips, make sash moldings, produce strong glue joints, and do many other operations. Once you become acquainted with the tool, you'll find that you can reproduce many standard wood patterns and also create virtually unlimited original molding designs. In a sense, it allows you to do decorative edging on the table saw.

The molder head (Figure 5-1) is a heavy steel disc that is mounted on the 5/8" molder/dado arbor, then onto the Mark V's main spindle.

Because the molder head works with knives that are 1"wide, it must be used with a specially designed molder insert (Figure 5-2). If the knife projection is small, make a hardboard insert for additional stock support around the cutter. Follow "Special Table Inserts" in Chapter 2 except use the molder insert as a pattern.

Use speed setting Q (3250 RPM) for hardwood and R (3500 RPM) for softwood.

MOLDING SAFETY

Warning: Before using the molder head accessory, read and understand these important safety instructions:

Danger Zone—The danger zone extends 3" out from the knives on all sides, 2' in back of the knives, and 8' in front of the knives. The reason for the extended danger zone in front and back of the knives is because of the danger of kickback.

- **Read and understand "Table Saw Safety" in Chapter 2.**
- **When the molder head accessory is used, it is necessary to remove the upper saw guard. Whenever the upper saw guard is removed, keep the lower saw guard in place and work with extreme caution.**
- **Never use the molder head accessory without the molder insert installed. After installing the molder insert, turn the upper auxiliary spindle by hand to be sure the knives clear the insert.**
- **Make sure the setscrew in the molder/dado arbor is tightened against the flat of the main spindle, the tongue washer is installed next to the hex nut, the threaded shaft of the arbor is flush with or extends past the end of the hex nut, and the hex nut is securely tightened.**

MOLDER KNIVES

All of the knives shown in Figure 5-3 are available for use with the molder head. This is quite an extensive assortment, but it isn't necessary to acquire all of them at once. Start with a few sets that will allow you to make a few basic cuts. Other sets can be added as you become more experienced with molder operations and as the need arises.

Knives, which come in sets of three matched cutters, are de-

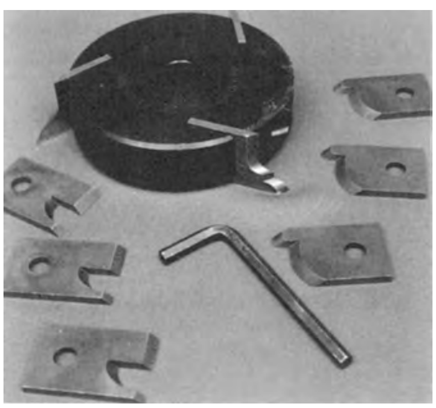


Figure 5-1. The molder head is a thick, heavy steel disc that has equally spaced slots around its perimeter to receive sets of molder knives. A special 5/8" molder/dado arbor (not shown) mounts the molder head to the Mark V main spindle.

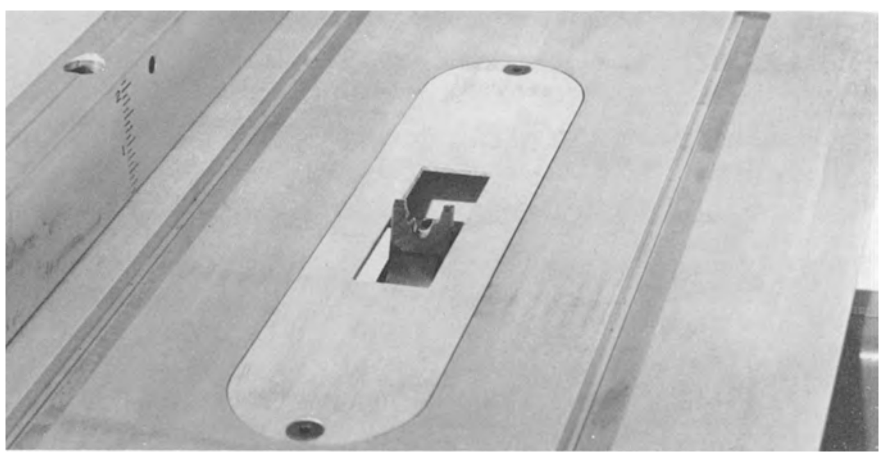


Figure 5-2. The molder head must always be used with the special molder insert (Model 500 insert shown).

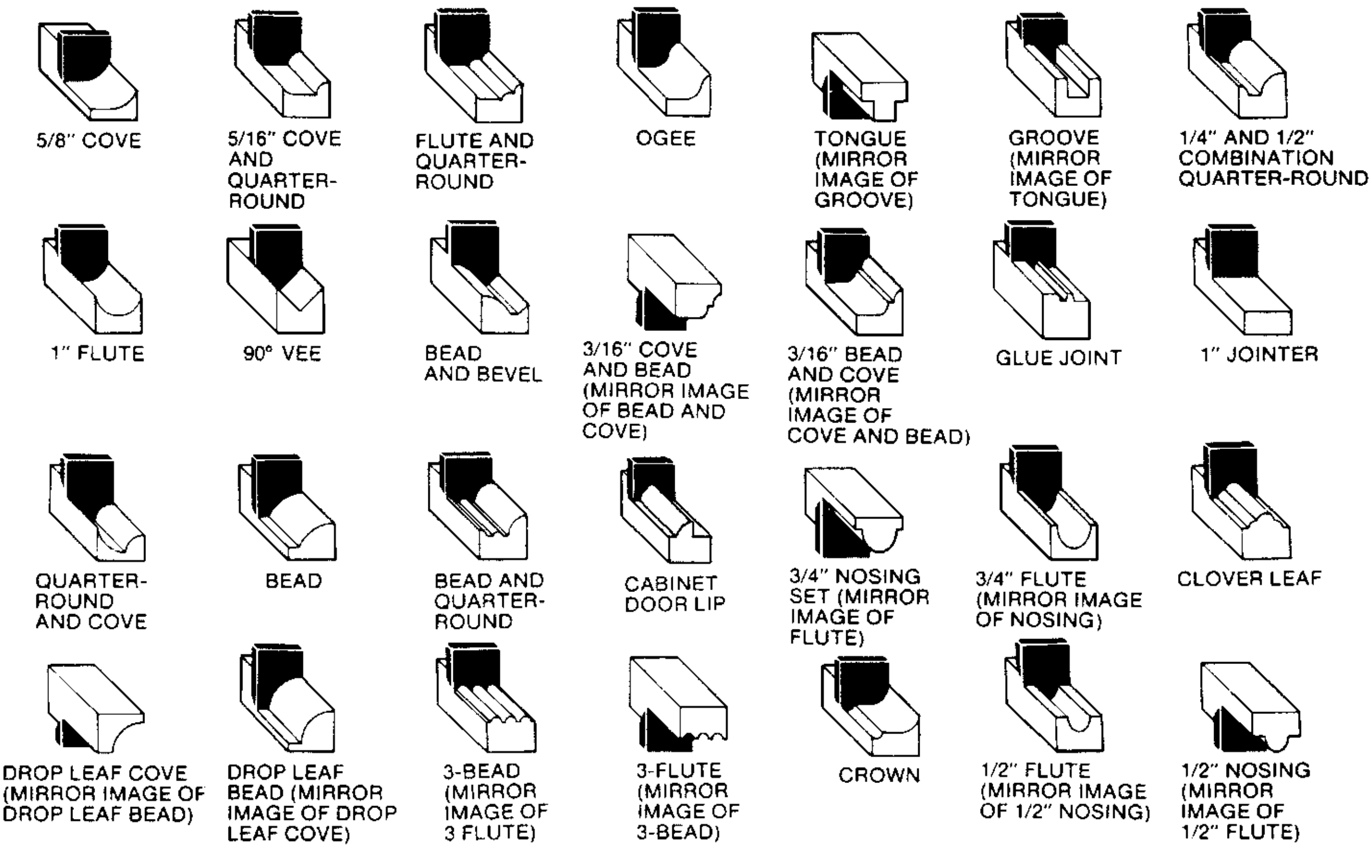


Figure 5-3. *All of these knives are available for use with the molder head. Buy a few that you can use now; acquire more as you become proficient and your work scope increases.*

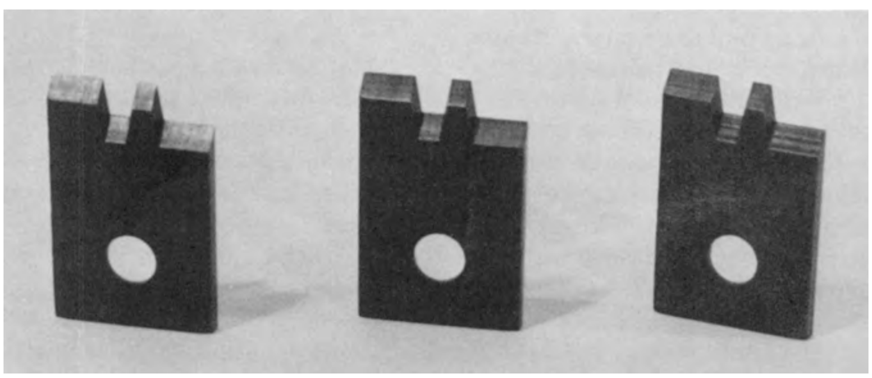


Figure 5-4. *This set of glue joint knives is typical of those which are designed for a special purpose. You can even use part of the profile.*

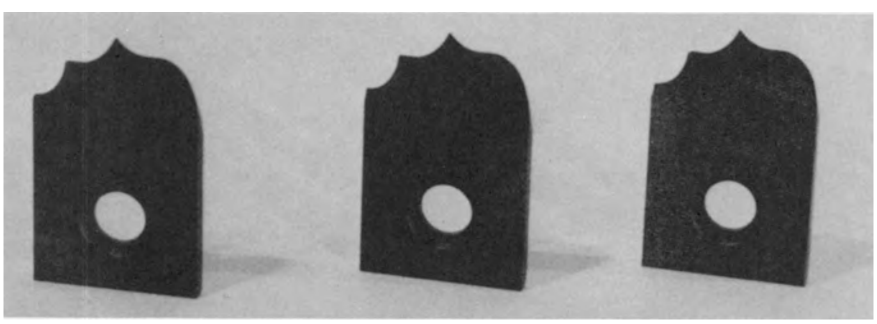


Figure 5-5. *This is a sample set of combination knives. Part of the profile is used to form flutes or quarter-round shapes. You can opt to use the full profile if the form pleases you.*

signed like the glue joint set in Figure 5-4 for full profile cuts; that is, the entire width of the knife is used to cut the shape in the wood. The set shown in Figure 5-5 is designed so only part of the edge is used to cut, in this case, flute and quarter-round shapes. However, the full profile may be used if the shape pleases you.

Other examples of partial-cut knives are shown in Figure 5-6. The different shapes that each knife will produce depend on how you set up for the cut and, sometimes, how many passes you make.

Knives, like the drop leaf table joint shown in Figure 5-7, are also available in matched sets. In this case, one set of knives forms the edge of the table, and the remaining set makes the matching cut on the hinged leaf of the table. Examples of three matching joints and two full-profile cuts are shown in Figure 5-8.

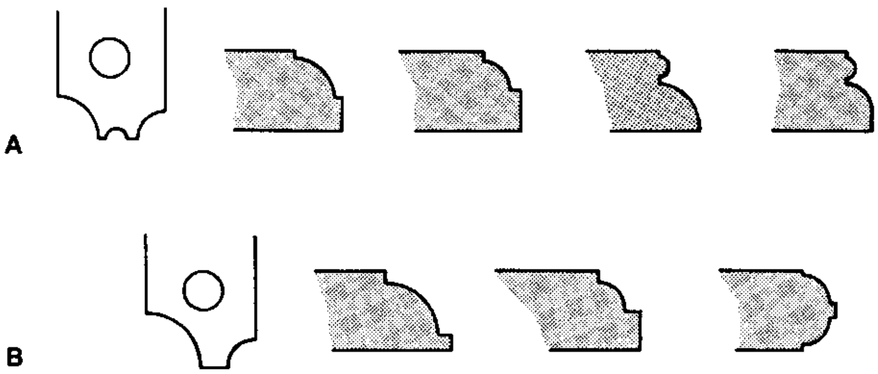


Figure 5-6. As shown here, combination knives can be used to create various shapes. (A) 3/16" and 3/8" quarter-round and 1/4" bead. (B) Combination 1/4" and 1/2" quarter-round.

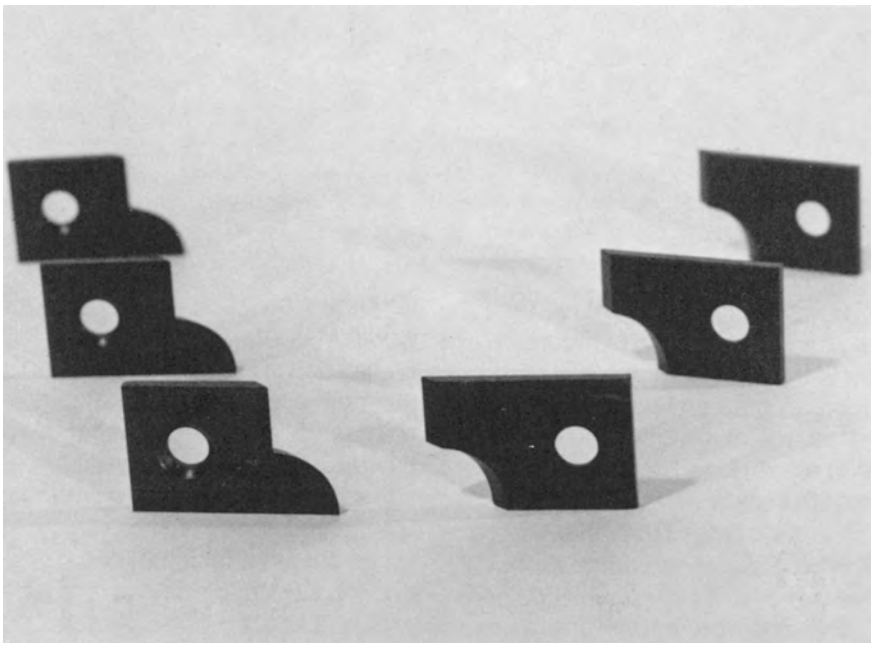


Figure 5-7. *A typical knife set. These two shapes produce the edges that are required for a drop leaf table joint. One set shapes the table's edge, the other makes a matching form on the drop leaf.*

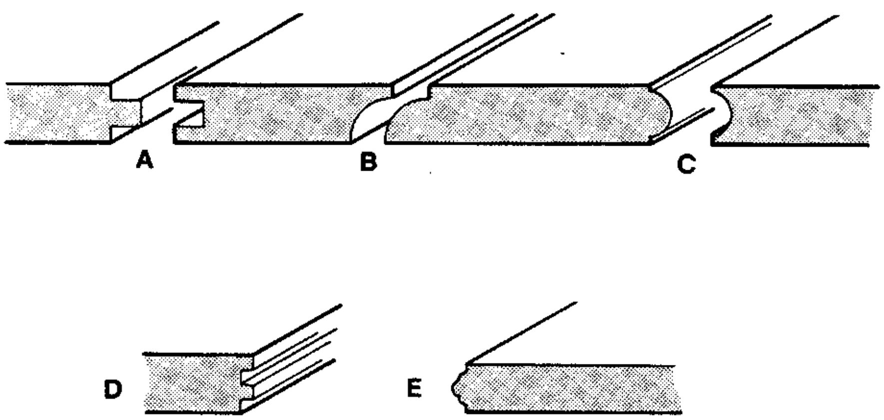


Figure 5-8. *Molder knives that produce these joints are purchased in sets: (A) tongue-and-groove; (B) drop leaf table; (C) flute and nosing. Examples of full profile cuts: (D) glue joint and (E) cloverleaf.*

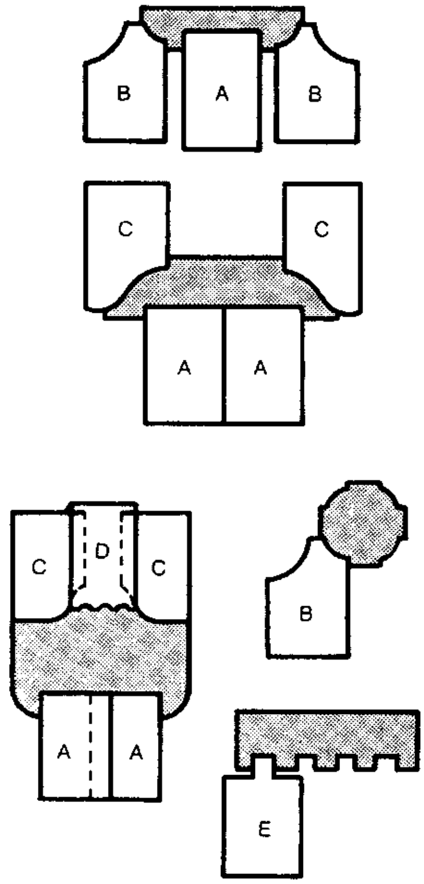


Figure 5-9. *These shapes are typical of advanced work you can do with the molder head accessory. The shapes of different knives combine to produce the final form. Work like this should be planned in advance, on paper, using the knives as templates: (A) 1" jointer; (B) combination 1/2" and 1/4" quarter-round; (C) ogee; (D) three-bead; (E) groove (part of the tongue-and-groove set).*

Knives may also be used in combination; that is, different knives may be used on the same piece of wood to produce a particular shape (Figure 5-9). The possible results are limitless, and with a good assortment of knives you could closely duplicate any molding shape that is displayed in any lumberyard.

Mounting the Knives—The molder head has three slots equally spaced around its perimeter. Each of the slots has its own prevailing torque setscrew which bears against a steel ball that will seat in the beveled knife hole when the setscrew is tightened.

Warning: Be sure the slots in the molder head and the knives are clean. Any dirt that keeps the knives from seating correctly will cause inaccurate cuts and can be dangerous.

Hold the molder head so the slot points toward you and loosen the knife retaining setscrew. Tilt the molder head a bit so the ball moves out of the slot and then, approximately centering the knife, slip it into place. Just before the ball contacts the knife, move the knife side-to-side as you tighten the setscrew. This will center the ball in the hole. The knife will adjust itself to the ball and each knife will be aligned as you secure the setscrew. *Caution: Do not overtighten the screws. This will damage the knife, making it difficult to remove.* Recheck the knives between jobs. Be sure the knives are correctly seated and that the setscrew is tight. The cutting edge of the knife is always on the side toward the setscrew. When the molder head is mounted on the spindle, the cutting edges will point toward the front of the worktable.

Since the profile of the knife is not the profile cut in the wood, you should keep sample cuts of the knives you acquire. These can be overlaid on a drawing of the shape you intend to produce so you can decide which profile, or which part of a profile, should come into play. Many molder knife profiles are duplicates of classic forms. Therefore, these sample cuts can be used as templates when planning designs, not only for molder work, but also when you are planning projects for lathe turning.

MOLDING OPERATIONS

Warning: Since many molder operations are best done by providing bearing surface close to the cutting area, the first thing you need to do is make a rip fence extension.

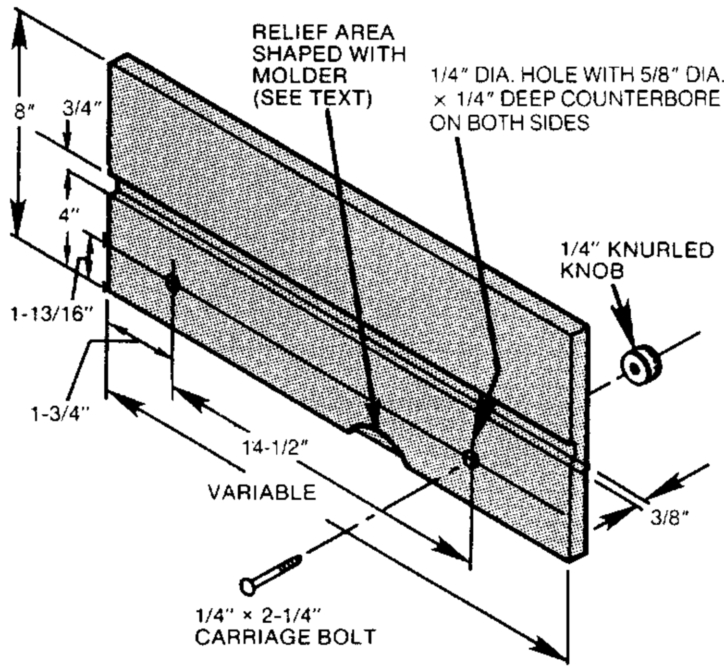


Figure 5-10. *Construction details of the rip fence extension. If you counterbore for the bolt heads on both sides of the fence, you'll be able to attach it on either side of the rip fence for use on the left or right side of the table.*

Construction details of the fence extension are shown in Figure 5-10. If the holes for the bolts are counterbored on each side of the fence, you can secure it to either side of the rip fence, so you will be able to work with the fence on the left or right side of the table. ***Warning: Never position a feather board over the molder head. Position feather boards in front of or behind the molder head.***

To make the arched relief area for the knives, mount the set of knives you are going to use in the molder head and, with the worktable elevated above the accessory, lock the fence so the knives will cut most of their width into the fence extension. Turn on the machine and very, very slowly lower the table until the knives have formed an arch the maximum depth needed.

Molder cuts remove a lot of material, so passes should be made slowly, allowing the knives to cut without choking. A slow pass also results in smoother cuts, since the knives will be working longer on any given area of the wood. Make very deep cuts in stages, lowering the table or adjusting the fence position after each pass until the full cut depth or width is reached. Some warning signs that indicate you are cutting too deeply or too fast include rough cuts, the molder slowing, and the work beginning to chatter.

Cuts that are made on stock edges are handled as shown in Figure 5-11. Smoother shapes result when you place the stock so you are cutting with the grain of the wood. This isn't always possible, so when you must work against the grain, feed the work even more slowly than usual.

Cuts made on stock ends can be held securely when you work with the miter gauge and safety grip (Figure 5-12). ***Warning: Use the miter gauge with safety grip to hold stock less than 10" wide. It is difficult and unsafe to try to hand-hold such work.***

Cuts that are made across the grain will always have slight imperfections at the end of the cut. To compensate, slow down when

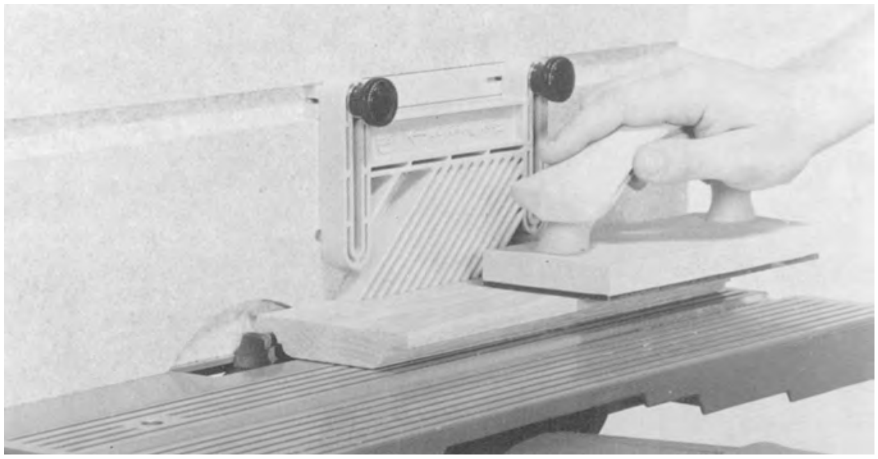


Figure 5-11. This is how to handle cuts on stock edges. Keep work flat and snug against the fence. Make the pass slowly.

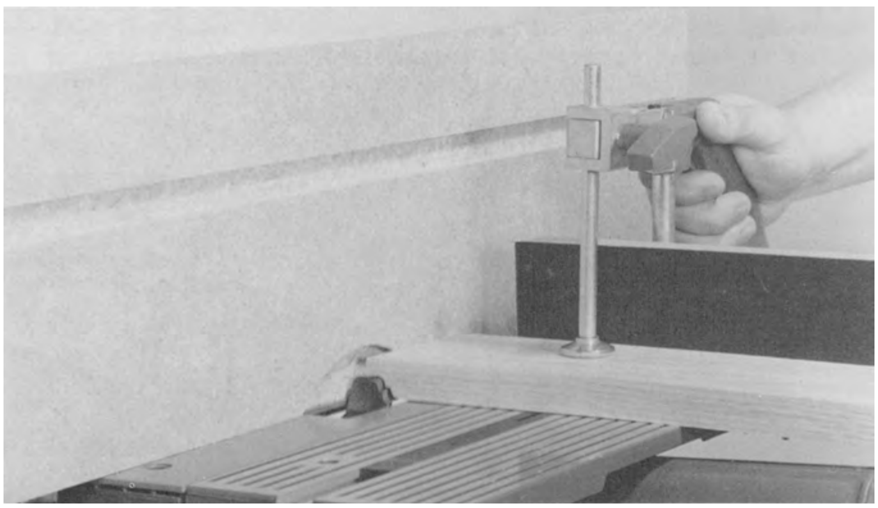


Figure 5-12. Cross-grain cuts or cuts on stock ends are done this way. The miter gauge holds the stock square to the fence; the safety grip keeps the stock secure.

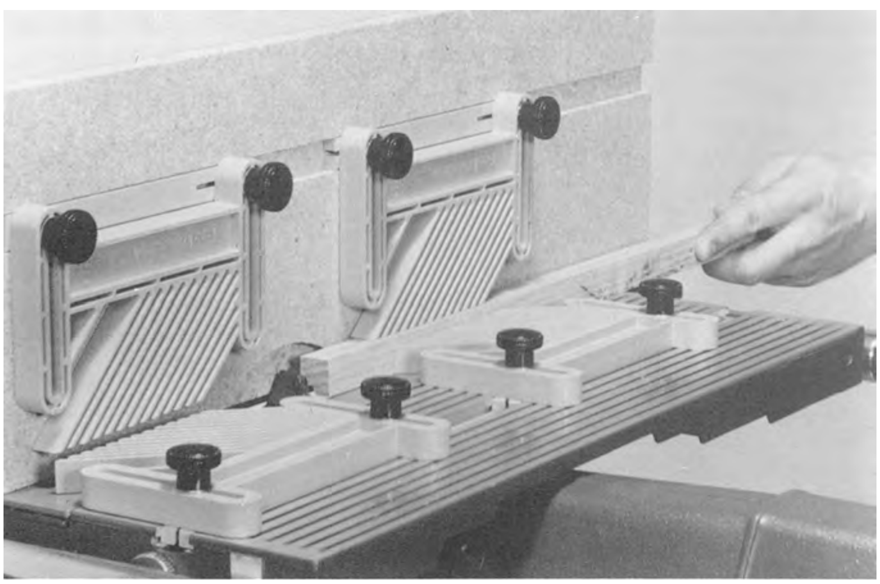


Figure 5-13. Work this way when you need many similar pieces of slim molding.

near the end of a cut or work with stock that is slightly wider than you need. A trim cut, made by ripping or jointing, can then bring the stock to correct width while removing the flaw.

When a project component requires that adjacent edges or all four edges of the piece be molded, make the cross-grain cuts first. The final cuts, made *with* the grain direction, will remove those slight imperfections that are characteristic at the end of cross-grain cuts.

Slim Moldings

If you need a single piece of narrow molding, it is safer to form the shape on a piece of wide stock that you can safely handle and then rip to remove the shaped edge. If many similar narrow pieces are needed, you should organize for the operation as shown in Figure 5-13.

Pre-cut workpieces to size on the table saw. The feather boards are positioned to suit the height and width of the workpieces. The best procedure is to push the workpieces at the infeed end without allowing the workpiece to stop. ***Warning: Use a small piece of scrap to push the workpiece past the cutter. Support long pieces with a roller stand.***

Surface Molding

One facet of woodworking that nearly always requires working

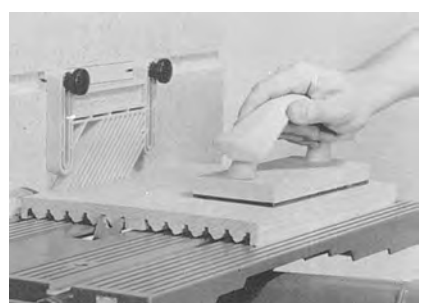


Figure 5-14. Surface cuts are done in routine fashion; but be careful with settings so cut spacing will be correct. The feather board helps to keep the work flat on the table.

with the molder head accessory is making decorative cuts on stock surfaces (Figure 5-14). The operation doesn't differ from usual procedures; it's the spacing of the cuts that is critical. Good work results when you are careful when making and changing settings.

Surface-molded pieces can be used as is, as decorative inset panels in furniture projects, or they can be the base material for fancy moldings. Once the surface molding is finished, the work can be strip-cut into wide or narrow pieces (Figure 5-15).

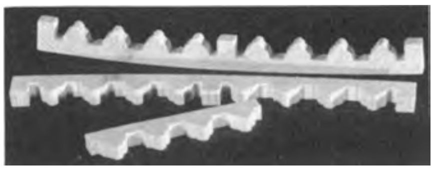


Figure 5-15. *Surface-molded stock can be strip-cut to produce interesting moldings.*

Other examples of surface-molded pieces are shown in Figures 5-16 and 5-17. Those in the latter photo were done with a set of 90° Vee-knives.

Remember, when you make cuts that cross each other, make the cross-grain cuts first, and make them very slowly. Even so, they will not be as smooth as those made with the grain. A light sanding of the cross-grain cut surfaces will improve them.

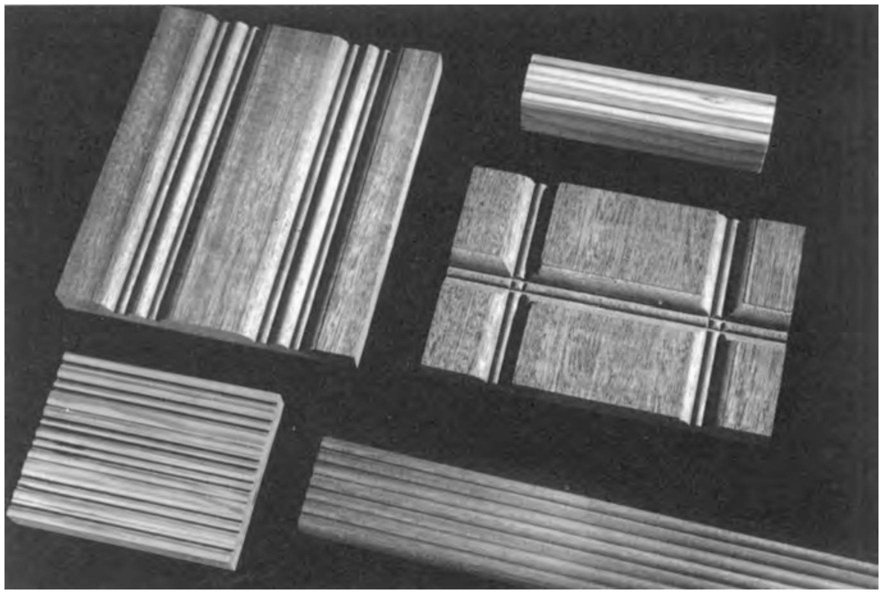


Figure 5-16. *Examples of surface-molded pieces. When cuts cross, make those that are across the grain very slowly. They will require some sanding to make them as smooth as with-the-grain cuts.*

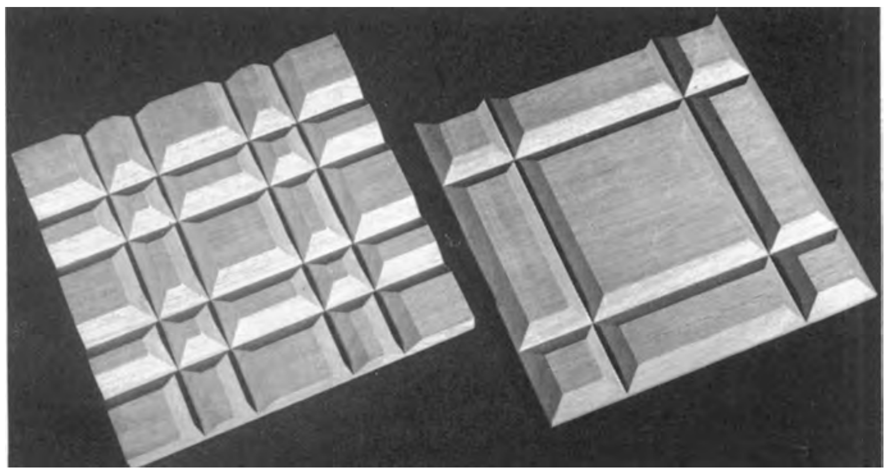


Figure 5-17. *These attractive, faceted panels, which can be used as insets in furniture projects, were surface molded with 90° Vee-knives.*

Forming Joints

When the molder head is equipped with 1" jointer knives, you can use it for joinery. For example, you can cut a rabbet (Figure 5-18) by holding the work flat on the table and moving it slowly and steadily throughout the pass. To form a tongue, just cut back-to-back rabbets (Figure 5-19).

Other molder knife profiles are used to produce joints; among them are the glue joint cutter and the tongue-and-groove set.

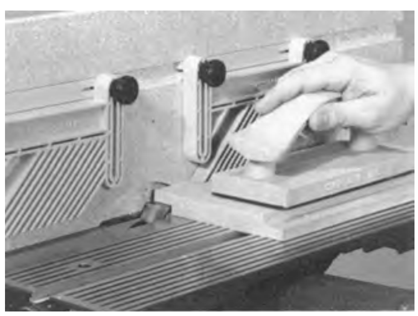


Figure 5-18. *Jointer knives can be used for joinery. Here, the operation results in a rabbet cut. Because of the width of the knife being used (1"), the rabbet can be formed to easily accommodate 3/4" stock.*

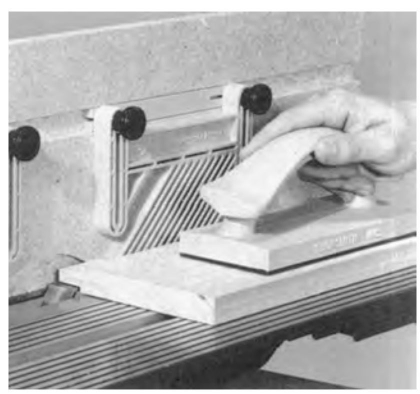


Figure 5-19. *A tongue is the result when back-to-back rabbets are cut on the same edge of the stock.*

Chapter 6
Jointer

The jointer is designed to quickly and accurately accomplish many operations that would require many hours of tedious labor if done by hand. It's a rotary cutter that will plane edges smooth and square, ready for gluing or assembling. It will do a fine job on light surfacing cuts also, but should not be confused with the planer, as jointers often are. The planer is designed to dress stock to exact thicknesses and perfectly parallel surfaces. The jointer is used to square edges to surfaces and straighten surfaces.

JOINTER — SETUP AND FEATURES

To set up your jointer, follow the instructions in the Owners Manual that came with your jointer.

As you work with the jointer, you'll find that it has several special features:

• The jointer mounts on the Mark V or a Shopsmith Power Stand (Figure 6-1).

• The dust chute will allow you to connect the hose from your dust collection system to the jointer. Since most heavy-duty dust collection systems have fairly strong motors, you should not plug a dust collection system into the same circuit as the Mark V.

• The width of cut is a full 4″.

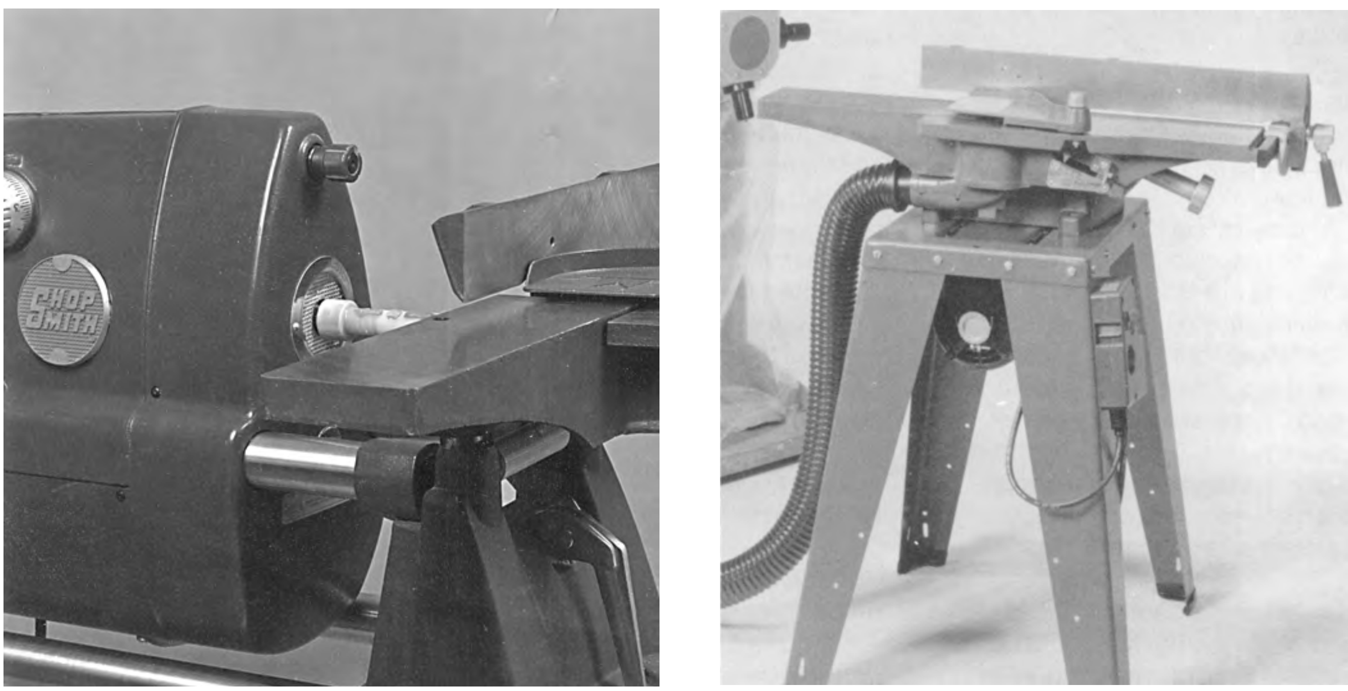
• The depth of cut is adjustable from "0" to 3/8″. The maximum depth of cut for most operations is 1/8″. When surfacing, the maximum depth of cut is 1/16″. You can make full use of the 3/8″ depth of cut in stages when performing special operations.

• The infeed table is 5-5/8″ wide by 13-1/4″ long. The outfeed table is 4-1/2″ wide by 13-5/16″ long. Together, the overall table length is 28″.

• The fence is 3″ high and 21-3/4″ long. It tilts 45° to **either** the left or right and has adjustable positive auto-stops at 45° right, 90°, and 45° left. It may be positioned anywhere over the cutterhead. Also, the fence has predrilled 1/4″ holes, making it easy to add fence extensions to help support wide stock.

• The cutterhead is 2-1/2″ in diameter, with three precision-ground steel knives. It's equipped with individual knife leveling screws so that you don't have to match-grind each knife.

• The jointer can make the cuts and joints shown in Figure 6-2.



A **B**

Figure 6-1. *The Jointer can be mounted on (A) the Mark V or on (B) a Shopsmith Power Stand.*

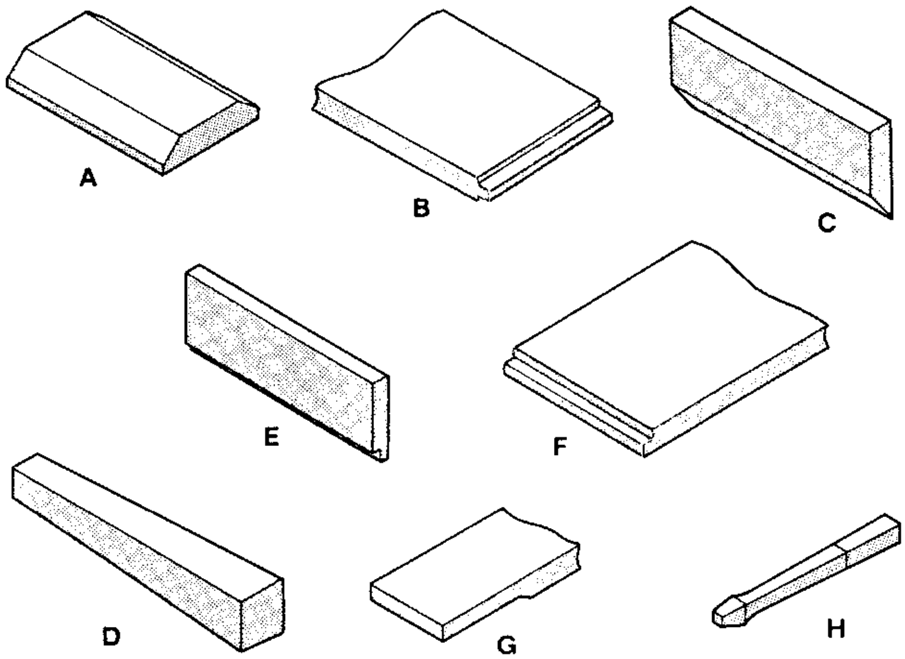


Figure 6-2. *The cuts and shapes listed here can be formed on the jointer: (A) chamfer; (B) tenon; (C) bevel; (D) taper; (E) edge rabbet; (F) end rabbet; (G) surfacing (cut depth exaggerated for clarity); and (H) furniture leg (example).*

SETTING DEPTH OF CUT

Never try to remove more than 1/8″ at a time when edge jointing or 1/16″ when surfacing. If you follow this rule, you'll get a much smoother cut and waste less wood. Most finishing cuts on the jointer are made with settings of 1/32″ or less.

The 3/8″ maximum setting is used only for special operations such as rabbeting (even then the stock must be removed in several shallow cuts).

When you set the depth of cut, always make your adjustment from a greater to a lesser depth. For instance, if the jointer is set to cut 1/16″ deep, but you want it to cut 1/8″ deep, turn the adjustment knob clockwise until the pointer goes past the 1/8″ mark on the depth-of-cut scale. Then turn the knob counterclockwise until the pointer rests on the 1/8″ mark.

This maneuver takes up any "slack" in the depth-of-cut adjustment mechanism. If you don't set the depth of cut from greater to lesser, there's a good chance the infeed table will move slightly during the pass and you'll get an uneven cut.

JOINTER SAFETY

Warning: Before using the jointer, read and understand these important safety instructions:

Danger Zone—The jointer danger zone is 3″ out from the cutterhead and knives and 8′ directly in front of the cutterhead. When you use the jointer, stand to the left of the machine (opposite the drive shaft) and keep your hands away from the knives.

- **Always wear proper eye and ear protection.**
- **Never remove the guards to increase the capacity.**
- **Use a push stick or push block to move stock past the cutterhead especially when the stock is lower than the top of the fence.**
- **Never remove more than 1/8″ at a time when edge jointing or 1/16″ when surfacing.**
- **Always lock the fence. If your jointer is mounted on the Mark V, secure the accessory mount lock, power plant lock and the eccentric mounting tubes.**
- **Never joint or surface stock less than 10″ long or more than 4″ wide, edge rabbet stock wider than 1″, surface stock less than 1/4″ thick or joint the end grain of stock less than 10″wide.**
- **Never joint 'second-hand' lumber. You could be hit by pieces of nails, screws, etc. Also, never joint or surface painted or dirty wood, plywood, particle board or other hard materials.**
- **Support long stock with roller stand(s).**
- **Turn off the power before making any adjustment, tightening the accessory mount lock or clearing wood chips.**
- **If an unusual noise, vibration or uneven cut occurs, turn off the jointer and check the wedge locking screws immediately.**
- **When using the saw-jointer combination, make sure the upper and lower saw guards are mounted on the Mark V.**
- **Knives that have been reground to less than 11/16″ (.6875″) wide should not be used.**
- **Use only Shopsmith Jointer knives in the Shopsmith Jointer. Other brands of knives are not wedge-shaped and will not seat properly in the cutterhead. Using other brands of knives is very dangerous.**
- **If you're using a Shopsmith Power Stand, be sure you're using the proper pulley and belt combination and that the pulley and belt are properly guarded.**

JOINTER SPEEDS

Before you begin any jointer operation turn on the Mark V, set the speed dial according to Table 6-1, and let the jointer come up to speed.

The deeper the cut or the harder the wood, the slower you should

Table 6-1: Jointer Speed Chart

Operation	Hardwood	Softwood
Heavy Cuts	M (3900 RPM)	O (4550 RPM)
Finishing Cuts	Q (5300 RPM)	S (6200 RPM)

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1. Because the jointer mounts on the lower auxiliary spindle, the rpm is 1.6 times faster than for the upper auxiliary and main spindles.

Figure 6-3. *The jointer can be used in combination with the Mark V table saw.* ***Warning: Be sure the upper and lower saw guards are in place.***

run the jointer. If the jointer runs too slow, you may get a rough cut, so you'll want to experiment with scrap until you can select the proper speed for the stock you're jointing.

SAW-JOINTER COMBINATION

The Mark V was designed so that the table saw and the jointer can be used in combination (Figure 6-3). When the speed dial is set at "Saw-Joint," the power plant runs each tool at the proper speed. ***Warning: Be sure the upper and lower saw guards are mounted on the Mark V.***

To square the edges, joint one edge of a board before beginning any sawing operation. This produces a smooth, straight edge to place against the rip fence and assures a straight, parallel cut. When you're ripping, cut the stock slightly oversize so that you can also joint the second edge.

EDGE JOINTING

The edging cut is made by moving the stock so the knives will be cutting with the grain of the wood (Figure 6-4). ***Warning: Working against the grain seldom produces a satisfactory surface; it also increases the danger of kickback and splintering.***

If the cutting action is not smooth or if you feel the stock pushing back against your hands, the chances are that you are working against the grain. Stop the pass immediately and reverse the position of the stock.

If you have to make a cut against the grain, take a very light cut and make the pass very, very slowly.

Depth-of-cut settings on edge jointing cuts never should exceed 1/8". A setting of from 1/32" to

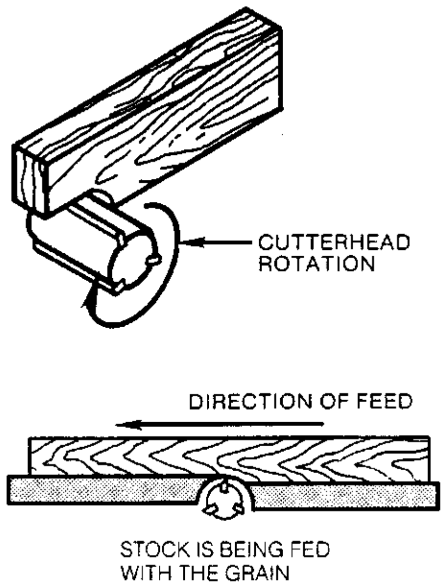
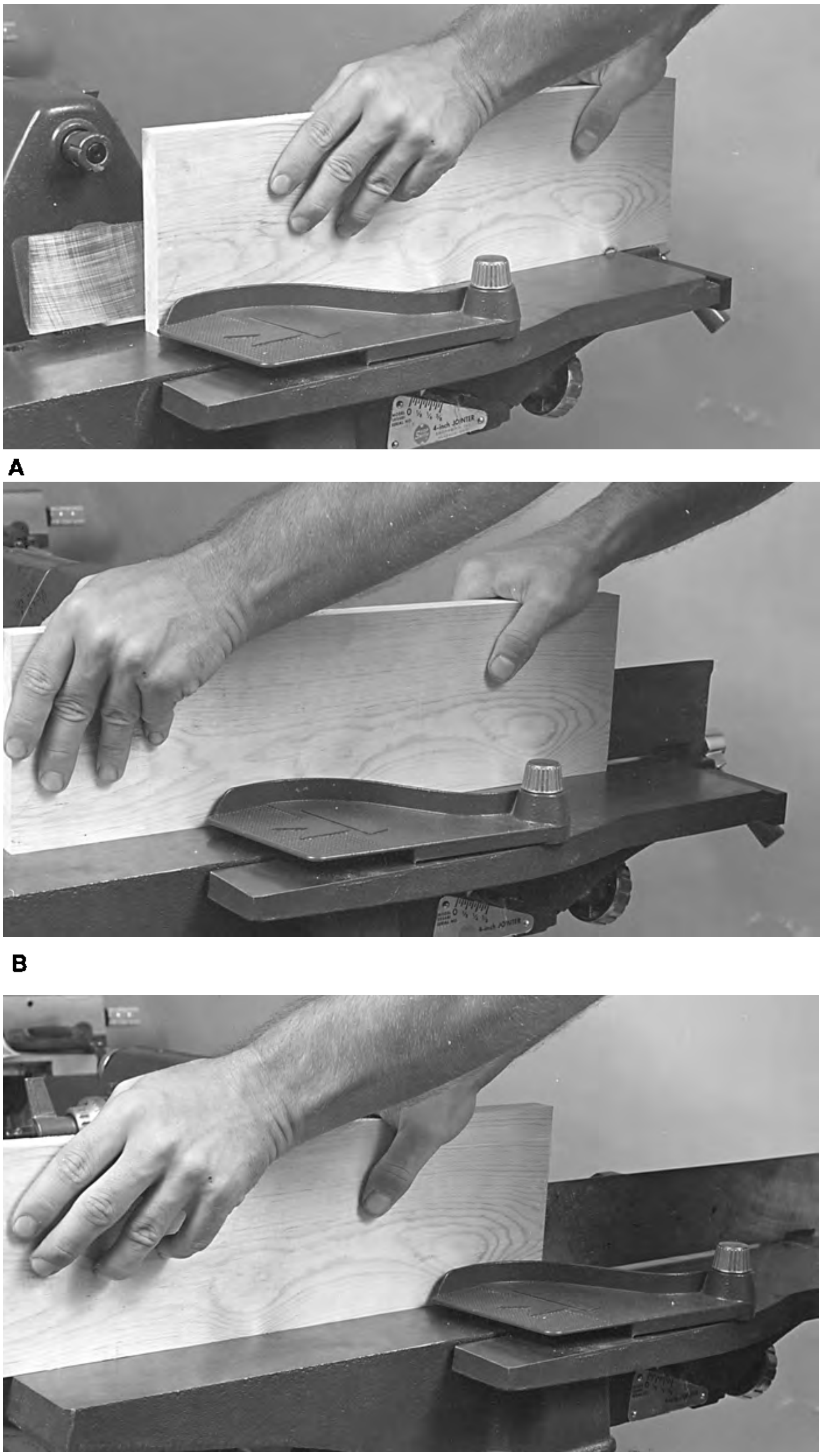


Figure 6-4. *Always try to work so you are cutting with the grain of wood; when this isn't possible, make very light cuts, very slowly. Note: The depth of cut is exaggerated for clarity.*

1/16" usually does the best job and wastes less wood.

Although the jointing cut is a smooth movement from start to finish, it may be thought of in the three steps shown in Figure 6-5. The better side of the stock is placed against the fence with the work edge down on the infeed table. Hands should be placed to hold the stock down on the table and snugly against the fence. The left hand holds the stock down 4" to 6" before the first bump on the top of the fence and guides the stock. This permits both side and down pressure to hold the stock firmly against the fence and flat on the table. The right hand is placed near the end of the stock and feeds the stock forward. ***Warning: If the stock is below the top of the fence, always use a push stick or push block to complete the pass.***

As the stock moves over the cutterhead, the guard moves aside to permit its passage. The left hand does most of the work of keeping the stock snug against the fence and down on the table, while the right hand moves it forward.



A

B

C

Figure 6-5. (A) Begin the cut using your left hand to steady the stock and your right hand to feed it forward. (B) As the stock nears the halfway point, reposition your left hand to the outfeed side of the jointer. (C) Continue to steady the stock with your left hand while you move your right hand to the outfeed table. Finish the cut by pushing the end of the stock past the cutterhead with both hands.

Always try to keep hands hooked over the top of the stock. ***Warning: Do not allow your hands to pass directly over the cutterhead.***

At the end of the cut, the hands are still in about the same position on the stock. Avoid heavy downward pressure at the end of the cut, since this might tilt the stock into the cutter, resulting in a gouged end.

If the machine is properly adjusted and the pass is made correctly, the jointed board will have edges that are square with its face. Edges of a group of jointed boards will fit against each other without gaps, checking out in all respects shown in Figure 6-6.

JOINTING EXTRA-WIDE STOCK

Wide boards that project significantly above the top of the fence require careful handling so they won't tilt as you make the pass. The best way to joint extra-wide stock is to equip the jointer with an extra-high (even extra-long) fence extension that you can bolt in place using the two holes that are in the fence.

Jointing passes are then made in normal fashion but with extra support provided by the fence extension to keep the stock from tilting (Figure 6-7).

Figure 6-8 shows how the fence extension is made. The height may vary according to its intended use. For example, a high fence is very helpful for jointing wide

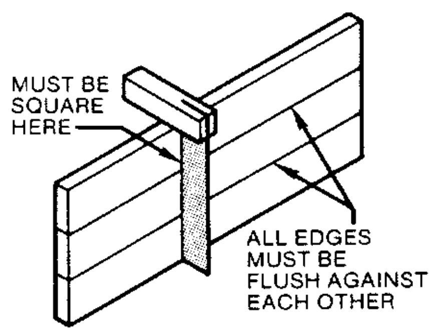


***Figure 6-6.** When jointed boards are butted edge-to-edge, they should have these qualities.*

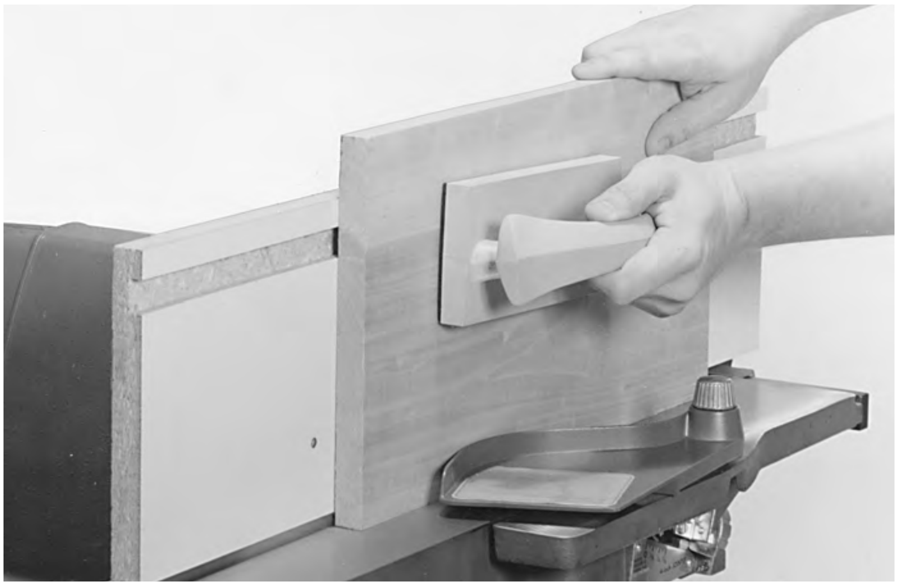


Figure 6-7. The high fence extension provides extra support when you are jointing extra-wide stock.

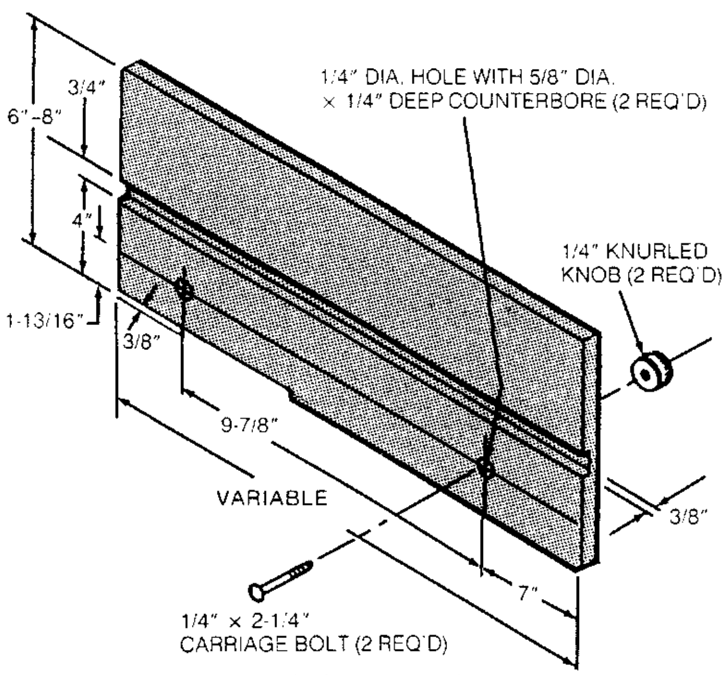


Figure 6-8. Construction details of a fence extension.

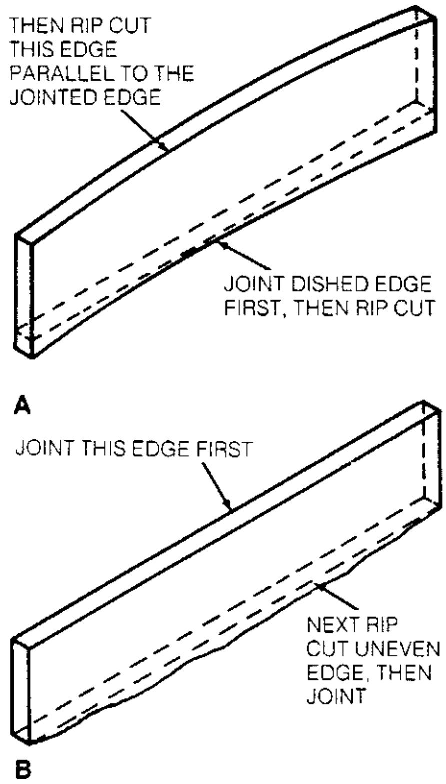


Figure 6-9. (A) The concave edge of a dished board can be straightened by making several light cuts. (B) When a board has an uneven edge, joint the opposite edge first. Next rip cut the uneven edge, then joint.

boards because it makes it easier to be sure the face is flat on the fence, and the edge is therefore going to be cut square to the fence.

EDGE JOINTING PROBLEM STOCK

Stock with knots, "wild grain," or extensive figuring is always difficult to joint; therefore, it requires extra care. For best results, feed the stock slowly and take very light cuts. ***Warning: Be especially cautious of kickbacks and stop cutting immediately if the stock will not feed smoothly.***

Whenever possible, stock that is distorted like the piece shown in Figure 6-9A should be jointed on the dished edge first. This is to provide adequate bearing surface for the jointing cuts that will produce one even edge so the stock may be ripped parallel on the table saw.

Warning: Use extra care when a curved edge must be jointed, since only a small area of the edge will bear on the table surface. The first pass will provide a flat area that will facilitate subsequent passes.

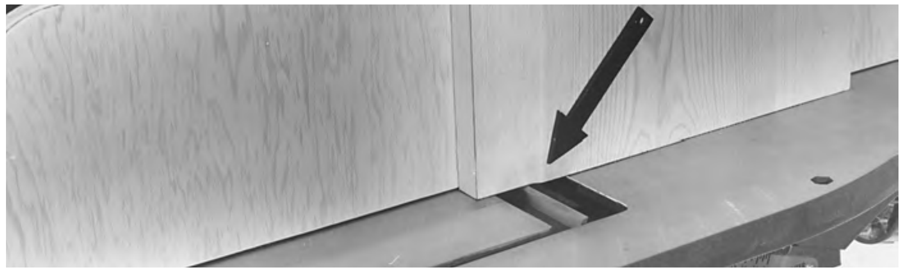
Stock having one uneven edge, as shown in Figure 6-9B, is handled by jointing the one straight edge first. This edge rides against the rip fence and is rip cut to remove the uneven edge; then the rip cut edge is jointed.

These guidelines apply to stock that has minor edge imperfections. ***Warning: Don't waste time on badly distorted material. It can be dangerous and you may not have much material left after the distorted areas are removed. It's a good rule to joint only good lumber.***

JOINTING END GRAIN

End grain jointing is always difficult because you're jointing at the worst possible angle to the grain. For most projects, end jointing is not even necessary. But when you need to do it, follow these steps:

Take very light cuts (1/32" or less) and feed the work as slowly as is practical. Check to be sure the jointer knives are sharp or they may burn the end grain during the cut. Joint the ends before jointing the edges so that any minor splintering will be removed. Splintering can also be reduced by jointing about 2" in from one side, then reversing the piece to complete the cut (Figure 6-10). You may also want to score the wood fibers at the very end of the cut with a chisel or utility knife before jointing.



A

B

Figure 6-10. *To reduce splintering, (A) make one pass to about this point; then (B) turn the stock end-for-end and make a second pass until it meets the first one which, here, is indicated by the arrow. Note: The guard is removed and the depth of cut is exaggerated for clarity.*

JOINTING FOUR EDGES

When four edges of a piece of stock are to be jointed, the operation may be done as shown in Figure 6-11. The first and second cuts—across the grain—can be accomplished with single passes; the third and fourth cuts—with the grain—will remove the slight imperfections resulting from the first two cross-grain cuts.

SURFACING

Surfacing—jointing the face of a piece of stock—is usually done for one of three reasons: to smooth up a rough surface, to thin down a workpiece, or to remove a warp. Always use extra care when you surface because the top of the work is below the top of the fence and your hands are close to the danger zone. ***Warning: Always use a push stick or push blocks to move the stock over the cutterhead. Never try to surface a piece of stock less than 12" long or 1/4" thick.*** If you need a smaller component for a project, do your jointer work on a larger piece and cut off what you need.

The technique for handling and feeding the stock is similar to edge jointing. However, since the stock lies flat on the table below the top of the fence, always use a push stick or push blocks (Figure 6-12). They help you to maintain even pressure, give you better control over the stock, and help keep your hands out of the danger zone. As you get used to using a push stick and push blocks, you'll find they may actually improve your woodworking. Since a push stick or a push block keeps your fingers safe, you feel more confident while making a cut. This confidence helps you achieve better control, and better control means a better cut.

If you are using push blocks with sponge rubber bottoms, you may want to modify the hand movements when cutting. Use your left hand to position the push block about midway along the infeed table and move the push block forward with the stock while maintaining downward pressure. As the push block starts to enter the danger zone, stop the feed, bring the left hand back to its starting point, and then continue. With a little practice, these short movements can be made without affecting the quality of the cut.

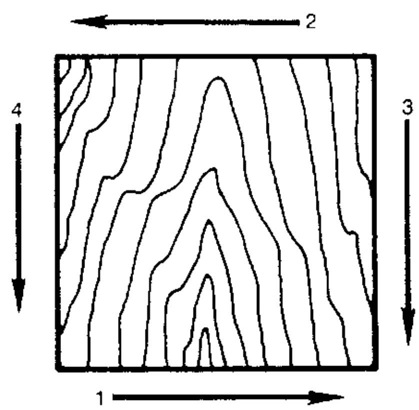


Figure 6-11. *When all four edges of a piece of stock must be jointed, follow the pass sequence shown here. The final passes will remove the imperfections caused by cross-grain cutting.*

SQUARING STOCK

Figure 6-13 shows the sequence of cuts if a board must be squared on all six sides. First straighten

Figure 6-12. A push block will help maintain even pressure, give better control over the stock, and keep your hands out of the danger zone.

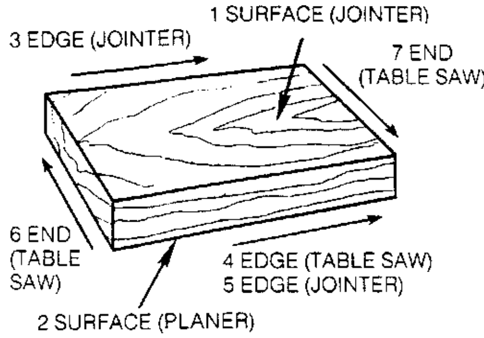


***Figure 6-13.** The seven steps and machines used to square up the six surfaces of a piece of stock.*

one surface using the jointer, then plane the second surface parallel to the first using the planer. Then joint one edge to straighten it with the jointer depth set to remove no more than 1/16″ per pass. Place the jointed edge against the table saw rip fence. Rip to width plus 1/16″. With the jointer set to remove 1/16″, joint the sawn edge. Crosscut one end. Remove just enough to square up the end. Measure to length and crosscut the other end.

SURFACING PROBLEM STOCK

Boards with defects such as cupping or wind must have special attention if they are to be surfaced safely and with a minimum loss of stock.

A cupped board is dished across its width as shown in Figure 6-14; its high points provide some bearing surface when the board is placed concave-side-down on the table (Figure 6-15). Keep the board as level as possible during the first pass; after that it will have a "flat" to provide bearing surface.

An optional procedure to use when the thickness of the stock permits is to resaw the stock after the jointer has established a flat surface for the rip fence. This will roughly surface the second side

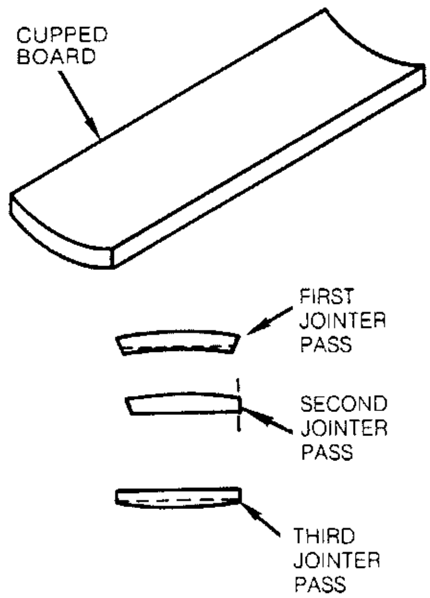


***Figure 6-14.** Cupped boards, if they are narrow enough and the cup is not extreme, can be jointed in this manner.*

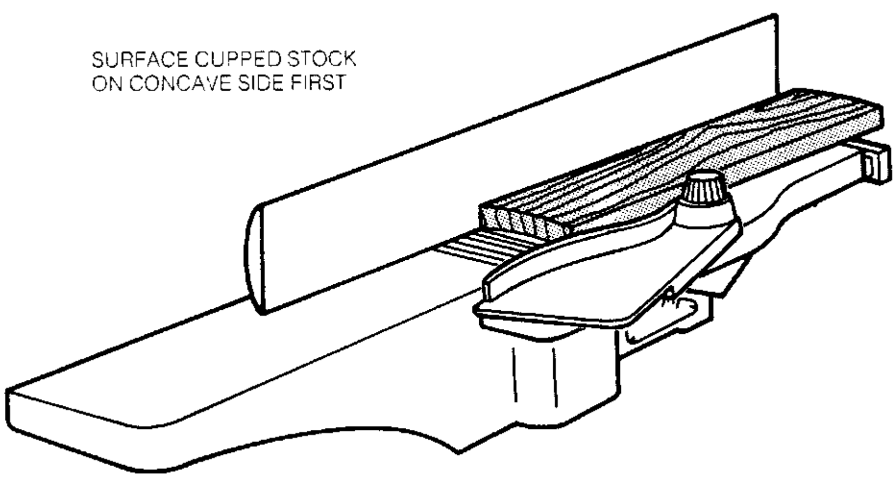


***Figure 6-15.** The high points provide some bearing surface when the cupped board is placed concave-side down on the table.*

parallel to the first one. The saw marks can then be removed with a light surfacing cut.

Boards with wind (Figure 6-16) have a twist in the length of the stock. The best way to level such a board is to mark the high spots and remove them in the first pass, creating flat spots on which the board can rest. ***Warning: Don't waste time on badly distorted material. It can be dangerous and you may not have much material left after the distorted areas are removed. It's a good rule to joint only good wood.***

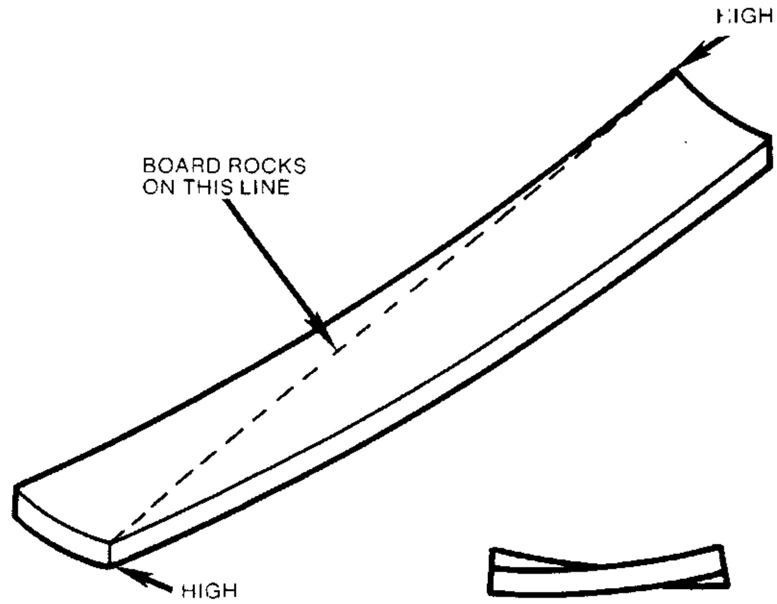


Figure 6-16. This type of distortion, called "wind," is indicated by a twist in the length of the stock.

BEVEL CUTS

By tilting the jointer fence, you can make smooth, accurate angular cuts for a variety of projects (Figure 6-17). Be sure the machine is off; then push the fence lock handle in and unlock the fence tilt. Adjust the fence to the desired angle, and relock the fence securely.

Whenever possible, work with a closed angle fence tilted over the knives, because it's easier to prevent slips and loss of control with this setup. Take shallow cuts with each pass. The face of the bevel will get wider with each cut; eventually reaching across the edge. However, if the stock is thick, the fence may have to be tilted backwards so it forms an open angle with the tables. ***Warning: When the fence is tilted backwards work with extreme caution. Hold the stock so it won't slide out from under your hands. Use push blocks to move the stock.***

CHAMFERS

A chamfer is a bevel cut that does not remove the entire edge of the stock. Accomplish it by setting the fence to the angle desired (as you would for a bevel cut) and then making the number of passes required to shape the chamfer; that is, if you're cutting chamfers all the way around a workpiece, start with an end grain pass; then work your way around the stock. Make one pass; turn the stock 90°; make another pass; turn the stock; and so on. Continue until the chamfer is as pronounced as you want it and you've made the same number of passes on all sides of the stock. This way each edge will be cut to the same depth and the chamfer will be even at all points.

Figure 6-17. Bevels are formed with the fence tilted over the knives.

OCTAGONAL SHAPES

Octagons are formed by making bevel cuts on the four corners of a square piece of stock that has been sawn and jointed (Figure 6-18). ***Warning: If you work with the fence at an open angle, work with extreme caution. Use push blocks to move the stock.*** Make the cuts as diagrammed in Figure 6-19 to remove the corners of the square and form four new faces. When you must make more than one pass, don't change the depth of cut. Make the same number of passes on each corner.

TAPERING

Special jointer techniques allow you to form tapers like those shown in Figure 6-20.

Almost always, the procedure calls for a stop block that is used to position the stock for the start of the cut. The stop block can be

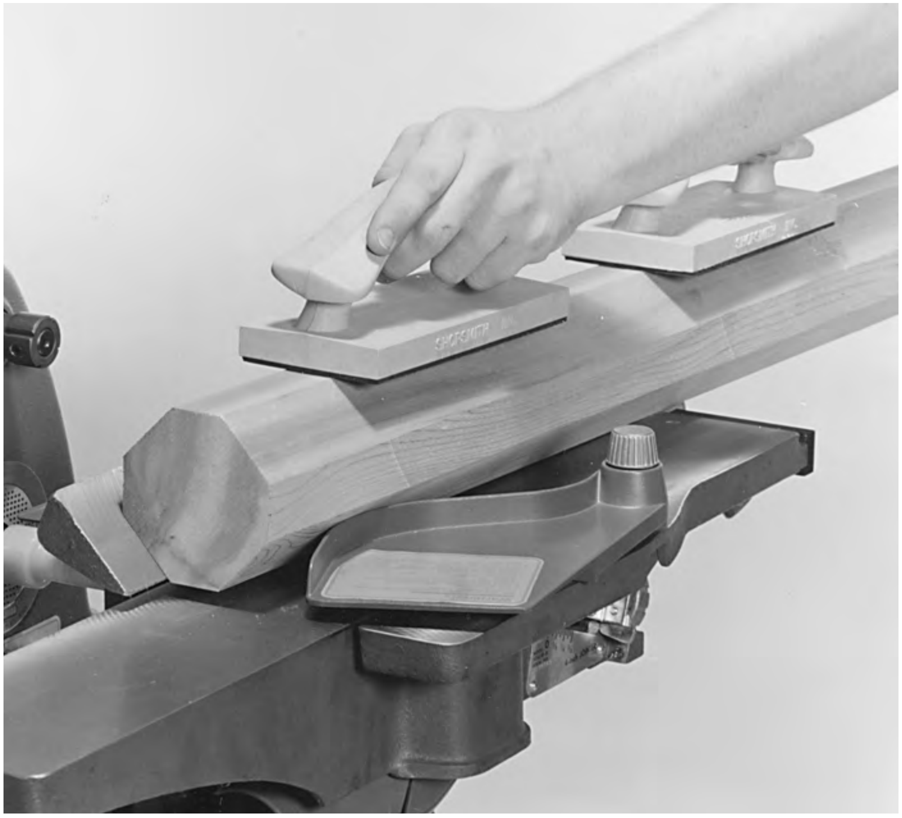


Figure 6-18. Octagons are formed by making repeat passes on all four corners of square stock.

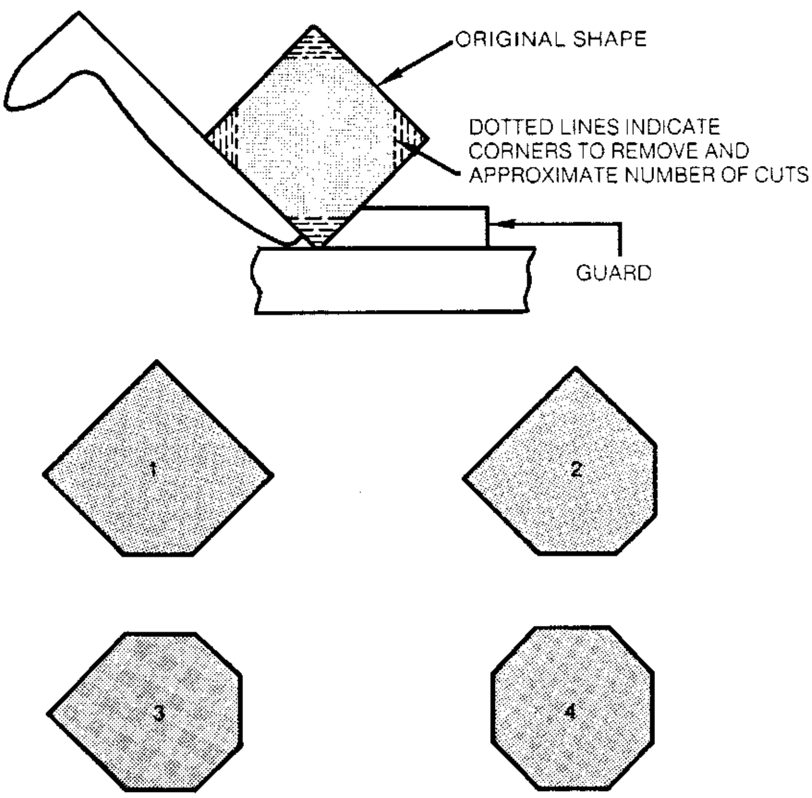


Figure 6-19. To form an octagon, start with a square piece of stock. When you must make more than one pass, don't change the depth-of-cut setting.

clamped directly to the jointer fence.

Use an extra-long fence extension with stop blocks like the one shown in Figure 6-21 when a tapered cut must start and stop on the stock being cut. The extension, which is diagrammed in Figure 6-22, is made long enough to provide extra support for the stock and the blocks are held in place with clamps so their position can be adjusted to suit the taper being cut.

To cut a taper that is, for example, 10" long and 1/4" deep, set the infeed table for a 1/4" depth of cut, and clamp the stop block 10" away from the topmost point of the knives' cutting circle. Brace the end of the stock against the stop block, pivot the guard, and then slowly lower the stock to make contact with the outfeed table. Turn the machine on. Use a push block and push stick to gradually feed the stock while you maintain contact between the stock and the infeed and outfeed tables.

Tapers that are longer than the infeed table must be handled differently. If, for example, the taper is to be 20" long and 1/4" deep on all four sides, mark the stock into two 10" divisions and set the depth of cut at 1/8". Place the stock so the line indicating the first 10" division is at the uppermost point of the knives' cutting circle and make two passes on all four sides. This will result in a taper 10" long and 1/4" deep. Reposition the stock at the 20" mark. Then make two passes on all four sides. You will then have a taper— 20" long and 1/4" deep.

EDGE RABBETING

Edge rabbeting is the process of removing part of the thickness of the stock along an edge to produce a lip or tongue. It's a fast and accurate way of making strong, interlocking corner joints or for recessing a panel into a frame.

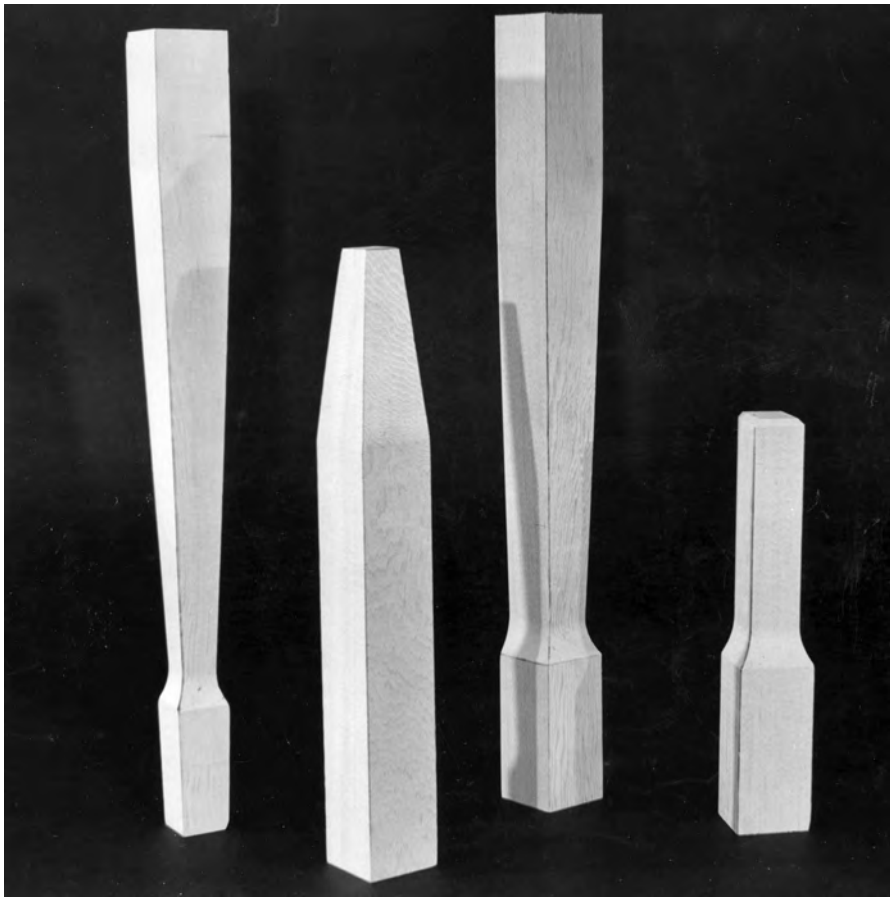


Figure 6-20. These are examples of forms you can produce by using the jointer for tapering. They can be used as legs for tables, chairs, and so on.

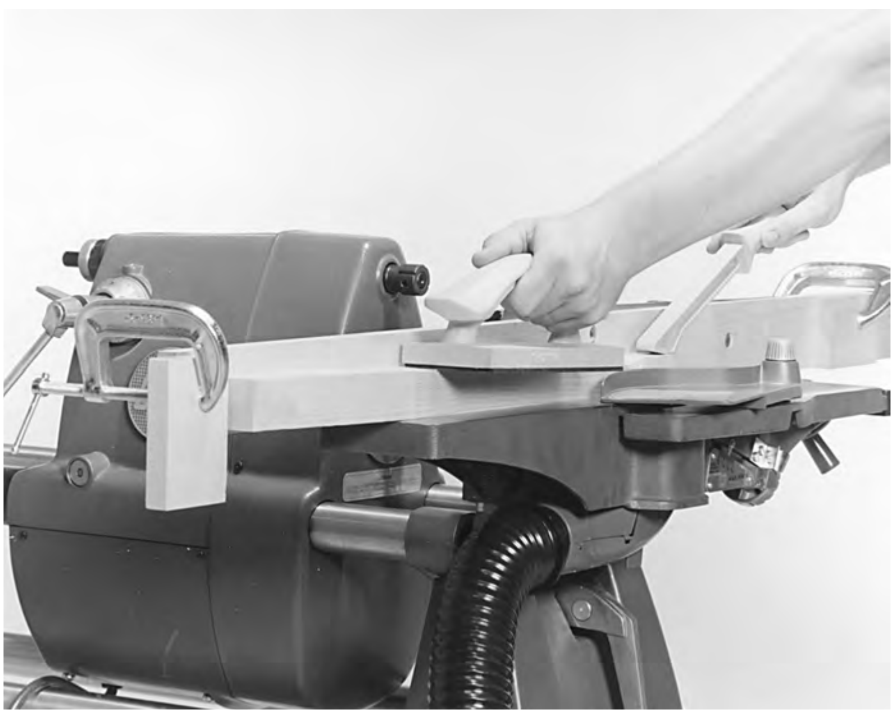


Figure 6-21. Tapering cuts are easier to do when you work with an extra-long fence extension that has its own stop blocks.

To set up to cut an edge rabbet, first unplug the machine. Check that the knives are evenly adjusted from side-to-side and that they extend 1/32" beyond the left side of the outfeed table. ***Warning: If the knives aren't properly positioned, the stock may not clear the side of the outfeed table when the cut is made.*** Pull the fence lock handle out, unlock the fence, and move it toward the left side of the table (away from the drive shaft). The width of the rabbet will be the distance from the outer corner of the knives to the fence (Figure 6-23). When you're satisfied that the setup is correct, lock the fence in place.

Your jointer will cut rabbets up to 3/8" deep, but never try to remove more than 1/8" of stock in a single pass. For deeper cuts, begin with the depth of cut set at 1/8"; then increase it after each pass. If you're making several rabbets to match, machine all pieces at each setting before changing the depth of cut.

When cutting end rabbets (Figure 6-24), there is a tendency for wood to split out or splinter at the end of the cut. As with end grain jointing, splintering can be reduced by taking very light cuts and by feeding the stock more slowly. You can also use a utility knife or chisel to score the wood fibers before rabbeting.

Follow the pattern illustrated in Figure 6-25 when you need rabbets, tongues, or tenons on narrow stock. After using the jointer, use the table saw to rip the material into correct widths. ***Warning: Never try to rabbet stock which will have less than 10" of support against the tables and fence or a piece so narrow that your hands will cross into the danger zone.***

TONGUES AND TENONS

Tongues and tenons are made on the edge and end of stock in

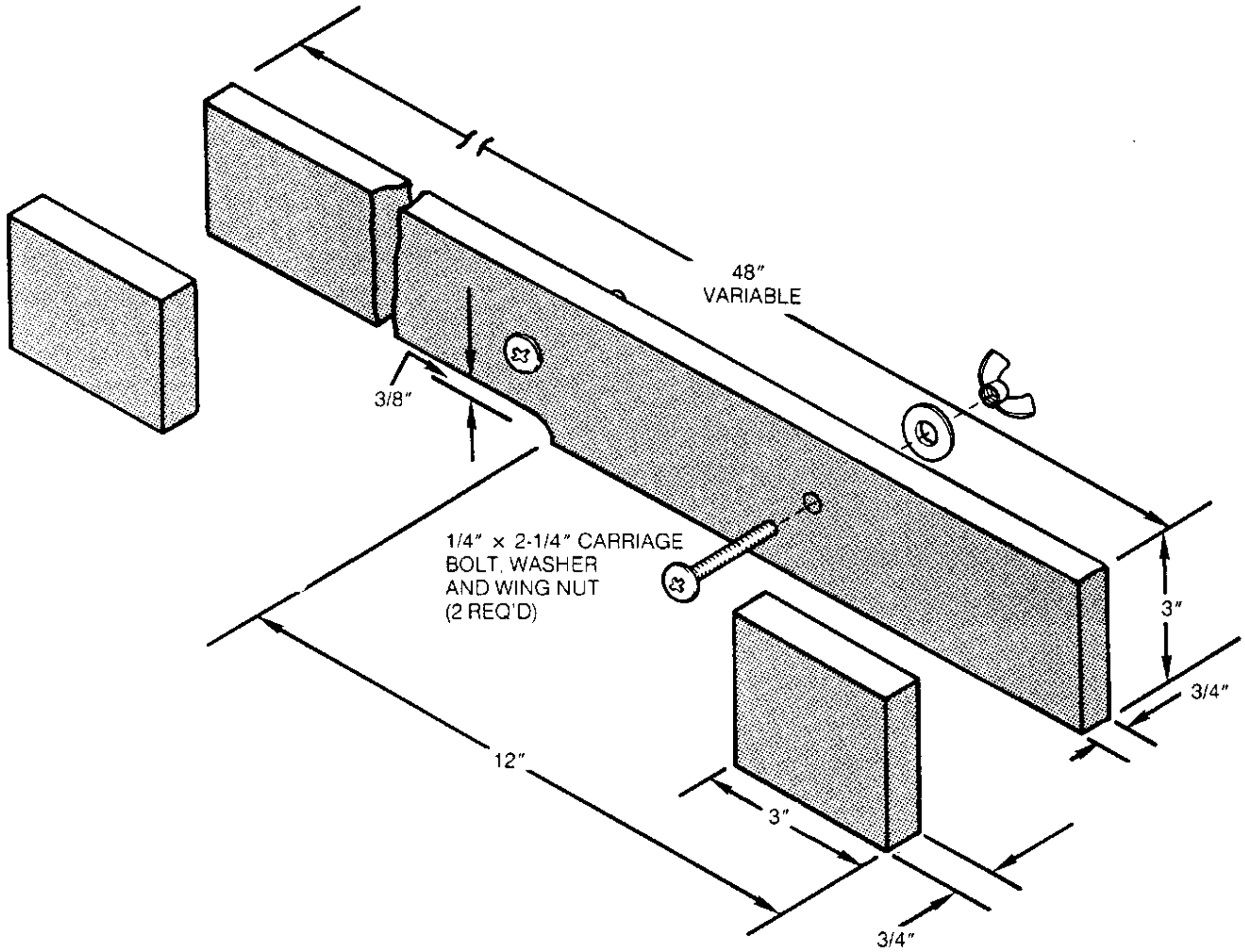


Figure 6-22. *Construction details of a fence extension used for tapering.*

Figure 6-23. *The width of the edge rabbet will be the distance from the outer corner of the knives to the fence.*

Figure 6-24. *Use the fence extension to provide support when cutting an end rabbet.*

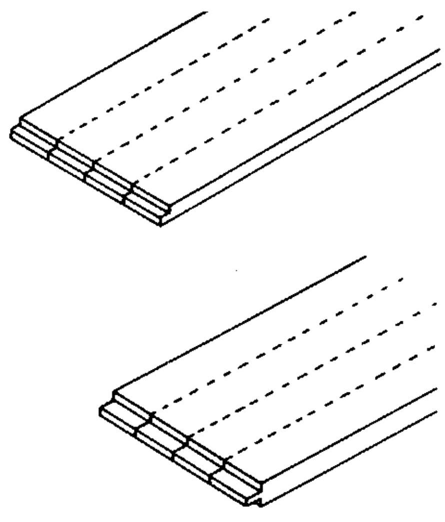
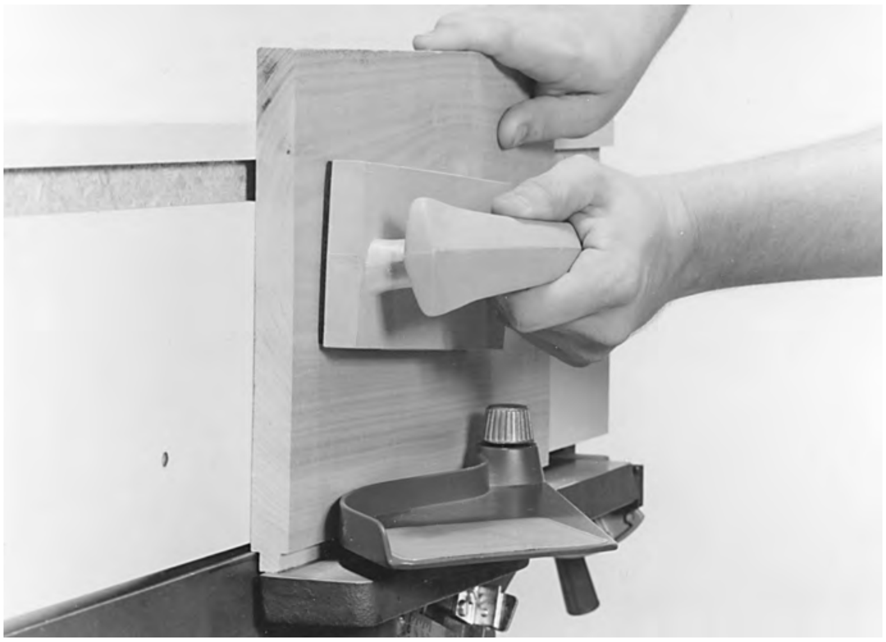


Figure 6-25. *When you need rabbets, tongues, or tenons on narrow pieces, do the work on pieces of stock wide enough to be safely handled and then rip them on the table saw.*



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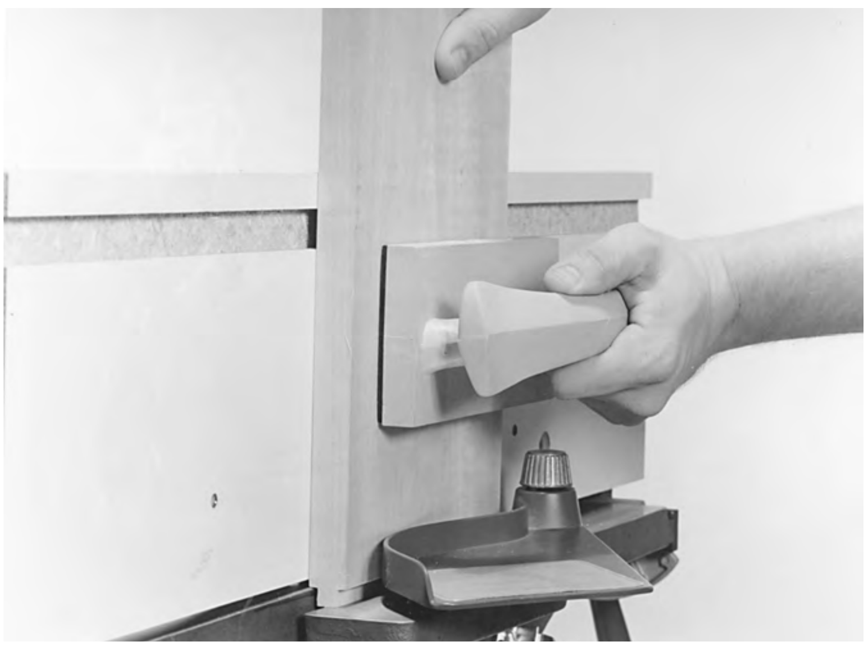


B

Figure 6-26. (A) A tongue or a tenon is formed on the edge of stock by making two rabbet cuts. (B) Tongues or tenons on the end of stock are done this way. Always use a fence extension to provide support.

the same manner as that described in "Edge Rabbeting." The difference is that the first cut is followed by a second one that is made after the stock has been turned around (Figure 6-26). The thickness of the tongue or tenon will be the stock thickness minus two times the width of the cut. Length, as in rabbeting, is controlled by the depth of cut.

When a tongue or tenon is located across the end grain, you must use a fence extension for additional support. Chip out is a problem with end grain jointing, so you'll need to make light passes and form the tongues or tenons before jointing the edges of the stock.

Chapter 7
Drill Press

Mastering the techniques in this chapter will enable you to perform operations that you might have thought impossible. Layouts and setups are featured that will add a professional dimension to your projects.

DRILL PRESS MODE—SETUP AND FEATURES

Use the accessories shown in Figure 7-1 for drilling operations. To set up your Mark V in the drill press mode, follow the instructions in the Owners Manual that came with your machine.

As you work in the drill press mode, you'll find that the Mark V is an extremely capable drill press with several special features:

- The distance from the chuck to the table can be adjusted to 26″ and from the chuck to the floor to 58″.
- The drill chuck holds bits with shanks 3/64″ to 1/2″ in diameter.
- The quill extends up to 4-1/2″, and the depth control (quill feed stop) can be set to automatically stop the quill at any point from "0" to 4-1/4″.
- The table tilts from "0" to 90° (Figure 7-2).
- The rip fence and miter gauge can be used to help hold and position workpieces.
- With a wide range of speeds, the Mark V can drill a wide range of materials—wood, plastic, and metal.

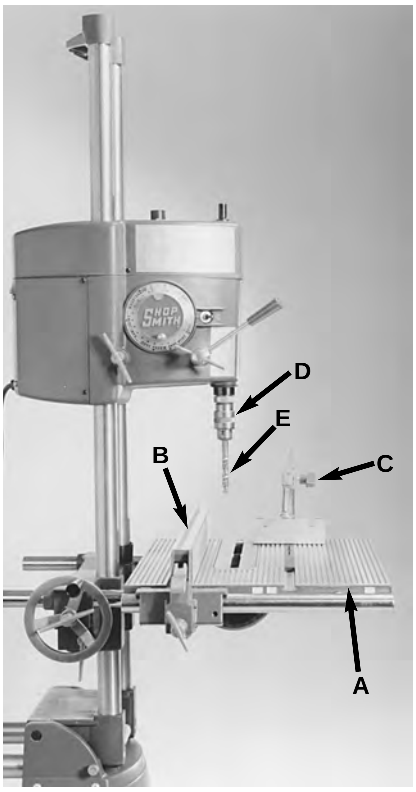


Figure 7-1. *The accessories that are used for drilling operations are the (A) worktable, (B) rip fence, (C) miter gauge, (D) drill chuck and (E) drill bit.*

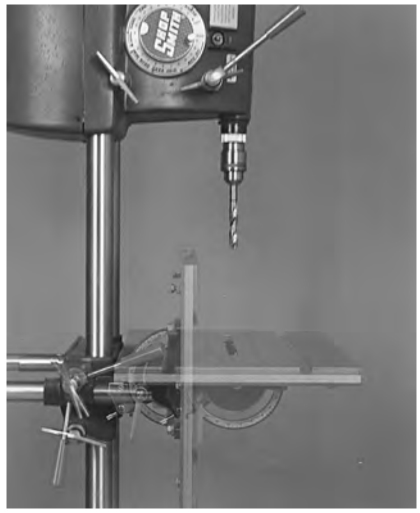


Figure 7-2. *In the drill press mode, the table tilts from "0" to 90°.*

DRILL BITS

There are three types of drill bits commonly available to woodworkers: *twist bits,* used to drill both wood and metal; *spade bits,* used when rough splintered holes are acceptable; and *power auger bits,* which drill slower and leave a smoother hole than either twist or spade bits (Figure 7-3). There are also specialty bits: brad-point, Forstner, multispur, screw drills, and plastic-drilling.

Most woodworkers aren't half as concerned with the type of bit they use as they are with the quality of the hole it leaves. As mentioned, in the course of a single project you might drill dozens of different holes for many different functions. For almost every hole you can imagine, there is a bit designed to make it a little better and a little easier to drill.

General Purpose Holes—Brad-point bits (also called machine spur bits) are a vast improvement over twist bits. A small point at the bottom of the bit bites into the wood first, holding the bit on center so it will not wander. Two side spurs slice through the wood grains to make a clean entrance, leaving a clean hole. Brad-point bits are your best choice for general drilling in wood. However, they should not be used to drill other materials.

Twist bits, usually associated with metal drilling, can be used to make holes in hard or soft woods. The hole will be rougher than you might want, and there can be considerable feathering or splintering when the bit breaks through, even when the work is supported on scrap stock.

Super-Smooth Holes—Decorative holes and holes for pivoting dowels need to have extremely smooth, splinter-free sides. Forstner bits were designed for

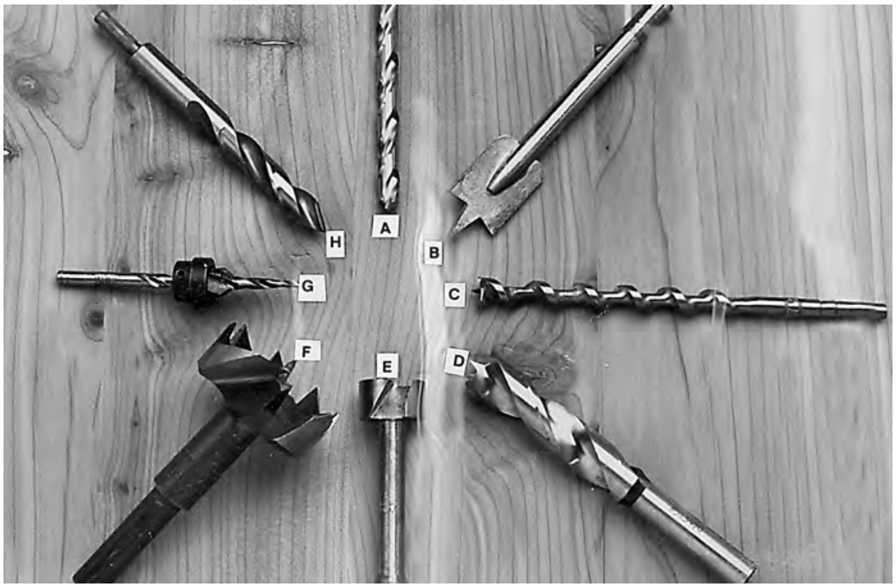


Figure 7-3. *The most common types of drill bits are: (A) twist bits, (B) spade bits, and (C) power auger bits. Examples of specialized drill bits include: (D) brad-point bits, (E) Forstner bits, (F) multispur bits, (G) screw bits, and (H) plastic-drilling bits.*

Figure 7-4. *Drill bits are secured in the chuck with a special key.*

just this purpose. They will bore small, shallow holes with flat bottoms and polished sides. Multispur bits will also bore flat-bottomed, smooth-sided holes, but they are designed to drill much deeper and much larger holes than Forstner bits.

Screw Holes—Screw bits will drill a pilot hole, shaft hole, and countersink for wood screws all in one operation. They can be adjusted for different lengths of screws.

Holes in Plastic—To avoid cracks and splinters, use plastic drilling bits to drill holes in plastic. Plastic-drilling bits will drill clean holes in many types of plastic.

If you drill mostly in wood, we suggest you start with brad-point bits. While they can be purchased individually, it's a good idea to begin with an assortment that includes the most useful sizes—1/4", 3/8", 1/2", 5/8", and 3/4". A complete set of brad-point bits start at 1/8" and increases to 1" in increments of 1/16".

The flutes in a bit are channels that guide waste material out of the hole. If the channels are clogged, waste will back up and both bit and wood will burn. That is why you should not drill deeply enough to bury the flutes. On most jobs it is good practice to retract the bit frequently so waste can be ejected. Adjust feed pressure to the job you are doing and the speed you are using. A heavy feed will clog the cutter; one that is too light is just as bad because the bit will do more burnishing than cutting.

Provide good storage for your bits so they'll keep clean and can't be knocked around.

Drill bits are secured in the chuck with a key that causes the chuck's jaws to close firmly about the shank of the bit (Figure 7-4). Be sure to allow enough shank for the chuck to grip. ***Warning: Remove the key from the chuck immediately after securing the bit.***

DRILL PRESS SAFETY

Warning: Before using the drill press, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V in the drilling mode extends 3" all around the bit and chuck and 5" beneath the bit. The reason for the extended danger zone beneath the bit is that the quill moves the bit in that direction. Always keep your fingers and hands out of the danger zone.

When you work at the drill press, pay attention to where you put your hands. Be certain they aren't beneath the bit when you advance the quill. Never reach in toward the bit or beneath it to clear away scraps. Turn off the machine and let it come to a complete stop first.

- **Always wear proper eye and ear protection.**
- **NEVER leave the key in the chuck. Remove the key from the chuck IMMEDIATELY after securing the bit.**
- **Always use the proper drill bit for the operation you are performing.**
- **Never wear jewelry, gloves, ties, loose clothing or clothing with long sleeves. Keep long hair tucked under a hat. Jewelry, gloves, ties, clothing and hair could become entangled in the bit.**
- **Position the worktable at mid-chest whenever possible.**
- **Use the rip fence as a backstop and hold the stock firmly against both the worktable and the fence. If you can't use the**

rip fence, use the miter gauge or clamp the stock to the worktable.

• Use only accessories and bits designed to be mounted in power drills.

• Never drill or bore metal or plastic freehand. Always clamp it to the worktable and back-up stock, or the rip fence and back-up stock.

DRILL PRESS SPEEDS

Before you begin any drill press operation, set the Mark V to run at the correct speed. To do this: turn the machine on, turn the speed dial to the correct speed and let the machine come up to speed.

The operating speeds for drilling are determined by the size of the hole you want to drill and the material you're drilling. Generally, you can use faster speeds with softer woods or smaller holes. Use slower speeds as the materials get harder or the holes get bigger.

To a lesser extent, the speed will also be determined by the type of drill bit you use. For example, twist bits will work better in wood at higher speeds. Spade bits must be used at slow speeds. Forstner bits must always be used at very slow speeds.

To help determine the right speed for the job, refer to Table 7-1. This table is intended as a general guide when using brad-point bits and twist bits. If you use other bits, follow the manufacturer's recommendations.

Note: A good rule of thumb is: The smaller the hole and the softer the material, the faster you can run the drill. But don't drill too fast or you may burn the wood and ruin the bit.

LAYING OUT THE WORK

Work carefully and slowly when measuring and scribing lines. The simplest and most accurate method of marking a hole location is to draw two lines that intersect at the center of the hole. A combination square is a good tool to have since it is used to draw lines square with the edge of the work and as an edge-marking gauge. Dividers work best when it is necessary to transfer a measurement from one piece to another or to mark off a line into a number of equal spaces.

Other methods may be used according to the job and the number of pieces to be drilled. Templates may be made of illustration board, hardboard, plywood, or metal, depending on how long they will be used. Some pieces of hardware are their own templates, for example, a hinge or a drawer pull.

One little trick that should be remembered for use on mating pieces, when ordinary layout may be impractical or time-consuming, is to insert headless nails in small holes drilled in one of the pieces (Figure 7-5). Let the points protrude about 1/16" and then press the piece against the mating part.

Table 7-1: Drill Press Speed Chart

Size of Hole	Hardwood	Softwood
1/4" and less	H (1600 RPM)	I (1750 RPM)
1/4" to 1/2"	F (1300 RPM)	G (1450 RPM)
1/2" to 3/4"	D (1050 RPM)	E (1150 RPM)
3/4" to 1"	B (850 RPM)	C (950 RPM)
Over 1"	SLOW (700 RPM)	A (750 RPM)
Boring metals (twist bits only) — Slow (700 RPM)		

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

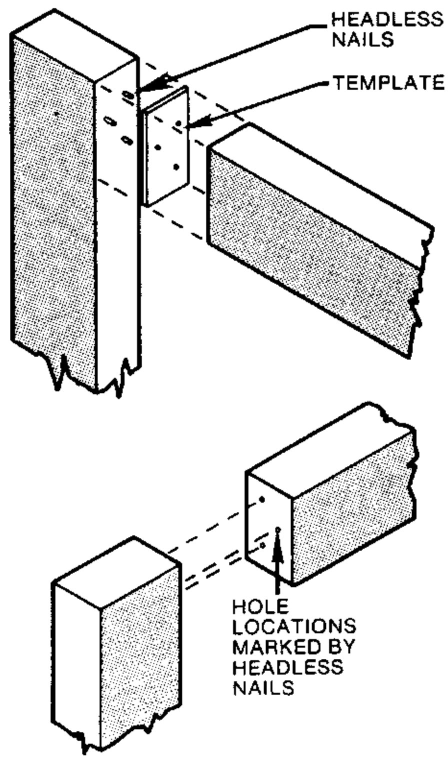


Figure 7-5. Use headless nails to mark hole locations for the second piece.

The nail points will mark the hole locations on the second piece. Pull the nails with a pair of pliers and drill the holes to full size.

Another method of marking jointing members (especially when employing dowels) is to use dowel center finders (Figure 7-6). After drilling the holes for the dowels in one piece of wood, you insert dowel centers in these holes. Then you align the two pieces of wood as they will be joined. When you press them together, the points on the dowel centers mark the second piece of wood. It is now possible to drill holes at these center marks. When the pieces are connected with dowels, the blind dowel joint is perfectly aligned. Dowel centers commonly come in assorted sizes to fit holes from 1/4" to 1/2" in diameter. For larger holes, a dowel rod with a brad in the center works well.

Figure 7-7 illustrates two methods of marking hole locations when boards are to be joined edge-to-edge by doweling.

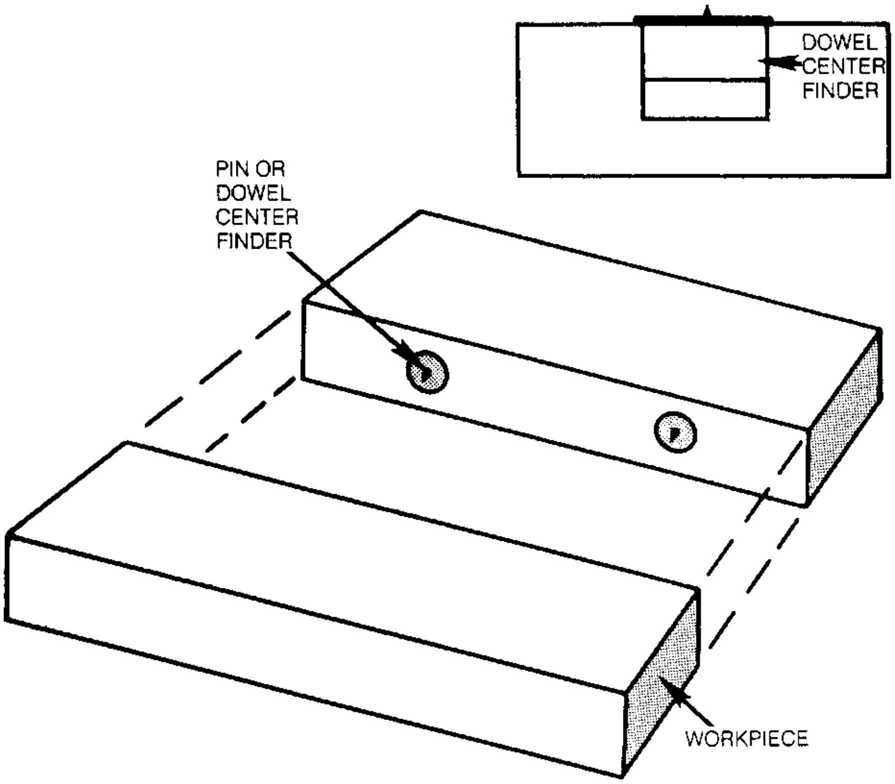


Figure 7-6. *Jointing members can also be marked by using dowel center finders.*

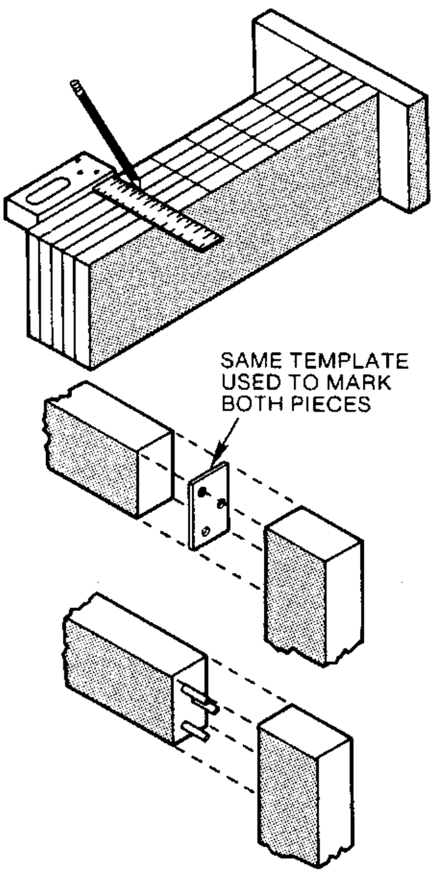


Figure 7-7. *Drilling accuracy depends on layout. Two methods are shown.*

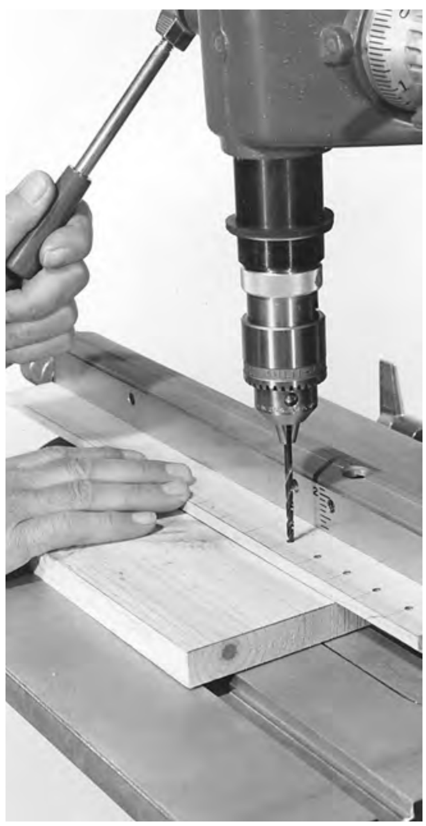


Figure 7-8. *Place a scrap block of wood between the work and the table when drilling holes through the workpiece.*

SUPPORTING THE WORK

When drilling through holes place a scrap block between the workpiece and the table (Figure 7-8). This protects the table and lets the bit point cut through into the scrap block so that it does not splinter the back of the workpiece as it emerges. ***Warning: Clamp the workpiece to a supporting surface to keep the bit from grabbing in the hole and jerking the workpiece out of your hands, particularly when the point is about to break through.***

Use of the rip fence or miter gauge as a guide and support will lessen the need for clamping. When the workpiece being drilled is held against the rip fence or miter gauge, the twisting force exerted by the bit is taken by the fence or miter gauge and not by your hands.

The grain on some woods, such as fir, may pull a bit off center. When this happens, try clamping the work, drilling a small pilot hole, and then enlarging the hole to full size by drilling halfway through from each side.

GENERAL DRILLING

There are two basic types of holes: holes that you drill completely through the workpiece and holes that you drill only partway through the workpiece.

Drilling Through

Mount the rip fence on the worktable. It will be used as a backstop. Adjust the rip fence to help you accurately position the hole where you want it. Make fine adjustments with the table height lever (Model 500) or crank (Model 510) (Figure 7-9). If there's no room for the rip fence, use the miter gauge. *Caution: Place a scrap of wood, wider than the workpiece, on the table to keep the bit from drilling into the table after it goes through the workpiece. It will also help keep* *the workpiece from splintering where the bit exits.*

Hold the carriage so that it won't drop against the base mount. Loosen the carriage lock and adjust the table height so that the tip of the bit is 1/4" to 1/2" above the workpiece. Then tighten the lock.

Extend the quill so that the tip of the bit touches the scrap block. Set the depth control to approximately 1/8", and tighten the depth control lock (Figure 7-10). Then retract the quill. When you drill the hole, the depth control will keep the bit from biting through the scrap block and into the worktable.

Make a five-point check. Four of the five locks—power plant, carriage, table height, and table tilt—should be secure. The quill lock should be loose.

Place the workpiece on the worktable and position it under the bit. Hold it firmly against the table and rip fence. Extend the quill with the machine turned off to be sure the bit will drill a hole right where you want it (Figure 7-11).

If the bit lines up correctly, turn the Mark V on and adjust it to the correct running speed. Feed the bit into the wood slowly and evenly (Figure 7-12). Don't force the bit; just maintain a light, steady pressure. When drilling deep holes, it is necessary to retract the bit now and then to clear chips from the hole.

When you feel the depth control stop the quill, retract the bit. Turn off the machine, let it come to a stop; then remove the workpiece.

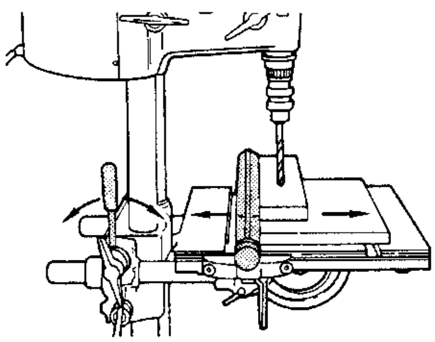


Figure 7-9. When drilling, use the rip fence to accurately position the holes. Make fine adjustments with the table height lever (Model 500) as shown or with the table adjustment crank (Model 510).

Figure 7-11. Before turning on the machine, extend the quill to be sure the bit will drill a hole where you want it.

Figure 7-10. Use the depth control to keep the bit from biting through the scrap block and into the worktable.

Figure 7-12. Feed the bit into the wood slowly and evenly, maintaining a light, steady pressure. Stop when you feel the depth control halt the quill.

Avoiding Tear-out—Tear-out, the rough, splintery edges where the bit exits the workpiece, can be avoided by moving the scrap block every time you drill a new hole, so there's always a flat, firm surface to back up the workpiece. Or, if you're using brad-point bits, you can use the depth control to avoid tear-out.

With the Mark V turned off, extend the quill until the pilot of the bit touches the scrap board. Set the depth control to "0" and lock it in place. Let the quill retract.

Drill the holes you need, letting the depth control stop the quill. Turn off the Mark V and turn the workpiece over. There will be tiny pinholes where the pilot started to come through the workpiece (Figure 7-13). Use these pinholes to line up the bit; then finish drilling the hole from the other side. Since brad-point bits have spurs that cut the wood grain smoothly when they enter the wood, there will be no tear-out on either side of the workpiece.

Drilling Partway

To drill a hole only partway through a workpiece, extend the quill until the cutting flutes of the bit just touch the workpiece (Figure 7-14). Set the depth control at the desired depth and lock it in place; then drill the holes you need.

The depth control will stop the quill when the bit reaches the proper depth in the stock. All the holes you drill at any one depth control setting will be exactly the same depth.

Another way of drilling partway is to mark the work to indicate the

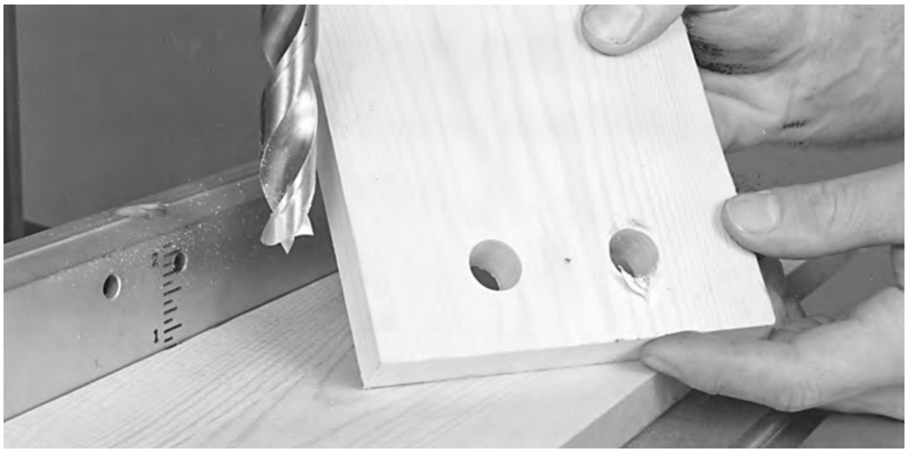


Figure 7-13. *When a bit exits a hole, you may get some tear-out, as shown on the right. To avoid this, drill partially through the board until just the pilot of the bit comes out the other side, as shown in the center. Then turn the workpiece over and drill from the other side. The hole will be clean, as shown on the left.*

Figure 7-15. *Extend and lock the quill so the point of the bit lines up with the mark you've made on the work.*

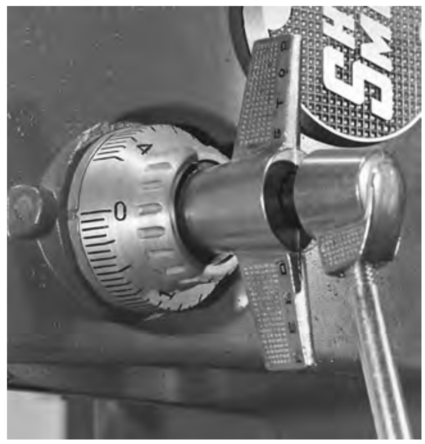


Figure 7-16. *Then turn and lock the depth control at "0." The quill will extend only the distance you have determined.*

necessary hole depth. Extend and lock the quill so the point of the bit lines up with the mark on the work (Figure 7-15). With the quill held in the extended position, rotate and lock the depth control at "0" (Figure 7-16). Unlock the quill and proceed with the drilling.

Drilling Screw Holes

If screws are to drive easily and hold with maximum strength, the screw holes must be drilled carefully and to size (Table 7-2). Usually two holes are needed: the shank hole, which equals the screw diameter, and a smaller pilot hole, which allows the screw end to penetrate the wood (Figure 7-17).

The easiest procedure is to drill the shank hole first. This establishes a guide and a center for the pilot hole. Countersinking, which can be controlled by using the depth control, is done on the surface to establish a seat for the head of the screw when it must be flush with the surface of the work (Figure 7-18). In softwoods or

Figure 7-14. *Extend the quill until the cutting flutes of the bit just touch the workpiece.*

Table 7-2: Drill Bit Sizes for Screws

Screw Gauge Number	Shank Hole (Hardwood & Softwood)	Pilot Hole (Softwood)	Pilot Hole (Hardwood)
0	1/16	1/64	1/32
1	5/64	1/32	1/32
2	3/32	1/32	3/64
3	7/64	3/64	1/16
4	7/64	3/64	1/16
5	1/8	1/16	5/64
6	9/64	1/16	5/64
7	5/32	1/16	3/32
8	11/64	5/64	3/32
9	3/16	5/64	7/64
10	3/16	3/32	7/64
11	13/64	3/32	1/8
12	7/32	7/64	1/8
14	1/4	7/64	9/64
16	17/64	9/64	5/32
18	19/64	9/64	3/16
20	21/64	11/64	13/64

when the head of the screw is small enough, countersinking may be eliminated since the screwhead will form its own seat as it is turned into the wood.

Screw and bolt holes can be counterbored when it is desirable for the fastener head to be set beneath the surface of the wood.

Counterbored holes are often sealed with plugs cut from the same type of wood. These may be set flush with the surface of the work and glued in place so the grains match, or they can protrude slightly to provide a decorative touch. This is seen quite often on Early American furniture.

Special bits, like the screw bit shown in Figure 7-19, let you drill accurate screw holes with minimum fuss. They are actually bits that form tapered holes and have sleeve-type, adjustable countersinks and collars so you can control hole depth and countersink diameter.

Drilling Holes Through Extra-Thick Stock

Because a spindle extension has a limit and bits should not be buried in the work more than the length of the bit's flutes, it isn't possible to drill through extra-thick stock in normal fashion. You must drill from both sides of the stock. The problem is that it is difficult to drill both holes on the same centerline; the solution is to use a guide that correctly positions the work after the first hole is drilled.

One method is shown in Figure 7-20. After the first hole is drilled in the work, clamp a piece of scrap to the table and drill through it. Insert a hole-sized piece of dowel in the scrap piece, replace the work so the first hole drilled will be over the dowel, and finish drilling.

Another method calls for a special insert (Figure 7-21A), one you can retain for future, similar operations. The drilling procedure is the same. Drill the hole as deeply as you can, or a little more than halfway through the stock. Then position the work by placing it over the pin in the insert and finish drilling (Figure 7-21B).

Make the special insert like the one detailed in Figure 7-22. Drill the hole for the guide dowel after the insert is assembled and locked in the table. Thus, alignment of the bit to the guide dowel will be assured.

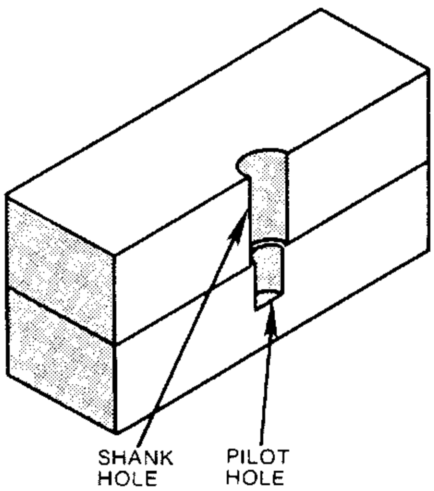


***Figure 7-17.** A screw usually requires a shank hole for the shank and a pilot hole for the thread. The shank hole should equal the gauge of the screw and go through the first piece. The pilot hole should be half the length of the threaded portion of the screw.*

***Figure 7-18.** A special tool called a countersink forms the inverted cone that allows countersunk screws to seat flush with work surfaces. Use the depth control to obtain identical countersinks.*

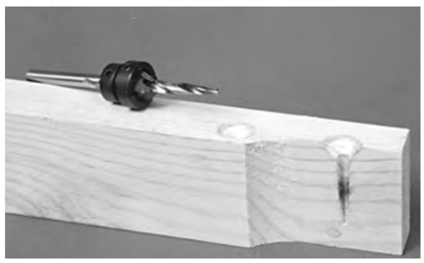


***Figure 7-19.** Screw bits control hole depth and countersink diameter.*

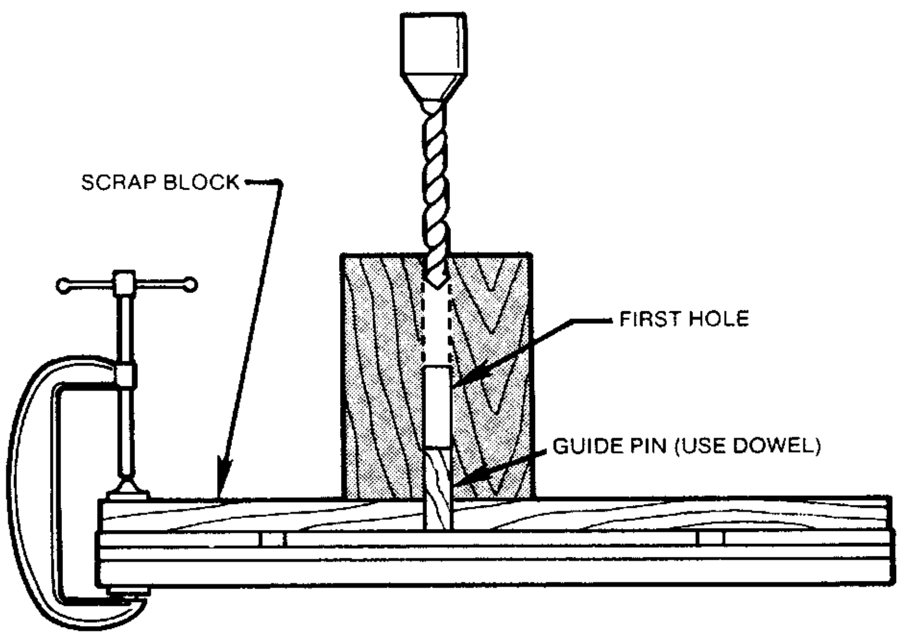
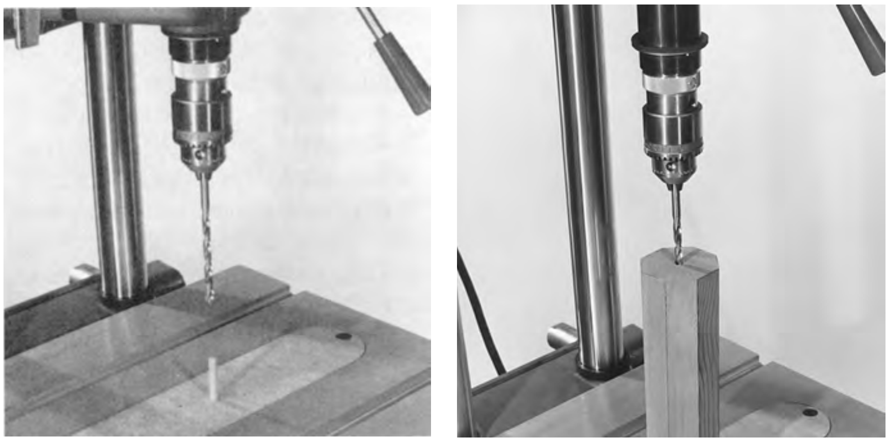


***Figure 7-20.** This is one way to drill from both ends of extra-thick stock. The work, positioned over the guide pin, is accurately placed for the second hole.*



A B

Figure 7-21. Another way to drill extra-thick stock is to: (A) make a special insert with a correctly located guide pin. (B) Then after the first hole is drilled, the work is inverted over the guide pin so it is accurately aligned.

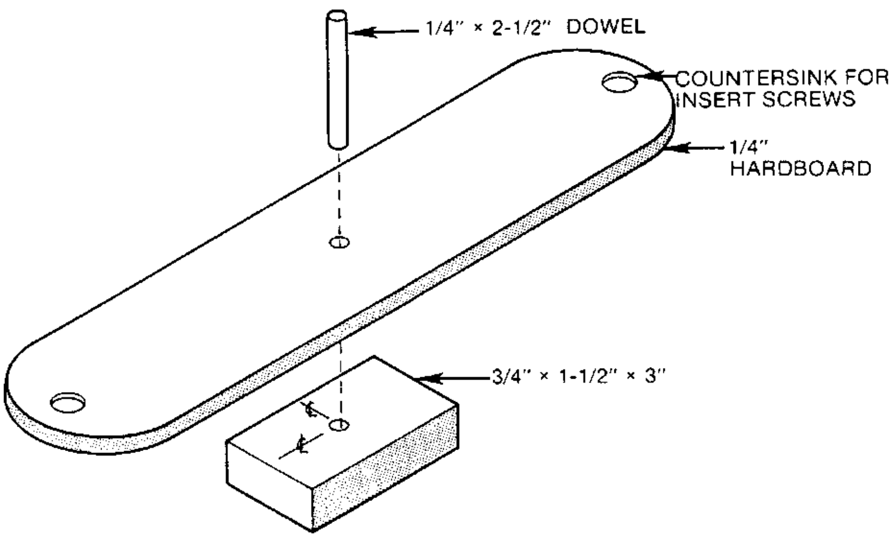


Figure 7-22. Construction details of a special drilling insert. Use your table saw insert (Model 500 or 510) as a pattern. Drill a hole for the dowel after the special insert is secured in the table.

Figure 7-23. Place a backup under the workpiece, set the depth control, then feed the hole saw lightly at a speed that permits it to cut without burning or binding.

Drilling Extra-Large Holes

Large diameter holes, can be formed using special cutters such as hole saws (Figure 7-23). Hole saws are heavy steel cups with small saw teeth on the perimeter. They mount on mandrels that have a shank that can be gripped by the drill press chuck. One mandrel is usable with several sizes of hole saws.

Start the operation at the proper speed recommended by the manufacturer and slowly increase feed pressure until the saw is cutting smoothly and without binding or burning.

Plug Cutting

As mentioned earlier in the chapter, the best method to conceal screwheads so they don't spoil the appearance of a project is to counterbore for them and then fill the hole with a wooden plug. Often, the hole is filled with a short length of dowel or a commercial, preformed plug. Both ideas work; however, the items are available only in limited wood species and it's often impossible to match the grain pattern of the plug and the work. The solution is to make your own plugs by working with plug cutters like those shown in Figure 7-24. With these, you can cut into the edge or end of stock and not only use a matching wood, but also control the grain pattern. Plug cutters are available in the sizes shown in Table 7-3.

A basic procedure is shown in Figure 7-25. Drill through the stock and remove the plug. Cut the plug about 1/16" longer than needed

Table 7-3: Plug Cutter Sizes

Plug Cutter Size	For Screw Sizes
3/8"	#8, #9, #10
1/2"	#12, #14
5/8"	#16, #18 also for bolts up to 1/4"

Figure 7-24. Plug cutters are precision tools that will form wood cylinders of exact diameter.

with a bandsaw, scroll saw or hand saw. Coat the plug with a little glue, match the grain, and then drive it into the counterbored hole. After the glue is dry, you can sand the plug flush or allow a bit of it to project as a decorative detail.

Another type of plug cutter, shown being used in Figure 7-26, can be used like the first ones mentioned but can cut deep enough to form plugs, or short dowels, up to 2″ long. Thus you can use them to form custom dowels for edge-to-edge joints and even to shape axles for small toy projects. Work as shown in Figure 7-27 when you want the wood grain to run in the plug's long dimension. After the plugs are formed, they can be separated by making a cut on the bandsaw or table saw.

An interesting use for plugs is shown in Figure 7-28. If you have made a mistake locating a hole or simply wish to enlarge a hole, fill it with a plug so you can establish a center for the new hole.

DRILLING AT AN ANGLE

To drill a hole at any angle between 45° and 90°, simply tilt the table. When the table is tilted, mount the rip fence on the "down" side of the table (Figure 7-29) or use clamps. This will give the workpiece the maximum support.

Angular holes in round work require an arrangement that keeps the work from turning while the hole locations have the same edge distance and are on a common centerline. V-blocks and stock are usually clamped to the table so the work can't be turned. Since the miter gauge can be locked in the table slot, it may be used together with a straight piece of wood to improvise a V-block that permits accurate drilling (Figure 7-30). The same type of setup can be used to drill angular holes in square workpieces (Figure 7-31).

It is good practice to work with a leveling block when the angle you need is sharp (Figure 7-32). On such work, the side of the bit may contact the work before the point does. This can cause the bit to drift off center. The block, when it is used as shown in Figure 7-33, establishes a center for the bit even before it touches the work, thus assuring that the hole location will be correct.

V-Block Drilling

The table and fence can be situated as shown in Figure 7-34 when you need to drill diametrically into or through round material. Tilt the table to 45° and then adjust it and the fence position so the point of the bit will exactly bisect the "V." If you need more than one hole on the same centerline, mark the workpiece so the bit point can be correctly positioned each time. For through holes, line the "V" with lengths of scrap wood. The same setup and procedure can be used when you need to drill holes in the corners of square stock (Figure 7-35). Make the initial contact slowly and carefully so the bit won't move off center.

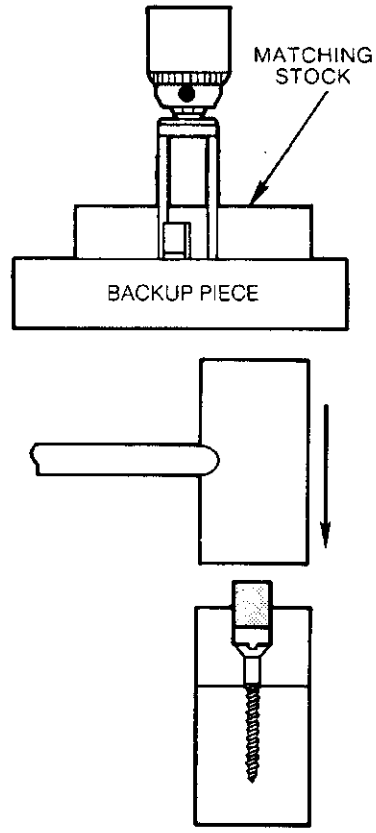


Figure 7-25. Wood plugs are commonly used to conceal screwheads. The basic procedure is shown here.

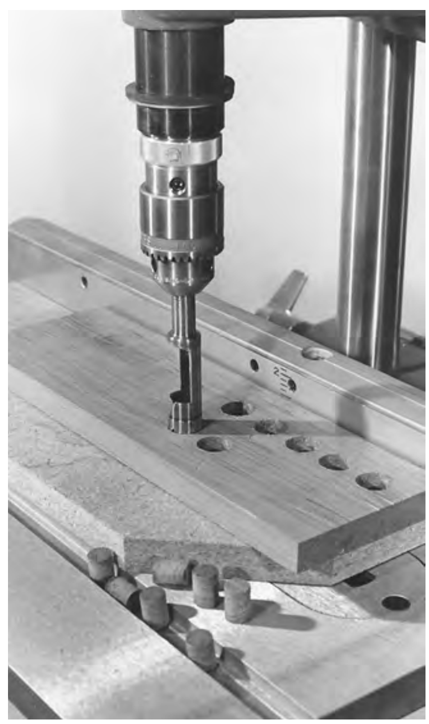


Figure 7-26. Another type of plug cutter will cut 2″ deep. It can be used for short plugs and for dowel-type cylinders.

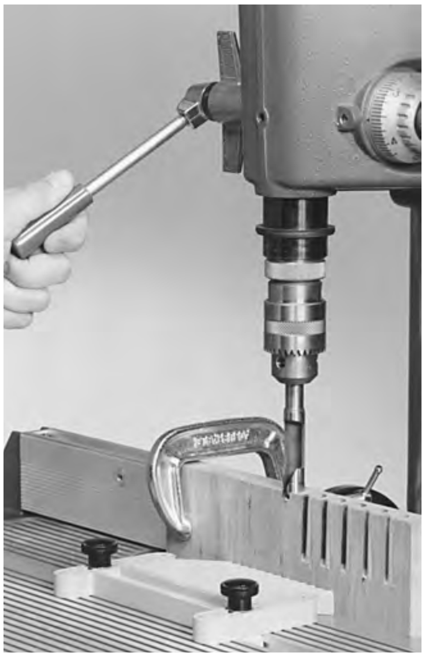


Figure 7-27. *Using the extra-deep plug cutters this way lets you form dowels for edge-to-edge and other type joints. A saw cut separates the dowels from the base stock.*

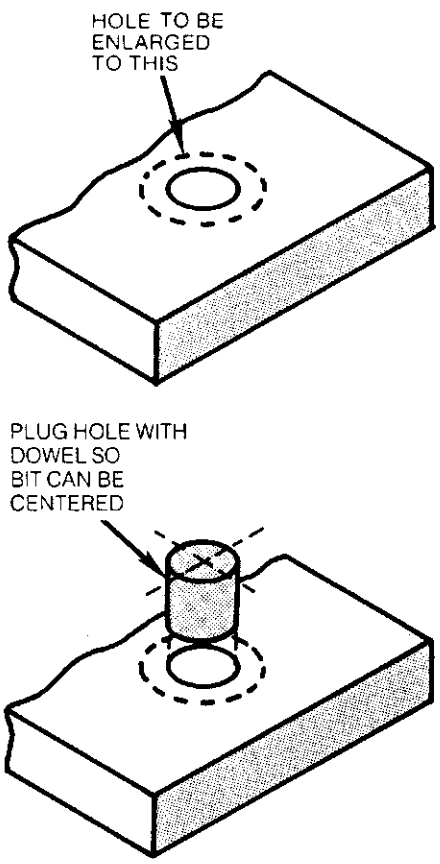


Figure 7-28. *You can relocate a hole or enlarge one already drilled if you first seal it with a plug so you can center the bit for the new hole.*

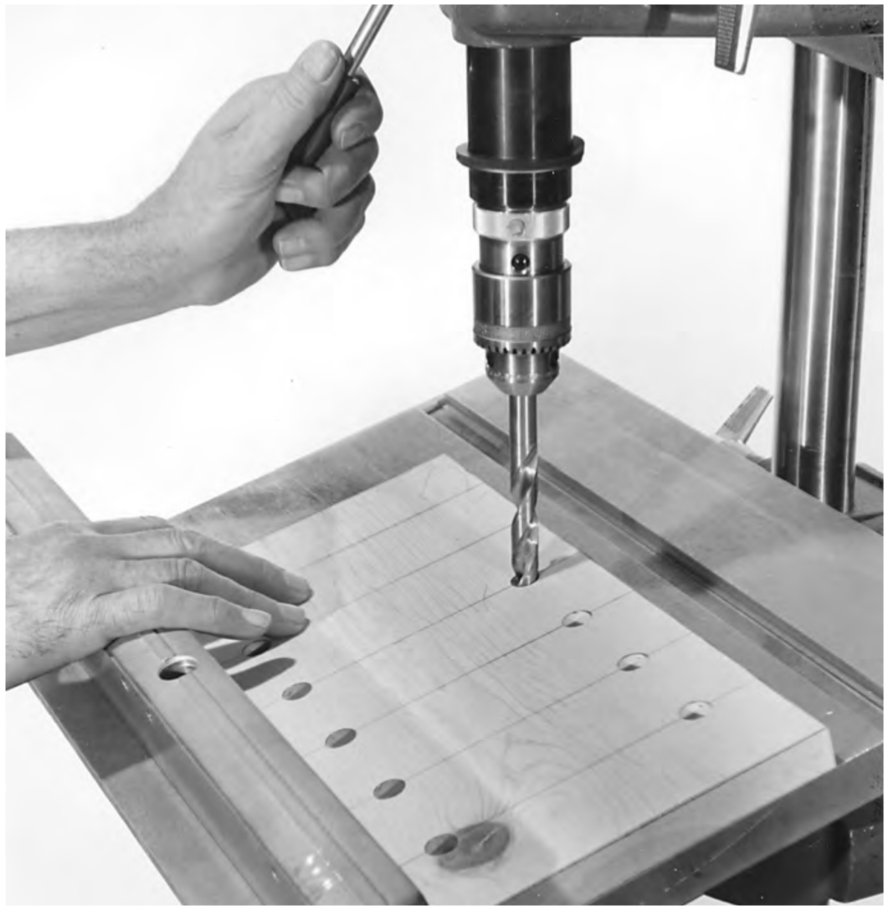


Figure 7-29. *Angular holes are drilled by tilting the table and using the rip fence as a guide and for support. Use a backup when drilling holes through the workpiece.*

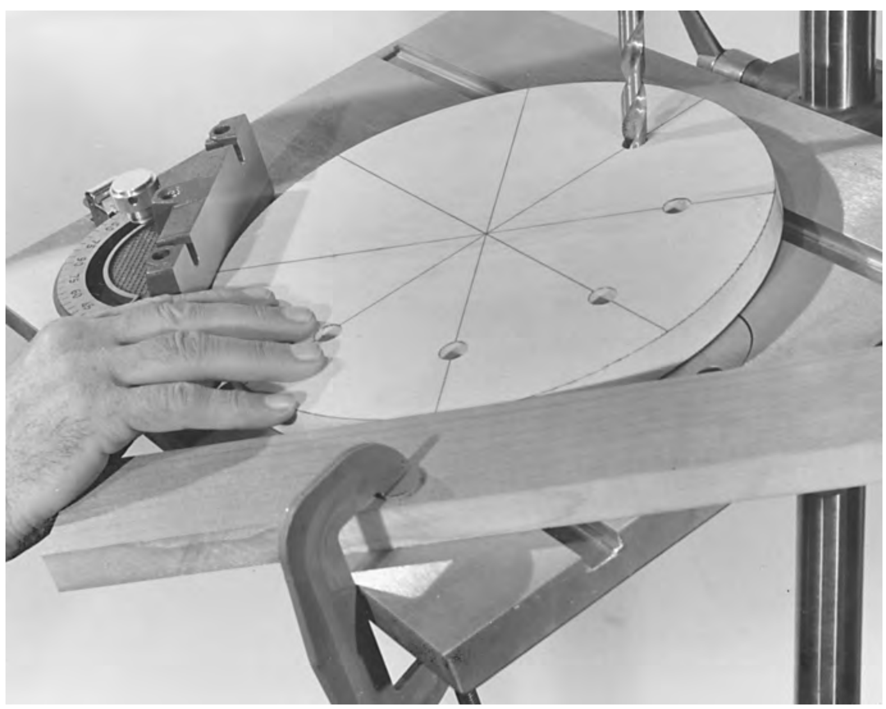


Figure 7-30. *Control accuracy when drilling angular holes in circular pieces by using the V-block arrangement shown here.*

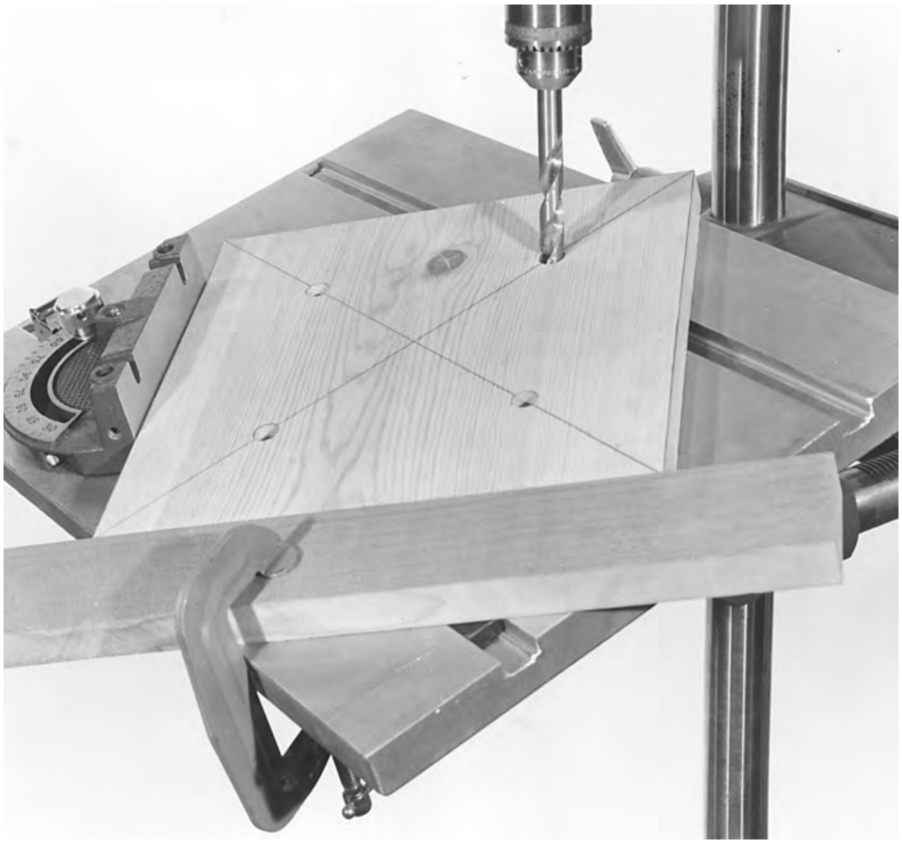


Figure 7-31. To a limited extent, the V-block setup can be used to drill angular holes in square workpieces.

Figure 7-34. The table and the fence, positioned this way, make a perfect V-block for holding a workpiece that requires diametrically accurate holes. Line the "V" with scrap blocks when drilling holes through the workpiece.

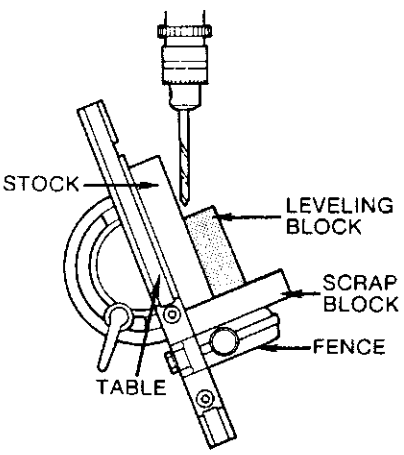


Figure 7-32. On sharp angles, the side of the bit may contact the workpiece before the bit center does. This can cause the bit to drift off center. A leveling block will solve the problem.

DRILLING USING SPECIAL SETUPS

Whether you are doing production work or simply wish to reduce layout functions on a single piece while still achieving accuracy, you

Figure 7-33. The point of the bit will contact the leveling block before it touches the work. Thus it can't move away from where you want it to drill.

Figure 7-35. The V-block arrangement is also suitable when you need holes in one or more corners of square material. Feed the bit very slowly when you make initial contact.

Figure 7-36. The rip fence guarantees all holes will have exactly the same edge distances.

Figure 7-37. An example of how the rip fence and miter gauge are used together. Since the miter gauge has its own lock screw (in the bar), it doesn't have to be clamped.

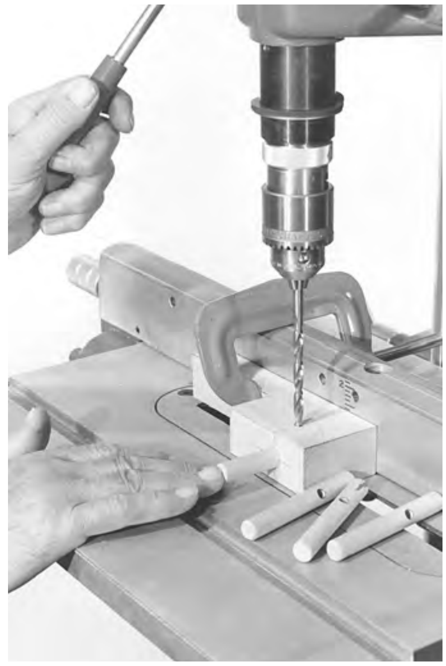


Figure 7-38. Setups are invented to suit particular applications. Once this setup is made, any number of pieces can be accurately drilled.

can work with setups using Mark V accessories or others that you invent to suit a particular application.

A basic setup, one that is needed quite often, is demonstrated in Figure 7-36. The job calls for a series of holes on a common centerline to have the same edge distance. The work is marked for hole spacing; the fence is adjusted for the edge distance. When adjusting the fence, lock it in an approximate position and then use the table height lever (Model 500) or the table height crank (Model 510) as a forward feed mechanism to make the final adjustment. When holes with the same edge distance are required on both edges of the stock, all you have to do to drill the second set of holes is turn the work so its opposite edge is against the fence.

In some situations, the rip fence and the miter gauge are used together (Figure 7-37). Because of the special screw and slot in its bar, the miter gauge's position can be secured without the use of clamps.

Even small pieces, like round pieces of dowels, can be organized for similar drilling on any number of pieces. The drill hole and the dowel accommodation hole are bored on the same centerline. You are then assured that the hole in each piece will be centered and will have the same edge distance (Figure 7-38).

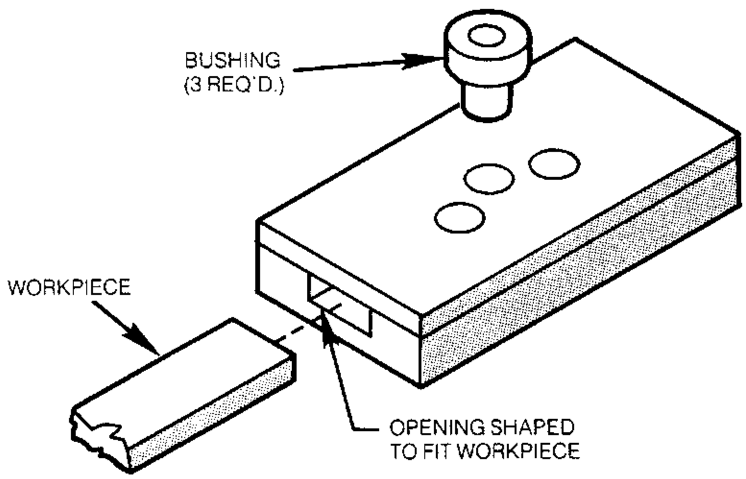


Figure 7-39. Another example of a hole locating setup. Bushings may be placed in drill guide holes to assure that holes will not become distorted by repetitive drilling. Bushings must be used when drilling metal.

Another example of a hole locating setup is shown in Figure 7-39. The design depends, of course, on the work that must be done. Using bushings will assure that the guide hole or holes will not become distorted by repetitive drilling.

Using a Hole-Spacing Guide

If you make the hole-spacing guide that is shown in Figure 7-40, you will be able to accurately drill a series of equally spaced holes, all with the same edge distance, without having to do layout work. The fence is locked in approximate position and the table is adjusted so drilling will occur on the centerline of the workpiece. After the first hole is drilled, the guide is adjusted so the guide pin will engage that hole and position the workpiece for the next hole. The procedure is then repeated—drill a hole, lift the guide pin so you can reposition the workpiece, insert the guide pin in the last hole, and position the workpiece for the next hole (Figure 7-41).

The guide is made by following Figure 7-42. The large holes are for the post—either the mortising hold-down post or 5/8" diameter bar stock—that is secured to the rip fence (Model 500) or a fence extension with a hole drilled in the top (Model 510). The small holes are for the guide pin. The guide pin is 1/4" dia. so you can only drill 1/4" dia. holes, but this is not a limitation. If you need larger holes, mount the proper size dowel to the end of the guide pin to enlarge it to the proper size.

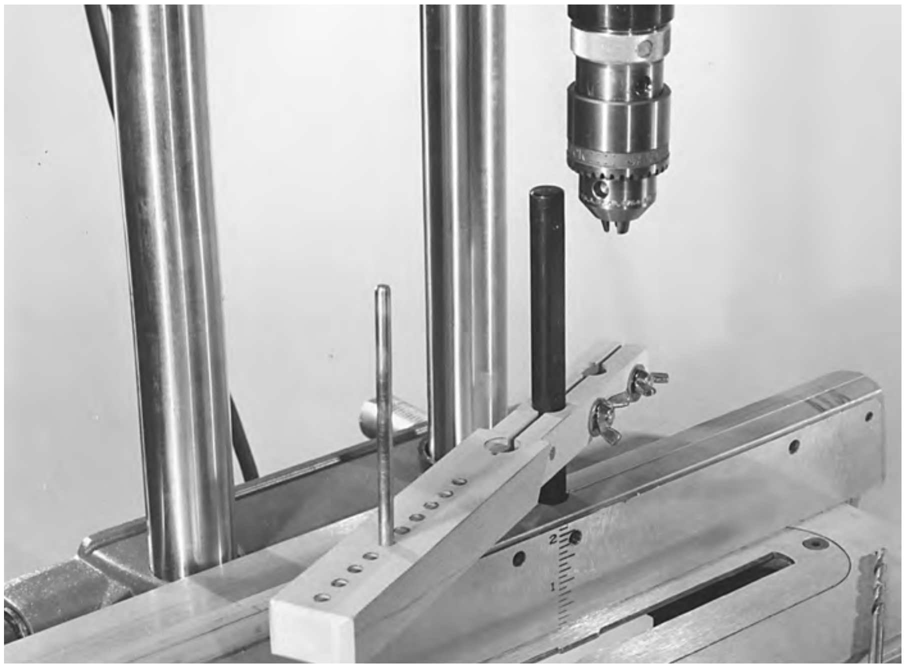


Figure 7-40. *The hole-spacing guide allows you to form equally spaced holes on a common centerline without extensive layout work. It's designed for working on stock of various widths and thicknesses.*

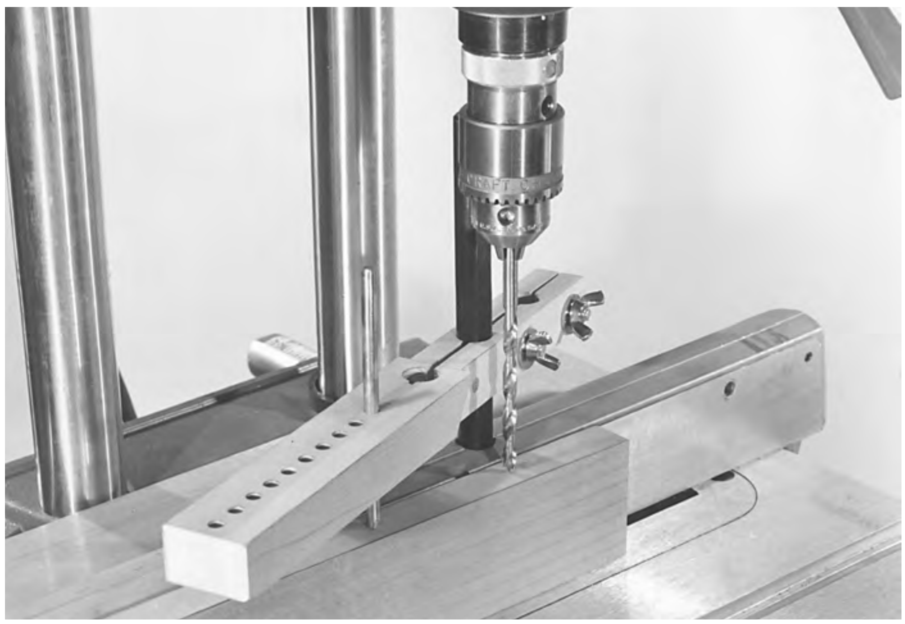


Figure 7-41. *After the first hole is drilled, the guide is positioned for the required hole spacing. The guide pin engages one hole to position the workpiece for the following one.*

Indexing

When you need holes that must be equally spaced around a circumference and have the same distance from a center, you can work accurately by using a pivot guide as shown in Figure 7-43. The guide is a table slot size strip of wood with a small nail driven through it that projects just enough to seat in the stock. The guide is clamped in place and the table is adjusted so the distance from the pivot to the center of the bit equals the radius you need. The distance between holes is determined by laying out equally spaced segments. *Caution: If the project calls for through holes, mount a piece of plywood to the guide strip to back up the bit.*

Another option is to make an indexing device (Figure 7-44). The guide disk has equally spaced holes around its edge so it can be turned a specific amount and held there by the guide pin that passes through the guide block. Since the workpiece turns with the disk, the holes you need will also be equally spaced. *Caution: When the holes must be drilled through the workpiece, mount a scrap backup to the indexing device.*

DRILLED MOLDINGS

You can produce interesting and original moldings if you follow the

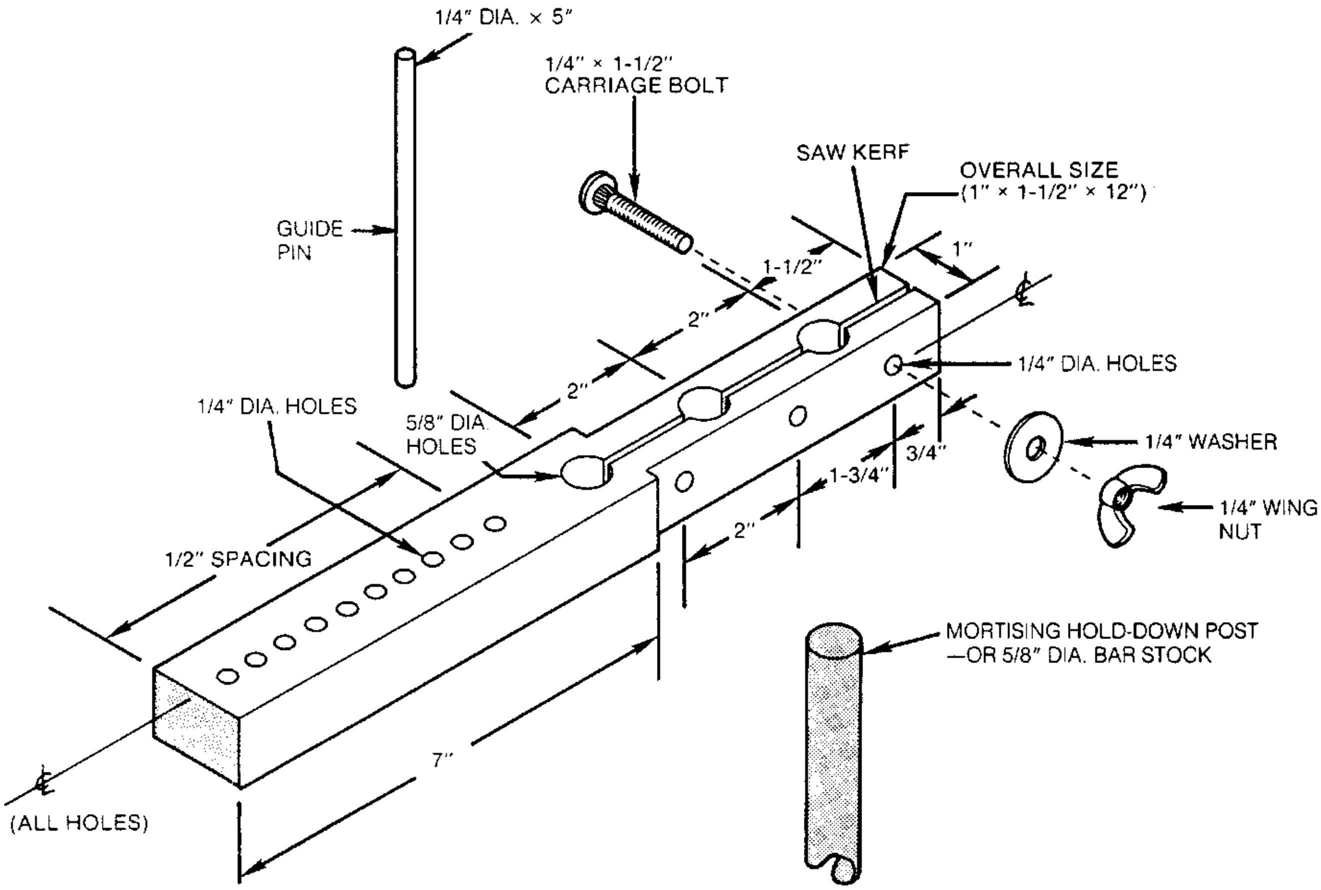


Figure 7-42. *Construction details of the hole-spacing guide.*

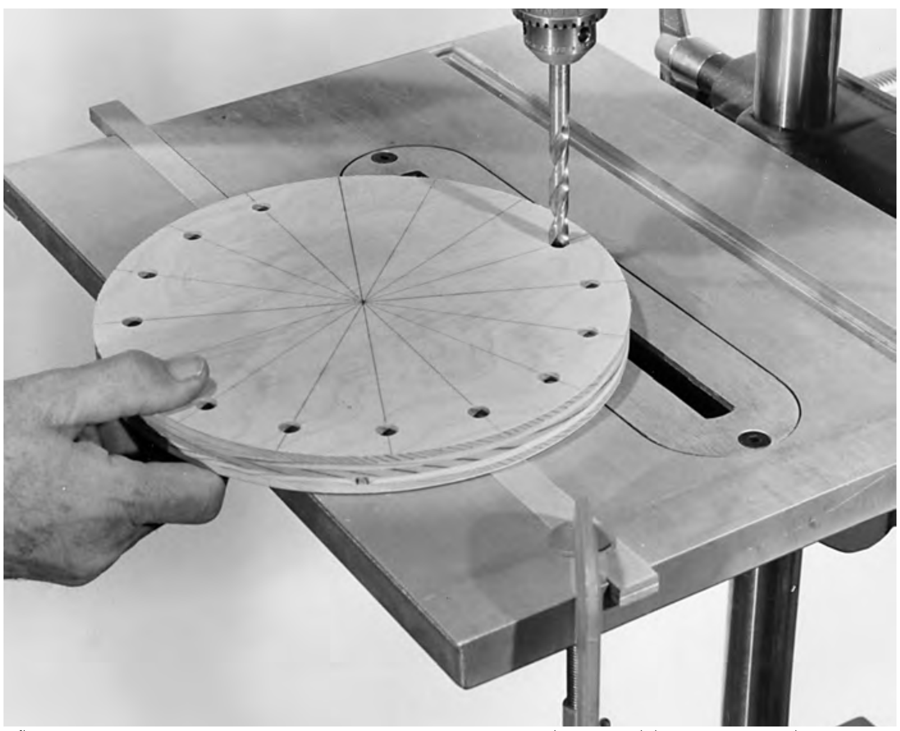


Figure 7-43. *A strip of wood, sized to fit the table slot, provides a pivot point so the workpiece can be rotated when equally spaced holes are needed on a circumference. The distance from the pivot point to the bit is the radius of the circle on which the holes are needed.*

procedure demonstrated by the following example. Clamp together three pieces of 1-1/2" thick stock and draw a layout for holes as diagrammed in Figure 7-45.

After the holes are drilled, separate the three pieces and strip-cut each one on the table saw or bandsaw so you end up with individual pieces like those in Figure 7-46. Saw with a smooth cutting blade so the pieces will be smooth without needing a lot of sanding.

The parts you produce can be used individually or they can be assembled edge-to-edge to make interesting panel designs (Figure 7-47). Try some experiments with how you strip-cut the pieces after they are drilled. For example, instead of sawing with the stock flat so you cut across the holes, make cuts with the stock on edge. By planning the saw cuts and then joining particular pieces, you can produce intriguing patterns like the one shown in Figure 7-48.

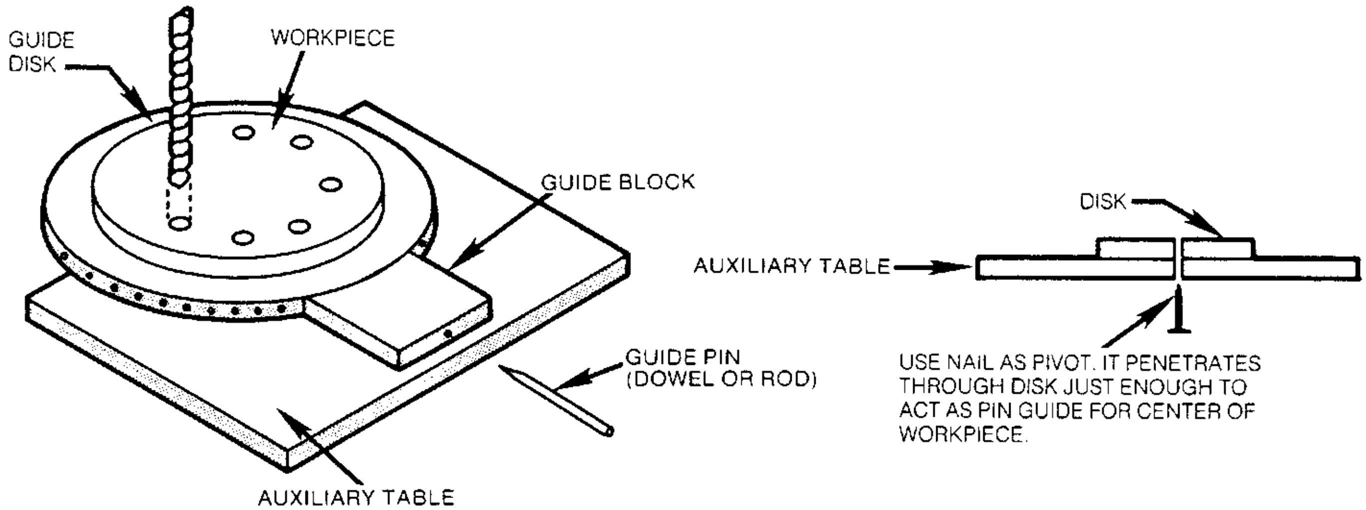


Figure 7-44. *Construction details of an indexing device that will automatically position the workpiece regardless of hole spacing or radial distance.*

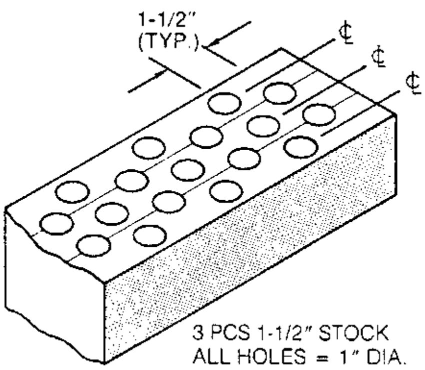


Figure 7-45. *A typical pattern for drilling holes in stock that will be strip-cut into molding.*

You can also vary designs by drilling different size holes and by changing hole spacing. The same drilling technique can be used to produce semi-circular grooves (Figure 7-49).

METAL DRILLING

Metal drilling requires a firm support as close to the cutting area as possible (Figure 7-50). ***Warning: The workpiece should always be clamped or gripped in a device such as a drill press vise or locking pliers.*** Backup scrap should be used so the torque of the bit, as it breaks through, does not jerk the metal.

When drilling metal, set the speed to the maximum recommended or slower and use a sharp,

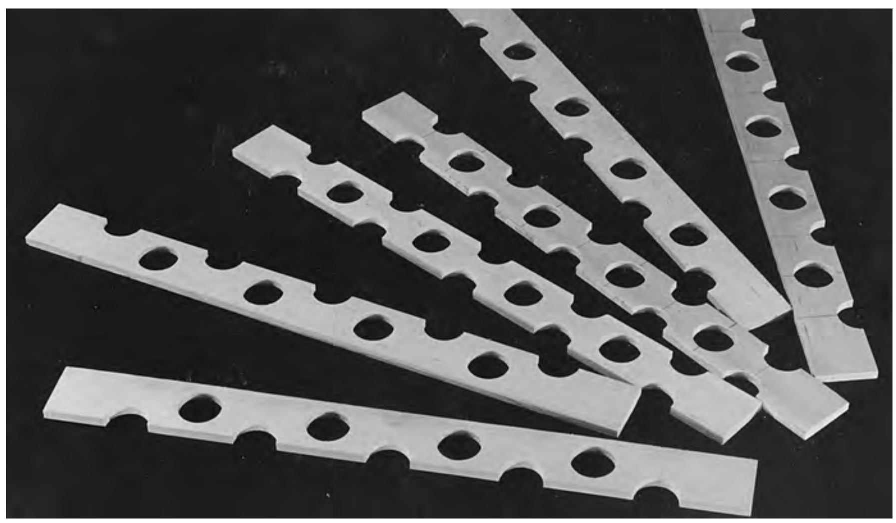


Figure 7-46. *Strip-cutting, after drilling, produces individual pieces like these.*

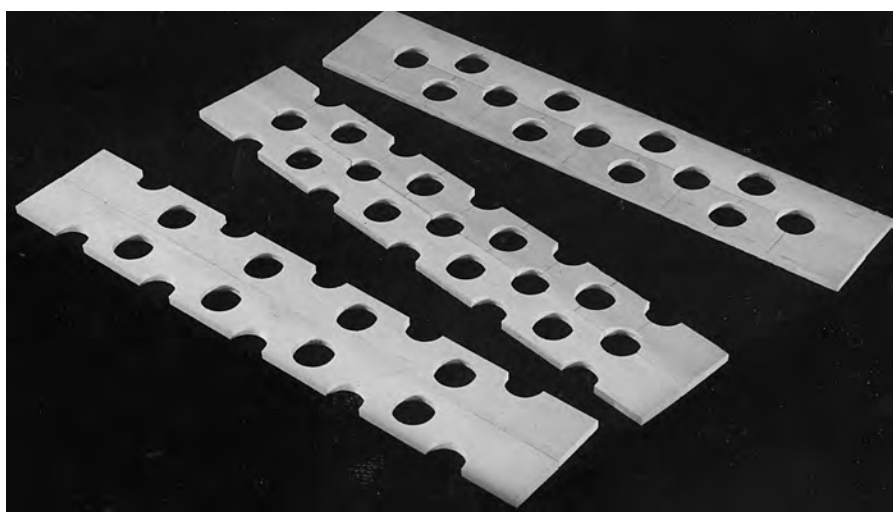


Figure 7-47. *The pieces can be used separately or they can be joined to form panel designs.*

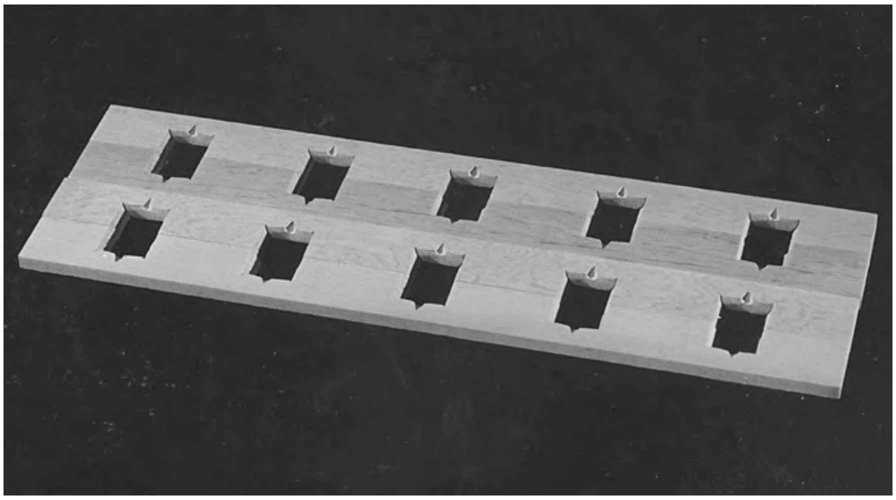


Figure 7-48. Patterns of assembled pieces can vary depending on how you strip-cut the pieces. A mortising chisel was used to drill the holes.

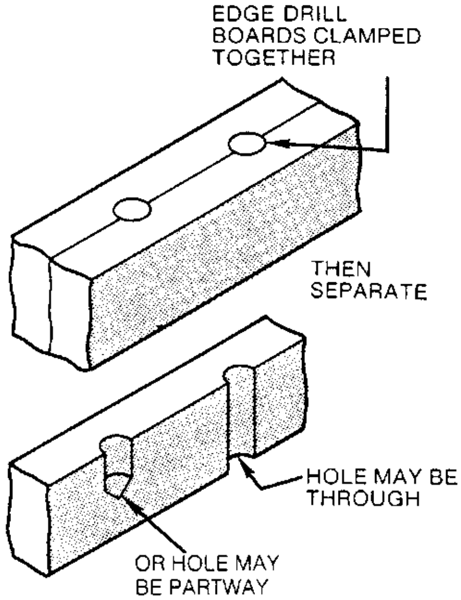


Figure 7-49. Semi-circular grooves, through or partway, are formed by edge drilling stock on the joint line of pieces that have been clamped together.

high-quality twist bit. To determine the maximum recommended speeds for various metals, use the following formula:

$$\frac{\text{Material*}}{\text{Drill Bit Diameter}} = \text{RPM}$$

*Material = Brass (860), Aluminum (764), Copper (592), Bronze (385), Cast Iron (382), Steel (306).

Example:

$$\frac{\text{Brass}}{1/4'' \text{ Dia. Bit}} = \frac{860}{.25} = 3440 \text{ RPM}$$

Caution: Feed the bit very slowly into the workpiece and apply plenty of oil to the tip of the bit while you're drilling. This will keep the bit from dulling (Figure 7-51).

If the bit catches, back it out quickly; then feed it more slowly with less pressure. If the bit stalls completely and the quill won't retract, quickly turn off the Mark V. Back the bit out of the hole, turning it counterclockwise by hand. Once the bit is free, turn on the machine and feed the bit very slowly back into the workpiece. Once the bit goes through the workpiece, turn off the Mark V and let it come to a complete stop before you remove the workpiece.

Metal Drilling Layout

A scriber is usually used for marking metals, but often the line won't show clearly unless you bear down on the scriber. Since this might scratch the material more deeply than desired, special dyes are used to coat the metal (Table 7-4). Apply the dye coater. Don't "paint" the metal; a thin but even coat is sufficient. Allow it to dry then scribe the lines. The scribe lines should be just light enough to remove a tiny thread of the coating and thus reveal the metal beneath. The metal itself is not harmed. ***Warning: Prepare the dyes carefully. Always follow safety cautions that may be on the container of the material you use.***

When marking a dimension point, don't place the scale flat on the work and then scratch with the scriber to form the mark (Figure 7-52). A precise method is shown in Figure 7-53. Set the scale on its edge and then run the point of the scriber down the graduation groove. This will leave a fine dot as a dimension point, which is all you need.

An angle gauge or similar marking tool (Figure 7-54) can be used as an edge-marking gauge when you need a line parallel to the edge or end of a piece of work. Maintain the scriber's contact as you move the gauge along. Dividers can be used to gauge the distance be tween holes (Figure 7-55) or to mark the locations of equally spaced holes.

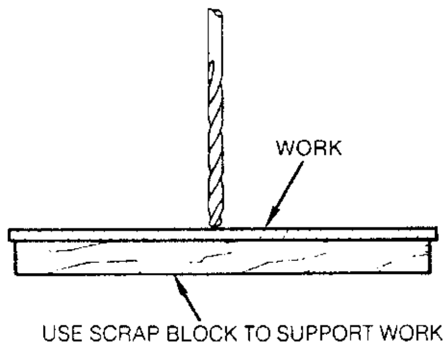


Figure 7-50. Always be sure that metal to be drilled is firmly supported close to the cutting area.

Figure 7-51. To drill metal, use a twist bit and feed it into the workpiece slowly while applying plenty of oil.

Table 7-4: Surface Coaters

Material	Dye
Rough Metals	White or blue chalk, rubbed on surface.
Castings	Whiting (mixture: 50-50 white lead and turpentine).
Smooth Steel	Copper sulfate (2 tablespoons in 1 cup water—crystals available at drugstore or chemical house) or layout compound (purple coating, available at hardware store).
Bright Sheet Metal	Layout compound.

Warning: Prepare the dyes carefully. Always follow the cautions that may be on the container of the material you use.

NOTE: You can keep layout dye in a discarded shoe polish bottle—one with dauber which may be used to apply the dye. Apply dye evenly and smoothly on the surface of the metal. Don't paint the metal; a thin, even coat is sufficient.

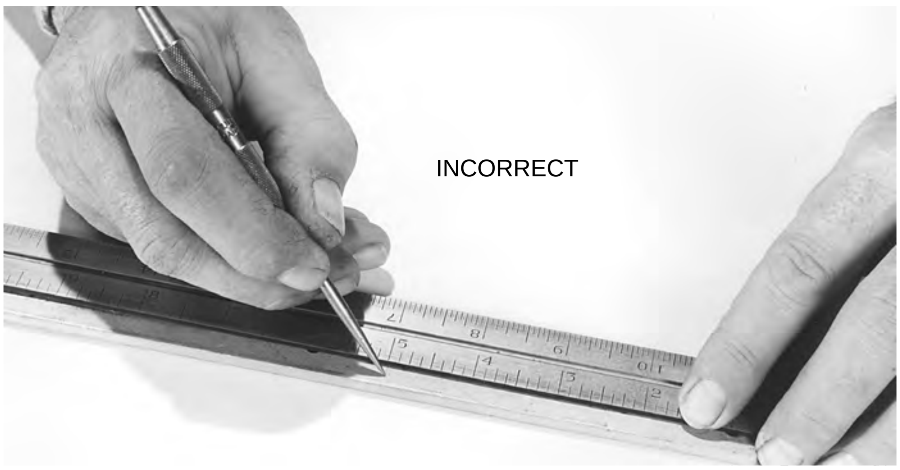


Figure 7-52. *Working with the scale flat and using the scriber to scratch a dimension mark can lead to inaccuracies.*

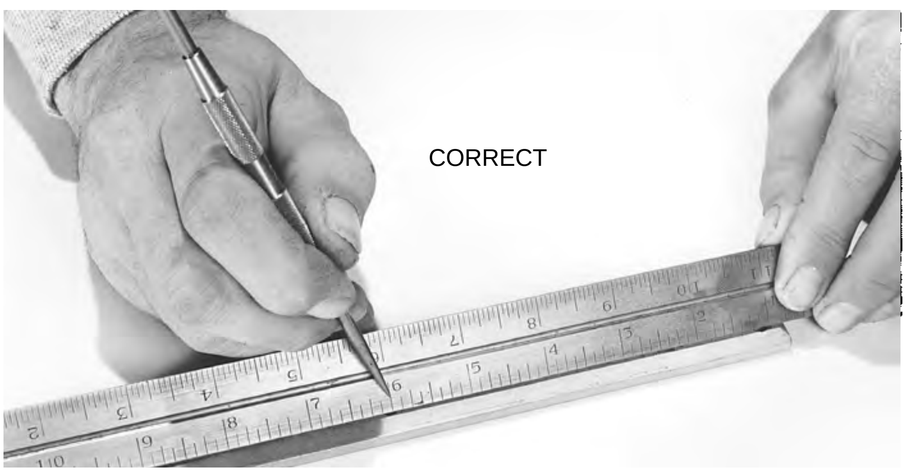


Figure 7-53. *When you work with the scale on edge and the scriber sliding down the groove in the scale, the dimension mark will be a fine point, which is all you need.*

Drilling Preparations

After hole locations have been established, a prick punch is used to mark the hole's center. The prick punch has a slender, sharp point which is easy to place at the correct drilling spot. The small spot it makes is enlarged with a center punch, which forms a small well that serves as a seat for the point of the bit (Figure 7-56A).

Figure 7-54. *Work with an angle gauge or similar measuring device to mark lines parallel to an edge.*

Figure 7-55. *Use dividers to gauge the distance between holes or to mark the locations of equally spaced holes.*

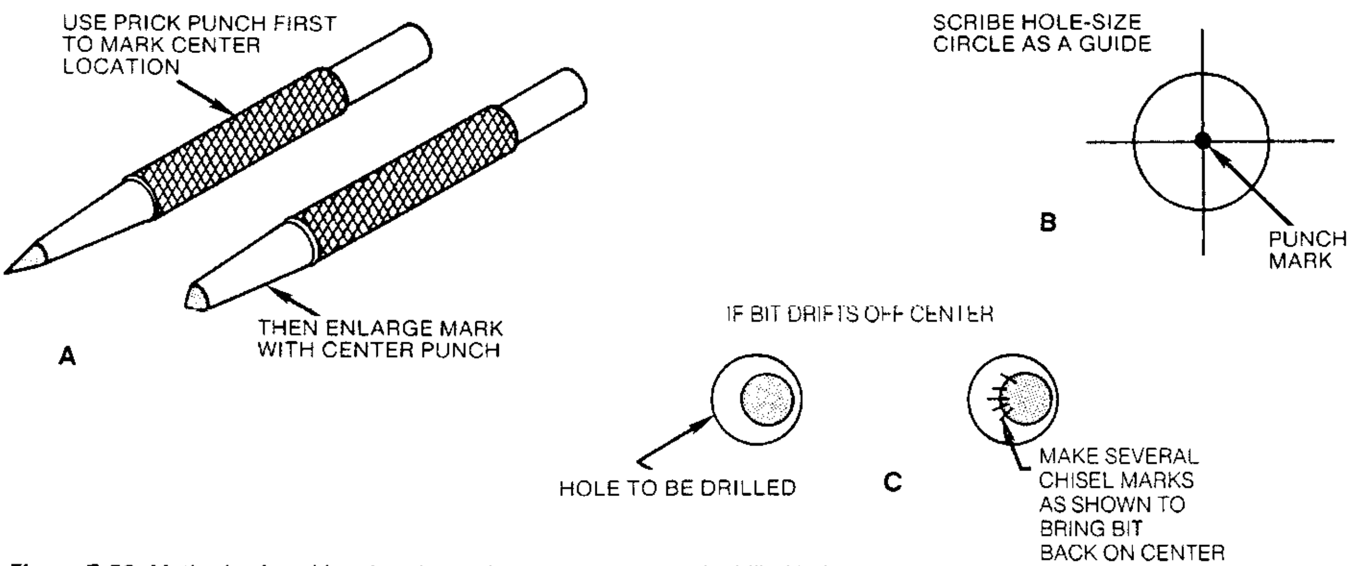


Figure 7-56. *Methods of working that do much to assure accurately drilled holes.*

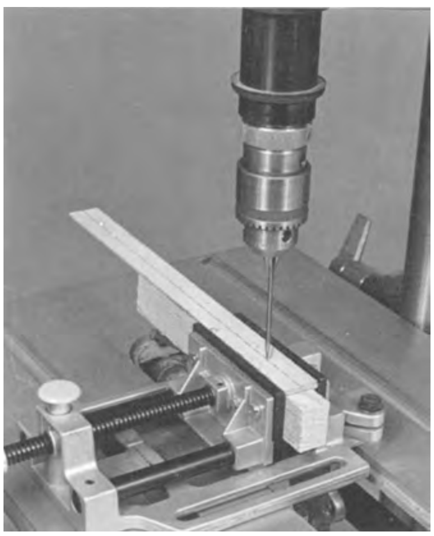


Figure 7-57. *How a centering pin is used. The wood block under the stock is there to back up and keep the stock level.*

Figure 7-58. *The bit is substituted for the centering pin after the stock has been positioned.*

Positive accuracy, especially when drilling large holes, is assured by using the method shown in Figure 7-56B. After the hole location has been prick-punched, scribe a circle the same size as the hole you want, or a bit larger, around the center mark. The scribed circle is a guide that will reveal any tendency of the bit to drift off center.

A way to work, should the bit start to drift, is shown in Figure 7-56C. Make a series of small chisel or prick punch marks as the illustration shows; then continue drilling.

Centering Pin Use

A precise way to position work so the hole location will be centered with the bit point is to use a centering pin (Figure 7-57). The pin itself is a short length of 1/8″ or 1/4″ steel rod, sharpened to a fine point at one end. The work is gripped in a holding device, in this case a drill press vise, and is positioned so the point of the pin engages the indentation made with the prick punch. Clamp the vise firmly in place; then do the drilling after substituting the bit for the pin (Figure 7-58).

The drill press vise is a unique tool in that it is easily bolted to the worktable. The replaceable jaws have vertical and horizontal V-grooves so they can securely grip round stock, triangular pieces, and flat material.

Concentric Drilling

A drill press vise is commonly used to hold short pieces of round bar stock vertically for concentric drilling. But, a unique and practical way to work, if stock diameter permits, is to use a lathe faceplate as shown in Figure 7-59. An advantage is assurance that the stock will be in true, vertical position. Place the faceplate on a flat surface as you insert the stock and secure it with the faceplate's locking setscrew.

V-Block Drilling

The combination of the rip fence and table as a V-block works for woodworking as well as metalworking. With the table tilted 45° and the fence secured, perfect support is created for drilling round stock (Figure 7-60).

Be sure that the setup is situated under the spindle so the bit meets the work at its highest point, which is the centerline of the work.

Caution: If the hole is to go through the stock, use scrap wood under the work to protect the table and fence.

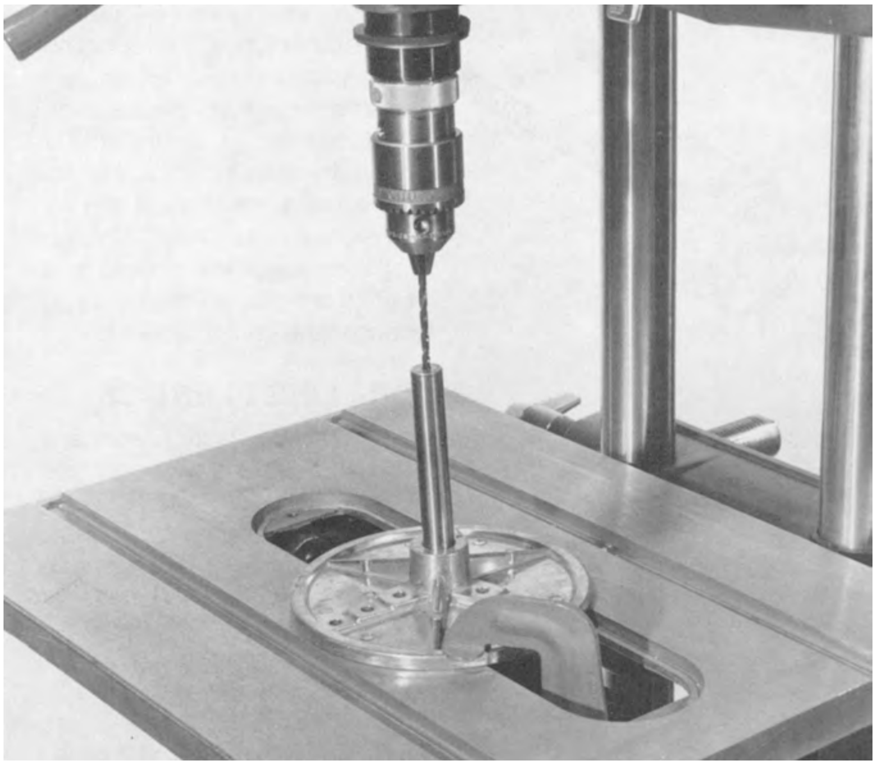


Figure 7-59. *Use a lathe faceplate to hold round bar stock for concentric drilling. If the stock is positioned carefully, this idea can be used for stock with a diameter that is less than the hole size in the faceplate.*

Countersinking

Machine screws and stove bolts often have countersunk heads, so they need a seat in the work if they are to be flush with work surfaces. Countersinking is done after the holes for the fasteners have been drilled. As with all metal work, be sure the workpiece is secure in a holding device and that the holder is clamped to the table (Figure 7-61).

Countersunk heads on stove bolts and machine screws have a different angle than those on wood screws, so be sure to use a countersink designed specifically for metalwork.

Spot Polishing

Spot polishing, or "damaskeen-ing," is an attractive finish easily accomplished on soft metals by working as shown in Figure 7-62. The spot-polishing tool being used is made by following the plan in Figure 7-63. The final appearance of the finish will depend on the uniformity of the application and how much you overlap the spots. Use a backup block under the work and set the rip fence so each

Figure 7-60. *The table and fence form a V-block so you can accurately drill diametric holes in round stock.*

Figure 7-61. *When countersinking metal, be sure to use a countersink that will cut at the correct angle for fasteners like machine screws or stove bolts.*

Figure 7-62. *Spot polishing creates a distinctive finish on soft metal surfaces.*

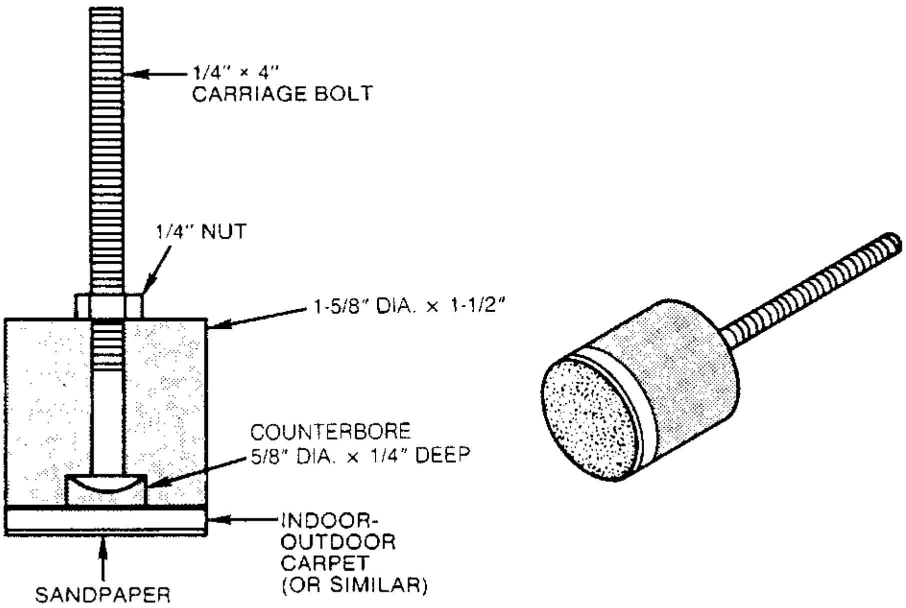


Figure 7-63. *Construction details of the spot polishing tool.*

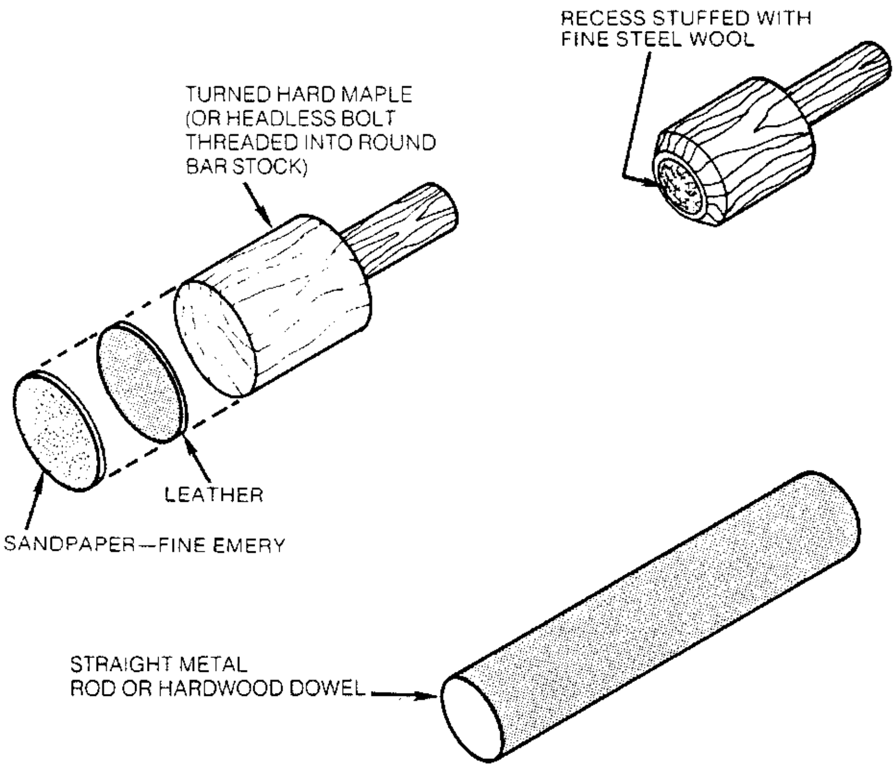


Figure 7-64. *Three examples of other types of homemade spot-polishing tools.*

set of spots will have a common centerline.

You'll be able to judge immediately, by checking the first spot, just how much feed pressure you should use. Figure 7-64 shows some other types of spot-polishing tools you can make. When abrasive paper or steel wool is used to abrade the spots, the work is done dry. If a straight rod is used, a mixture of emery dust and light oil is used on the work. The turning rod causes the mixture to abrade the metal which, in turn, causes the spot to appear.

DRILLING PLASTICS

When drilling plastics, work at a fairly slow speed, between "Slow" (700 RPM) and "D" (1050 RPM). The larger the hole, the slower the speed should be. If you go too fast, the bit will heat up and melt the plastic.

Don't use brad-point bits; you will dull them. You can use a twist bit, but you risk splintering certain types of plastic. The best bit is a special plastic-drilling bit. These bits have a tip ground at 60° for a smoother cut in plastic (Figure 7-65). ***Warning: Do not use twist bits to drill plastics. They will splinter certain types of plastic.***

Figure 7-65. *For best results when drilling plastic, use a plastic-drilling bit. These special bits are ground at a steep angle to make a smooth cut in different types of plastic.*

Chapter 8 Mortising

Mortise-and-tenon joints are some of the strongest woodworking joints. They are used extensively in cabinet and furniture making. The special mortising accessory for the Mark V eliminates tedious hand work when cutting mortises for mortise-and-tenon joints and other joints calling for a square cavity.

MORTISING SETUP

To perform mortising operations, set up the Mark V in the drill press mode and use the accessories shown in Figure 8-1.

The mortising attachment is slipped over the collar on the quill. Position the arm to the right or left and secure with the Allen screw. To secure the chuck, turn the spindle by hand so the tapered flat faces away from the arm and secure the setscrew. ***Warning: The chuck must be secured while the flat of the spindle faces away from the arm of the mortising attachment.*** *Caution: Place a scrap piece of wood on the worktable to protect the bit and chisel if they are dropped.* Insert the chisel in the adjustable sleeve and secure it with the setscrew (Figure 8-2). Insert the bit through the chisel and into the chuck and lock with the chuck key. ***Warning: Be sure to remove the chuck key.*** The adjustable sleeve of the mortising attachment is positioned so there is a gap of 1/32" to 1/16" between the cutting edge of the bit and the chisel (Figure 8-3).

Since the rip fence is used as a guide for the workpiece, the chisel must be square to it. Place the head of a combination square against the fence and the chisel (Figure 8-4). Make the adjustment by turning the adjustable sleeve; then secure it with the setscrew.

The mortising hold-down which attaches to the rip fence, keeps the workpiece from pulling up when the quill is retracted.

The final step is to adjust the quill feed stop for the depth of cut needed. *Caution: If the cut is to go through the workpiece, use scrap wood to protect the table.*

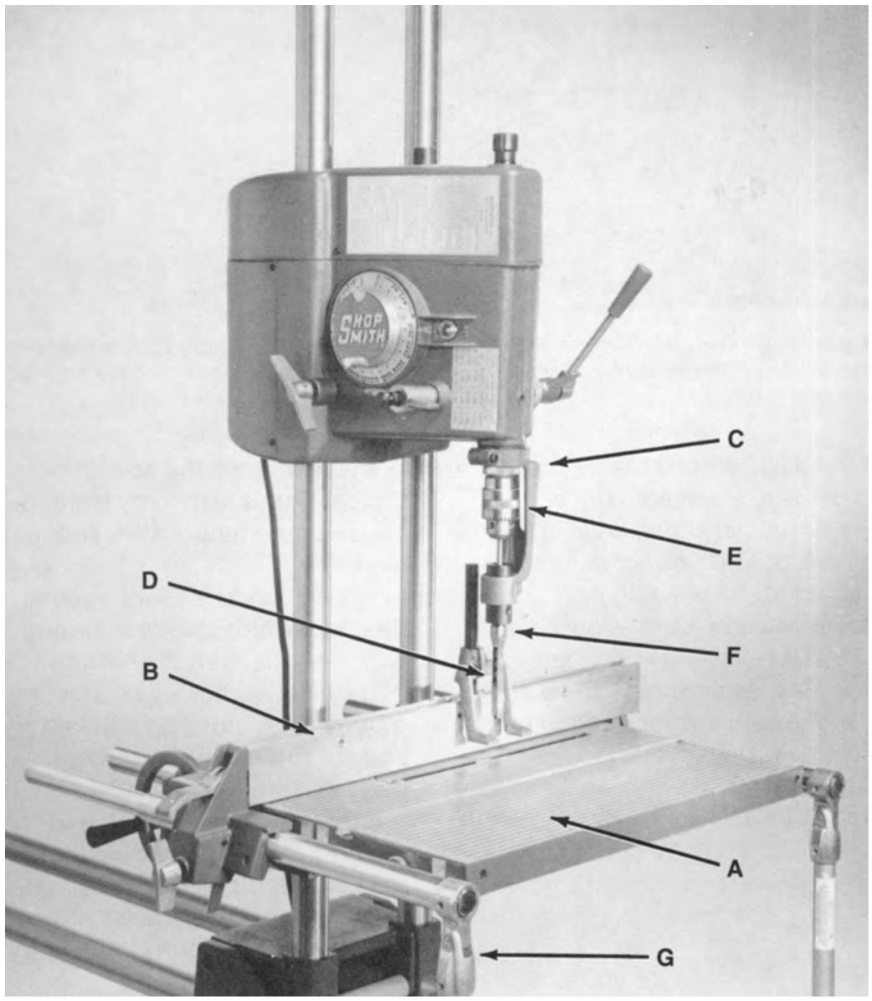


Figure 8-1. *The accessories that are used for mortising are: (A) worktable, (B) rip fence, (C) mortising attachment, (D) mortising hold-down, (E) drill chuck and (F) chisel and bit. (G) The internal tubes and telescoping legs of the extension table system support the table (Model 510 only).*

MORTISING SAFETY

Warning: Before using the mortising accessory, read and understand these important safety instructions:

Danger Zone—The danger zone during mortising operations

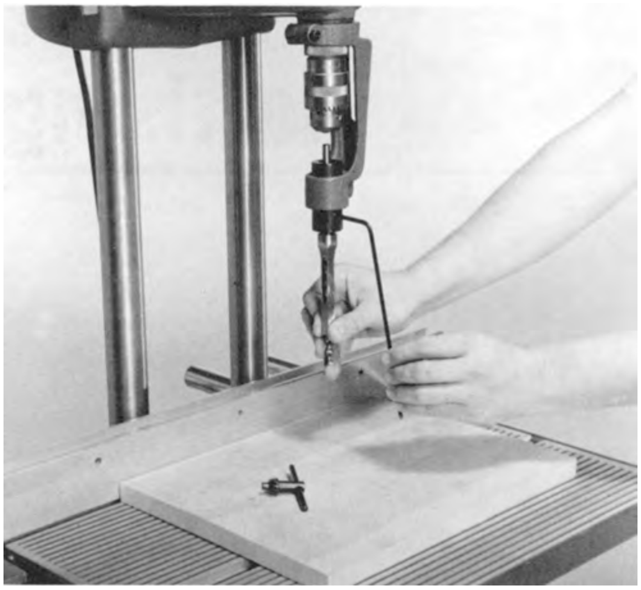


Figure 8-2. Insert the chisel in the adjustable sleeve and secure it with the setscrew. A piece of scrap stock protects the worktable.

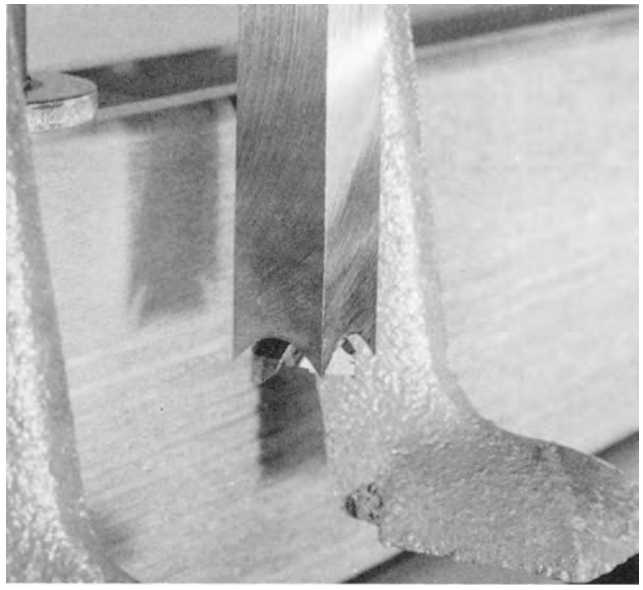


Figure 8-3. There must be a clearance of 1/32"-1/16" between the bit and the chisel.

extends 3" around the bit and chuck and 5" beneath the bit. When you perform mortising operations, be certain your hands and fingers aren't beneath the bit when you advance the quill. Never reach in toward the bit or beneath it to clear away scraps. Turn off the machine and let it come to a complete stop first.

- **Wear proper eye and ear protection.**

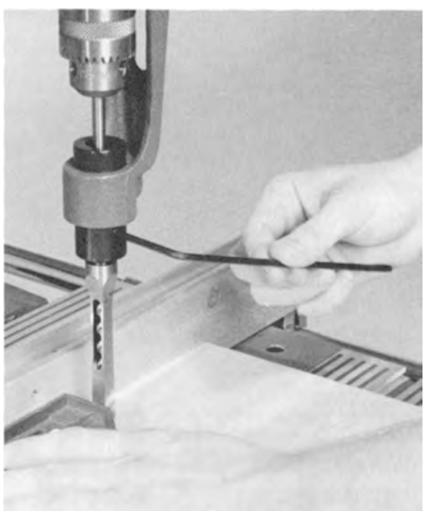


Figure 8-4. The side of the chisel should be positioned at right angles to the rip fence. Check it with the head of a combination square.

- **Never leave the key in the chuck. Remove the key from the chuck immediately after securing the bit.**
- **Never wear jewelry, gloves, ties, loose clothing or clothing with long sleeves. Keep long hair tucked under a hat. Jewelry, gloves, ties, clothing and hair could become entangled in the bit.**
- **Position the worktable at mid-chest whenever possible.**
- **Use the rip fence as a backstop and hold the stock firmly against both the worktable and the fence.**

MORTISING SPEEDS

Before you begin any mortising operation, set the Mark V to run at the correct speed. To do this: turn the machine on, turn the speed dial to the correct speed and let the machine come up to speed.

The operating speeds for mortising range from speed setting "H" (1600 RPM) to "G" (1450 RPM). For the most part, the correct speed is determined by the size of the mortise you want to make and the material you're using. Generally, you can use faster speeds with softer woods or smaller mortises. Use slower speeds as the materials get harder and the mortises get larger.

MORTISING

All the joints shown in Figure 8-5 can be made using the mortising accessory.

Position the workpiece on the table and depress the chisel to do the cutting. Use only enough pressure to keep the bit cutting (Figure 8-6). Pressure required will vary with the size of the chisel and the hardness of the wood. Softwoods such as pine cut easily, while hardwoods such as maple require considerably more pressure. If you can't make the cut without exertion, it is probably because the edges on the bit and/or the chisel are dull.

The rip fence/worktable V-block arrangement can be used to hold round workpieces. Be sure to mark the workpiece so the cuts will begin and end on the same line (Figure 8-7).

Two factors which tend to spoil a mortise are illustrated in Figure 8-8. To eliminate these, cuts should be made as shown in the order given

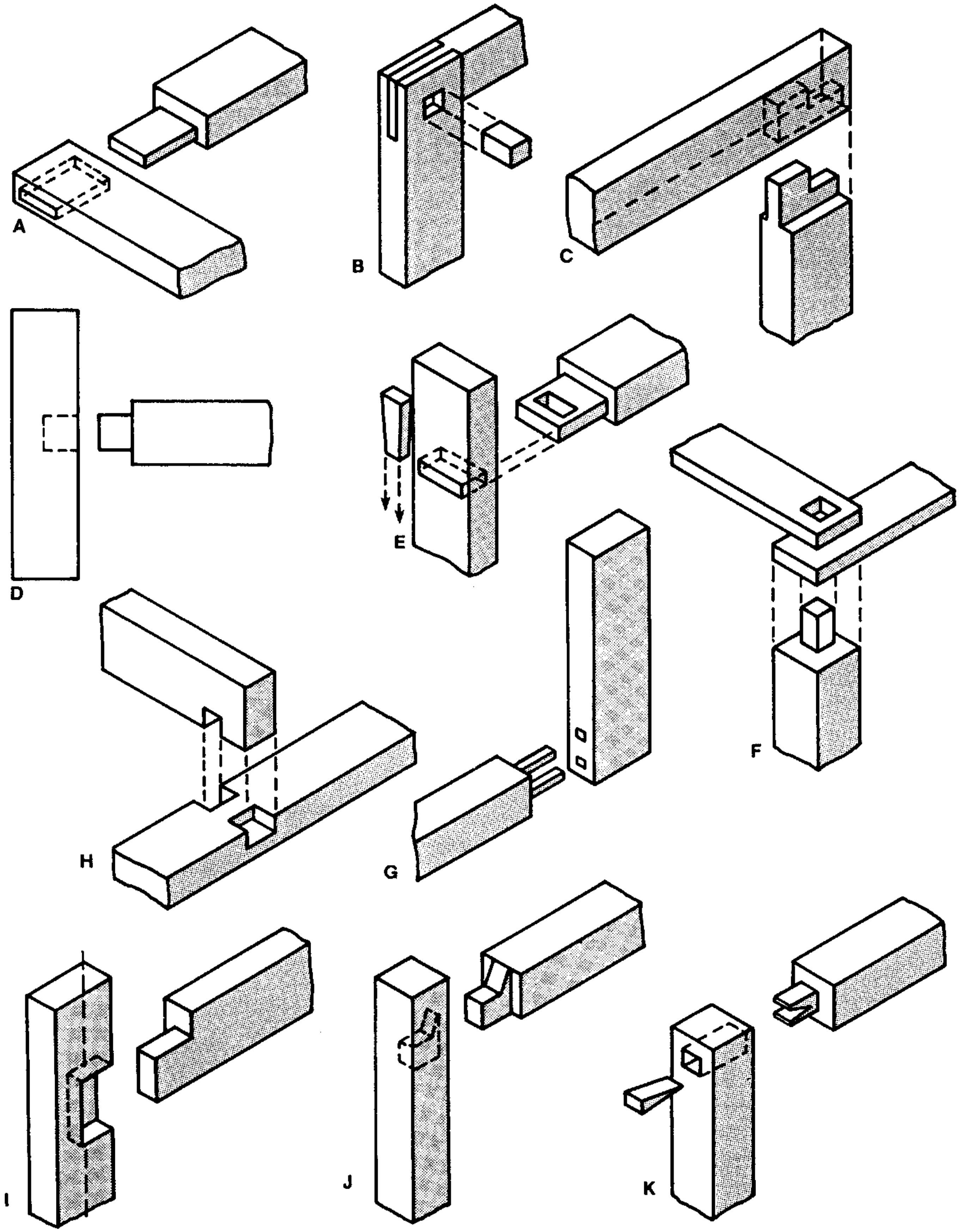


Figure 8-5. *All of the following joints can be made by working with mortising bits and chisels: (A) through, (B) keyed, (C) haunched, (D) blind, (E) loose wedged, (F) three-way, (G) twin, (H) notched, (I) open-faced, (J) concealed haunched, (K) through wedged.*

in the second detail of the drawing. The general rule is: Always make the end cuts first. Start with 1/4″ deep cuts, never less than three-quarters of the full width of the chisel. This may not be possible on the last cut, but keep as close to it as you can. Repeat until desired depth is achieved.

Avoid narrow shoulders. The chisel will drift away, leaving a tapered side. Many workpieces split because tenons are forced into mortises with sloping sides. If necessary, use a smaller chisel.

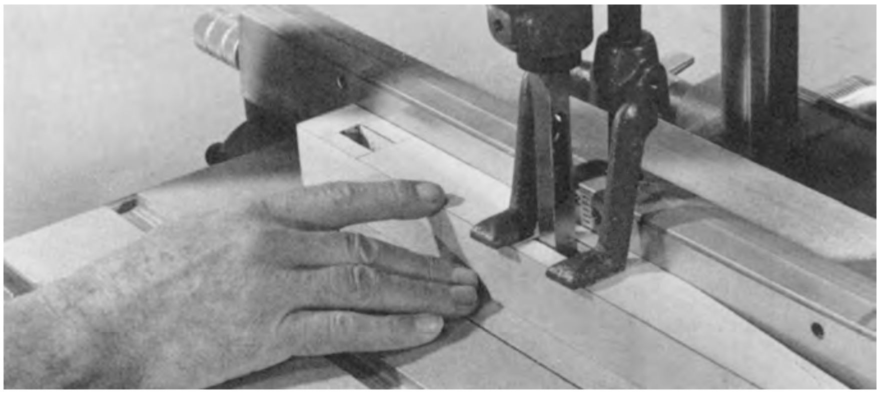


Figure 8-6. *Work with the correct speed and use only enough feed pressure to keep the bit cutting. Mortising cuts need a heavier feed than simple drilling, but if you must really lean on the feed lever, check the chisel and bit for sharpness.*

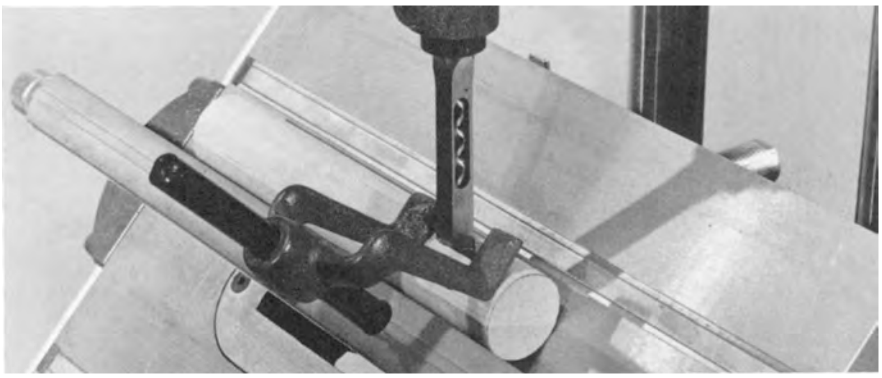


Figure 8-7. *The fence/table V-block arrangement can be used to hold round workpieces for mortising. Be sure to mark the workpiece so the cuts will begin and end on the same line.*

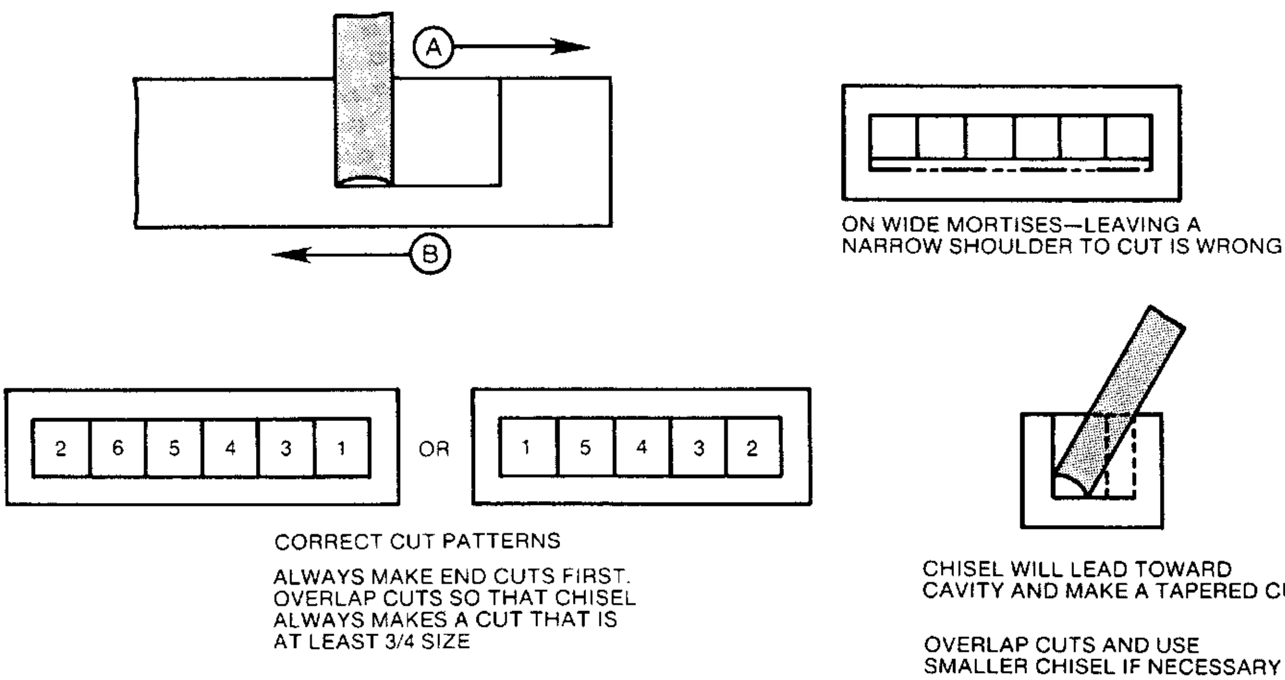


Figure 8-8. *Two factors that may spoil a mortise: (A) Chisel tends to lead off toward the cavity already formed, and (B) workpiece tends to drift away from the chisel as the cut is being made.*

Chapter 9
Shaping

The difference between a plain edge and shaped one is often enough to elevate the beauty and elegance of the simplest project. The shaper not only makes it possible to embellish otherwise square, plain edges, but it also has practical applications as well. Among other things, you can form the parts of a drop leaf table joint, do drawer joints, make a tongue-and-groove joint, shape half-round or curved moldings, and so on.

The Mark V becomes a very efficient shaper when it is in the drill press mode and equipped with the special shaper accessories (Figures 9-1 and 9-2). The shaper insert should always be used to provide maximum support for the work around the cutting tool. For fence shaping the shaper fence is secured to the table. Both fence boards are adjustable endwise and front to back, so the opening for the cutters can be kept small for safety. The infeed board is screw-adjusted for depth of cut. Pins that are screwed into the shaper insert are used for pin shaping.

SHAPING SAFETY

Warning: Before using the shaping accessory, read and understand the following safety instructions:

There are two major factors to consider about the safe operation of the shaping accessory: the speed and the sharpness of the cutter. Remember that the faster the speed and the sharper the cutter, the smoother the cut.

Danger Zone—The danger zone extends 3″ out from cutter in all directions. Work cautiously and slowly, especially when shaping against collars. Working this way will not only keep your hands safe, but will also increase the quality of your output.

Guards for the Shaper — Shaper guards must be used for all shaping operations. The fence guard is mounted on the shaper fence and the feather board guard is mounted to the quill when fence shaping. The feather board guard is adjustable to accommodate various thicknesses of stock. A feather board is used to hold stock up to 6″ wide against the fence.

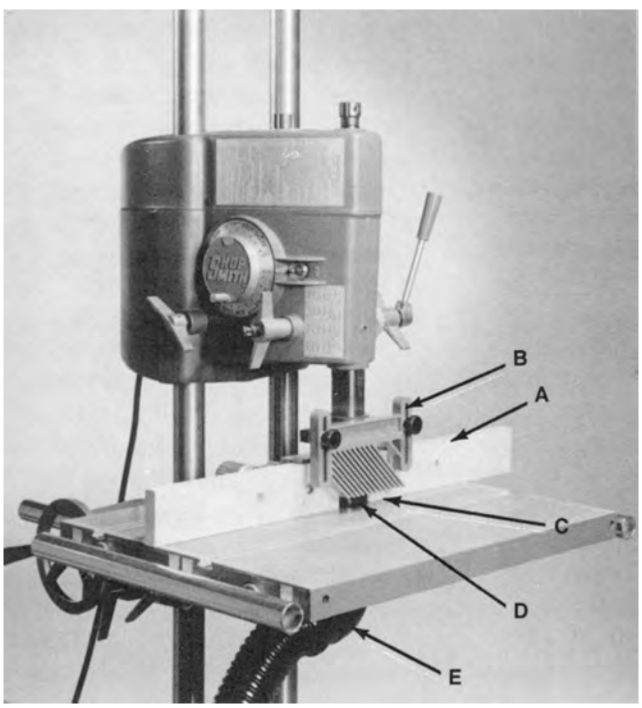


Figure 9-1. *The accessories used for fence shaping are: (A) shaper fence, (B) feather board guard, (C) shaper insert, (D) shaper arbor and cutter and (E) dust chute.*

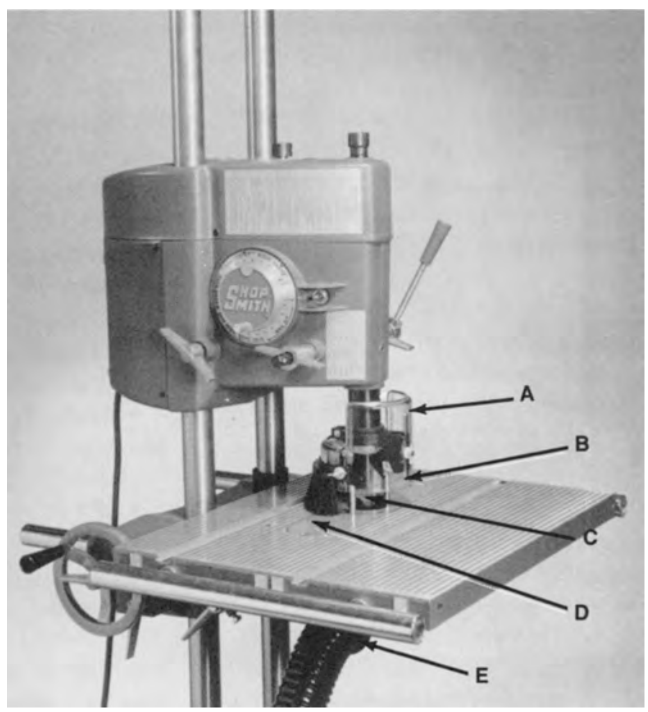


Figure 9-2. *The accessories used for pin shaping are: (A) circular shield and brush, (B) pins, (C) shaper arbor and cutter, (D) shaper insert and (E) dust chute.*

The circular shield and brush assembly is mounted on the quill when pin shaping. The shield is adjustable to accommodate various thicknesses of stock.

- **Wear proper eye and ear protection.**
- **Always use the shaper insert.**
- **Wear a dust mask or connect a dust collection system to the dust chute. Keep the dust chute mounted to the shaper insert even if you do not have a dust collection system. The chute guards the cutter below the table. You can collect dust and chips in a trash receptacle positioned beneath the table.**
- **Tuck long hair under a hat or tie it up. Do not wear ties, gloves, jewelry or loose clothing. Roll sleeves up above your elbows. Wear non-slip footwear.**
- **When mounting cutters and collars, make certain that the tongue washer is correctly installed and directly under the hex nut and that the nut is tight. Also that the arbor setscrew is tightened against the flat of the spindle.**
- **Be sure the cutter(s) is positioned with the cutting edge facing to the left.**
- **Listen for chatter or signs of looseness at start-up. If you hear, see or suspect problems, turn off the power and unplug the machine. Correct any problem before proceeding.**
- **Keep cutters clean, maintained and sharp.**
- **Operate the shaper at speeds between "U" (4400 RPM) and "Fast" (5200 RPM).**

Fence Shaping

- **When edge shaping, always use feather boards to guide the workpiece.**
- **When shaping the end grain of stock 2" to 6" wide, use your miter gauge with safety grip to control the stock, and keep the feather board guard in place to protect your hands and hold the stock down. Do not shape the end grain of stock less than 2" wide.**
- **Always feed the workpiece from left to right against the rotation of the cutter. Otherwise a kickback will occur.**
- **Use a push stick to feed a narrow workpiece. When it is necessary to push a workpiece underneath the feather board guard, use a long piece of scrap wood.**
- **Avoid taking deep cuts. If the amount of material to be removed is substantial, make more than one pass. Set the fence to make a partial cut and then readjust the fence accordingly to reach the final shape.**
- **Cut with the grain.**
- **Do not stand in line with the workpiece being fed. In the event of a kickback you could be hit.**
- **Feed the workpiece slowly. Use extra care in shaping workpieces that contain figured grain or knots, as these may cause kickbacks.**

Pin Shaping

- **Always feed the workpiece against the rotation of the cutter, left to right in front of the cutter, right to left if cutting with the rear of the cutter. Otherwise a kickback will occur.**
- **Always use at least one push block to help control the workpiece. Use two if possible.**
- **Always use the left starter pin. Use the right pin whenever possible.**
- **Hold the workpiece firmly against the left starter pin and feed the workpiece slowly into the cutter.**
- **Internal shaping, i.e., the shaping of the edge of a hole or small opening (less than 6" in diameter) in any shape, should not be attempted.**

SHAPER CUTTERS

Attempting to maintain a complete assortment of cutters can be expensive. A careful selection of from ten to twenty shapes (Figure 9-3), picked for the type of work you do, is adequate. With a basic assortment on hand, you can always add a new cutter as the need for it arises.

Probably the most practical type of shaper cutter for home workshop use is the three-lip shaper cutter shown in Figure 9-4. This type of cutter is available in a great variety of shapes: some are combination cutters, others have a profile that will produce a particular shape such as a tongue or groove. Other shaper cutters come in sets so mating parts can be cut (Figure 9-5).

The shaper arbor holds standard shaper cutters and collars (Figure 9-6). The arbor is locked firmly in place by securing its setscrew against the spindle's tapered flat. The collars are used for depth-of-cut control and for cutter spacing. The cutters and collars are secured to the arbor with a nut. Be sure the nut is tight before starting the operation.

When positioning for cutter height, make the major adjustment by raising or lowering the table. The final setting is made with the quill feed lever. On shaping operations, especially at high speeds and on hardwoods, quill extension should be held to a minimum.

It is not usually desirable to use the full shape of the cutter to form a molding. How one versatile cutter is intended to be used is partially described and shown in Figure 9-7.

A wide variety of shapes can be made by changing one or more of the following:

- The depth of cut, which is adjusted by moving the table or the fence or by using collars.
- The height of the cutter in relation to the work, which is con-

Figure 9-3.** Three-lip shaper cutters are available as combination cutters, full-profile cutters, or in sets that form the mating parts of a particular joint.* ****Warning: Always use the fence assembly when using these cutters that remove the entire workpiece edge.

trolled by the table or the quill feed lever.

• The position of the work when making the pass.

Figure 9-8 shows a few shapes formed by a single cutter; in this case a combination cutter that can be used to shape a bead or two sizes of quarter-round was utilized. Some of the shapes were cut in a single pass, others required two or more passes, but the same cutter was used every time.

The important thing to remember is that not all cutters are intended to cut their full-profile shape, even though they can be used that way. Most of them are combination cutters.

Collars come in various sizes and are used to control the depth of cut and to position the cutter. As shown in Figure 9-9, they may be set over, under or between cutters. Be sure to position the keyed washer so it seats correctly in the arbor slot. Never set up cutter/collar assortments that don't allow the arbor nut threads to be fully engaged.

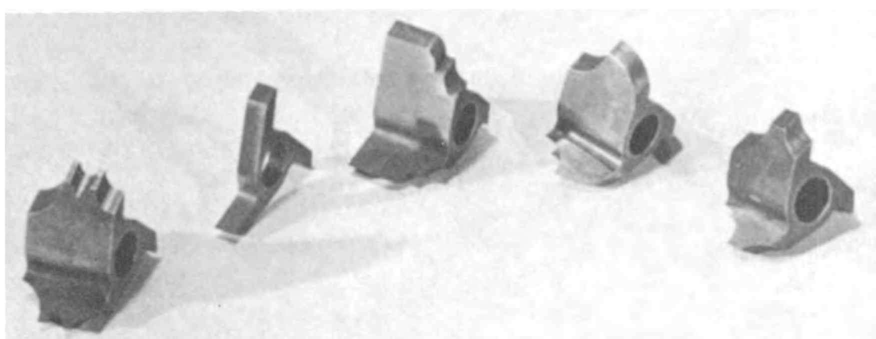


***Figure 9-4.** Examples of three-lip shaper cutters.*

Since the collars lock on the arbor together with the cutters and turn at the same speed, there is the potential, when the workpiece bears against them, of scoring or even burning the workpiece. Keep the collars clean, smooth, and free of knicks and burrs. When cutting, hold the workpiece against the collars with just enough pressure to maintain contact.

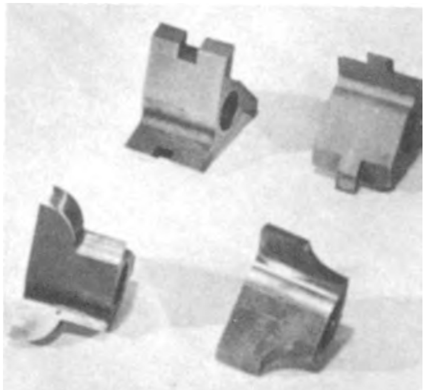
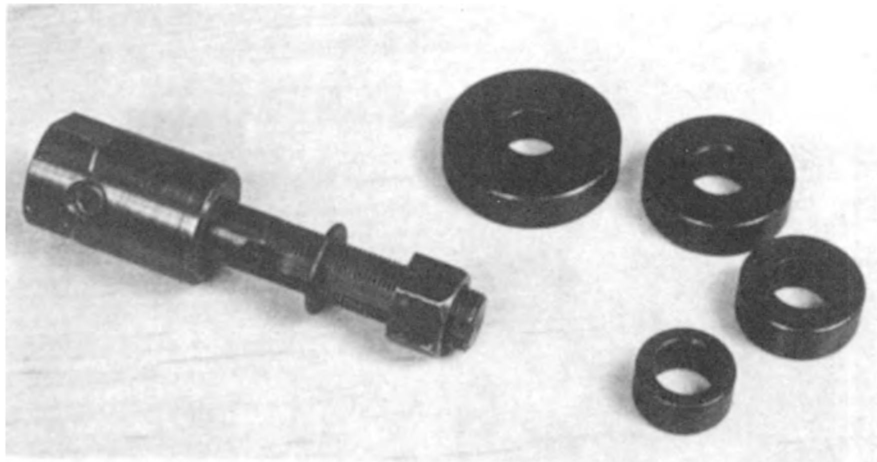
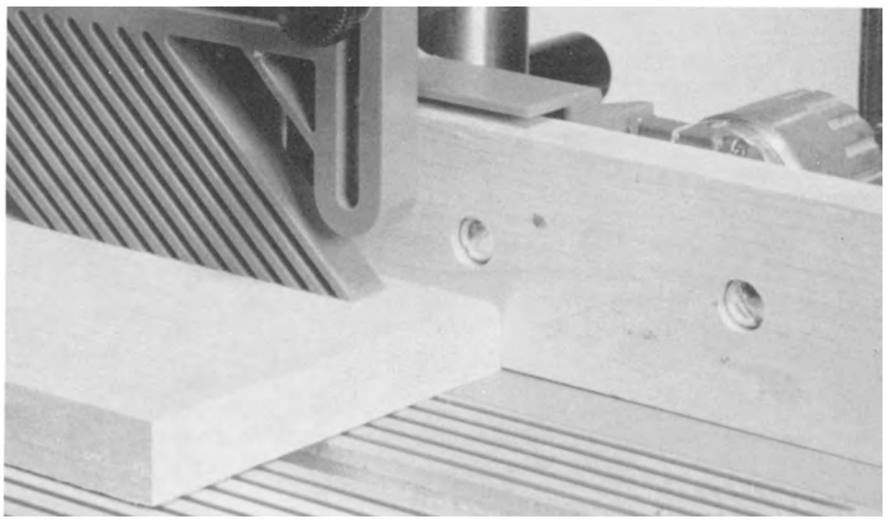


Figure 9-5. Examples of cutters that should be purchased in sets. At the top, tongue-and-groove cutters. The others are mating cutters for the drop leaf table joint.

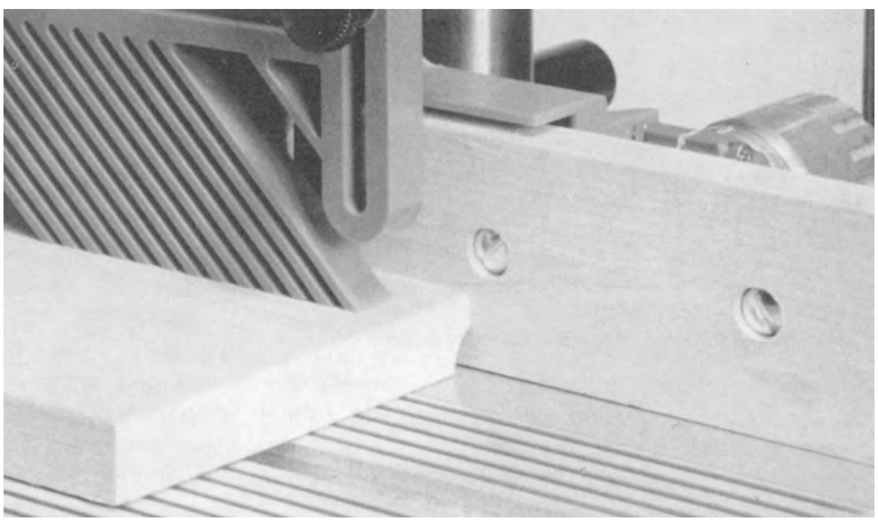


A B

Figure 9-6. *(A) The shaper arbor and (B) various collars.*



A



B

Figure 9-7. *Combination cutters can do various jobs. (A) Here a quarter-round and cove cutter is used to round off the edge of a workpiece. (B) The same cutter is shown forming a cove.*

CUTTER STORAGE

Three-lip shaper cutters should be respectfully cared for. They are an investment, and they work best when they are clean and sharp. They can be kept in the plastic cases they are packed in, but selecting the cutter you want will be more convenient if you make the case shown in Figure 9-10. It will hold up to 30 cutters, or you can use some of the dowel posts for storing the collars. Use gummed labels near each post to identify the cutter. Construction details for the case are shown in Figure 9-11. Cutters should be carefully cleaned before storage.

FENCE SHAPING

When fence shaping the width of the stock determines the position of the stock and the shaping accessories used:

- Stock less than 1″ wide, use the feather board guard, one feather board on the infeed side and an additional feather board on the outfeed side, secured in the table slot (Figure 9-12A). Use a push stick or when it's necessary to push stock underneath the feather board, use a long piece of scrap wood.
- Stock 1″ to 2-3/4″ wide, use the feather board guard and a feather board secured in the table slot (Figure 9-12B).

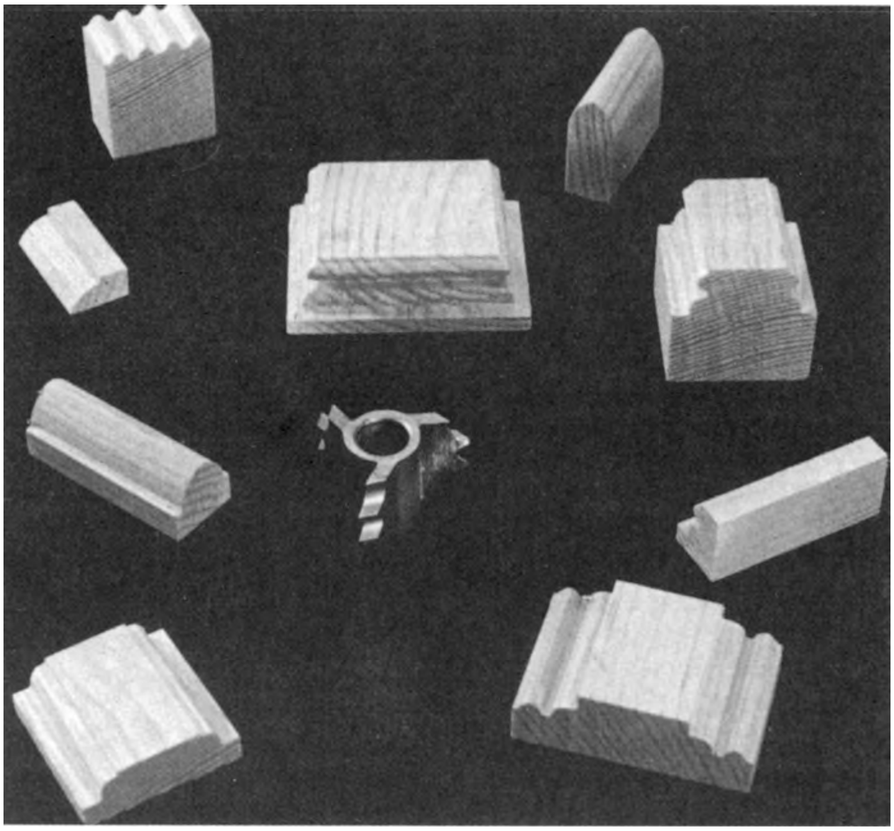


Figure 9-8. One combination cutter, in this case a bead and a quarter-round, can produce many shapes. Some forms are done with one pass, others require two or more passes.

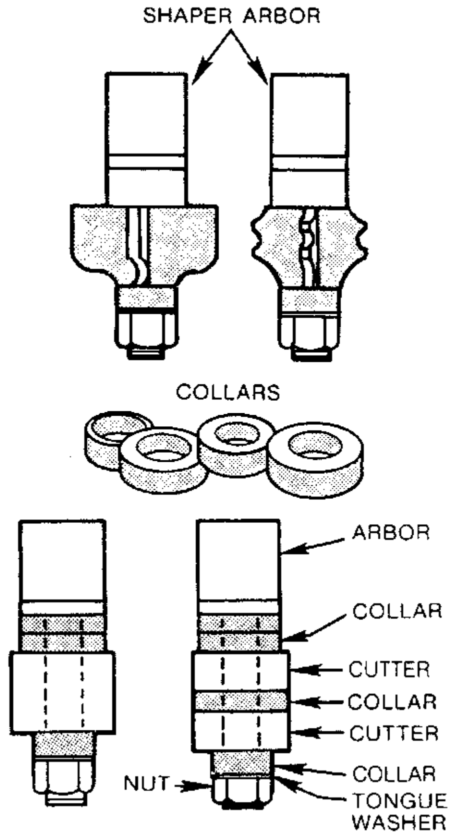


Figure 9-9. Collars are used above, below, even between cutters as controls for depth of cut and, when doing pin shaping, to provide bearing surface for the workpiece.

Figure 9-10. This shaper cutter storage case holds up to 30 three-lip shaper cutters.

• Stock 2-3/4" to 6" wide, use the feather board guard and a feather board secured to the table with C-clamps (Figure 9-12C).

• Stock over 6" wide, use the feather board guard and a push block (Figure 9-12D).

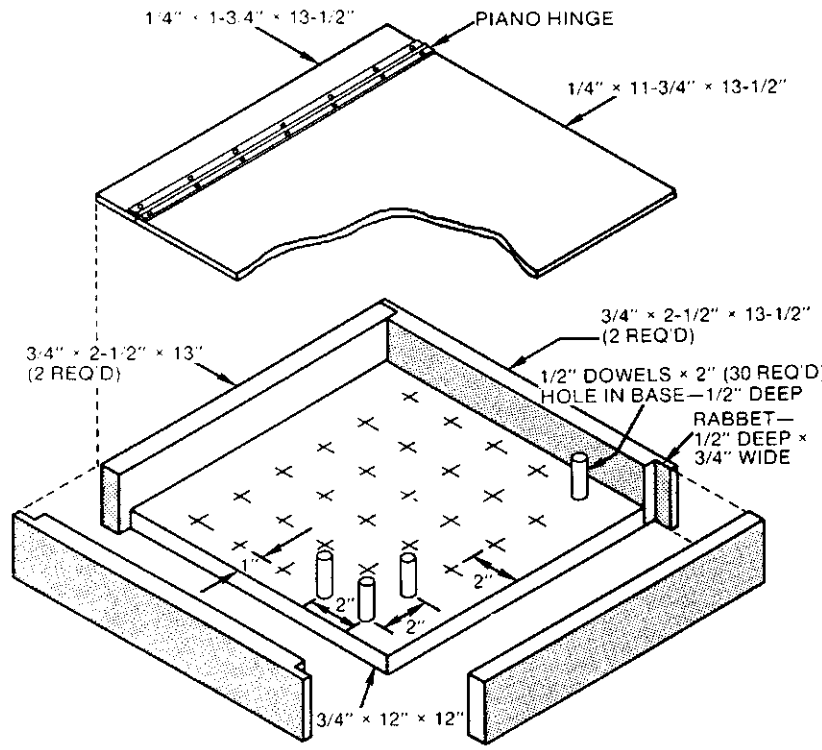


Figure 9-11. Construction details of a shaper cutter storage case.

You can remove the entire edge of the stock or only part of it (Figure 9-13). It depends on the cutter you are using and the shape you wish to produce. When only part of the edge is cut away, the surfaces of the fence boards must be on the same plane (Figure 9-14). The workpiece moves across the cutter and receives the same support from the outfeed board as it did from the infeed board.

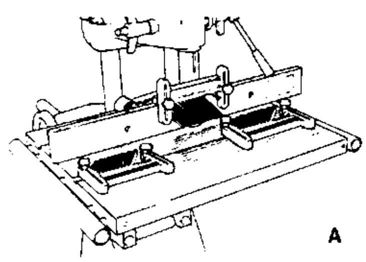
When the entire edge of the workpiece is removed, fence alignment must be adjusted to suit the depth of cut. You can do this by offsetting the outfeed board (Figure 9-15). Once the work has passed the cutter, the position of the outfeed board must compensate for the change in the stock's width.

Use a feed that is slow and steady. A slow feed allows the blades of the cutter to work longer over a given area of the wood and this produces smoother cuts, while allowing the cutter to work without choking. Of course, this can be overdone. Judge feed speed so the cut progresses smoothly without straining you or the cutter. Try to work so you are cutting with the grain of the wood. When you must cut against the grain, use an even more conservative feed speed.

Some shapes are attained by making two or three passes. Reposition the workpiece and the cutter after the first pass to provide the additional cut that completes the form. Operations like this are best handled by first sketching the shape required on the edge of the stock, then selecting cutters that will fit the contours of the form.

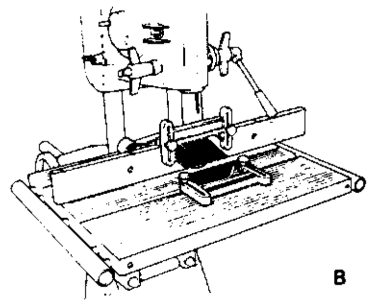
Drop Leaf Joint

This popular joint (Figure 9-16), is used to extend the size of a table by means of leaves that are hinged to a fixed center section. The drop leaf joint, or "rule joint" as it is sometimes called, is preferred over a simple butt joint because of its neater, more professional appearance.



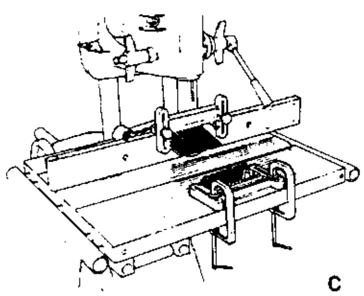
A

SETUP FOR STOCK LESS THAN 1" WIDE



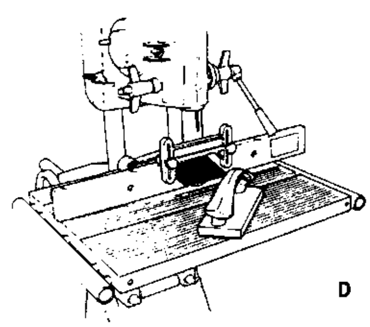
B

SETUP FOR STOCK 1" TO 2-3/4" WIDE



C

SETUP FOR STOCK 2-3/4" TO 6" WIDE

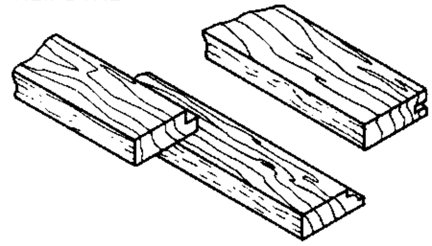


D

SETUP FOR STOCK OVER 6" WIDE

Figure 9-12. The width of the stock determines the setup.

PARTIAL EDGE REMOVAL



ENTIRE EDGE REMOVAL

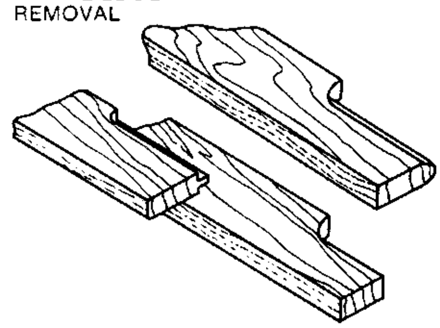


Figure 9-13. Shaper cuts can remove part of or the entire edge of the workpiece. ***Note:*** *Depth of cut exaggerated for clarity.*

WHEN PART OF EDGE IS REMOVED

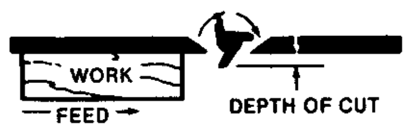


Figure 9-14. When removing part of an edge, align the two fence boards.

WHEN ENTIRE EDGE IS REMOVED

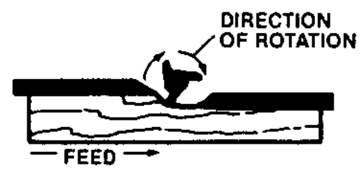


Figure 9-15. When removing an entire edge, offset the outfeed board.

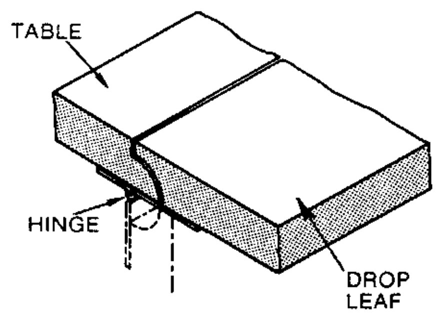


Figure 9-16. The drop leaf joint is used to extend the size of a table by means of hinged outer leaves.

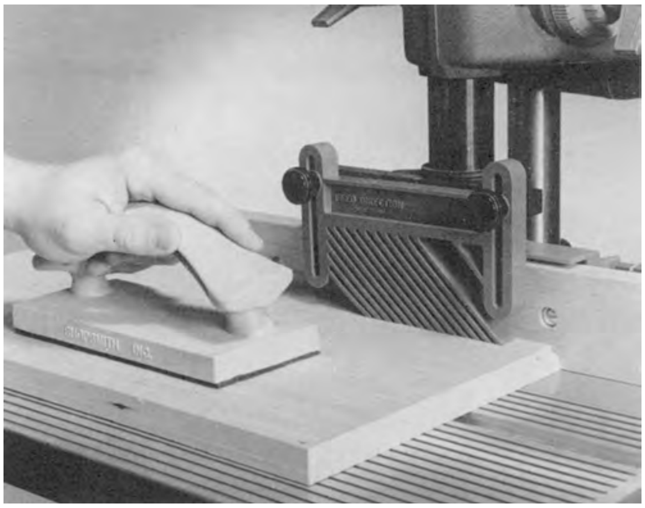


Figure 9-17. One cutter of the drop leaf set is used to form the table's edge. It isn't necessary to form the shoulder to the cutter's full depth.

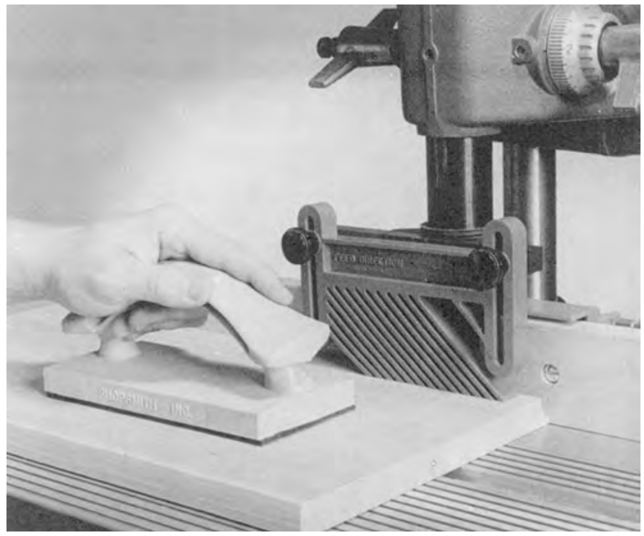


Figure 9-18. The second cutter is used to form the edge on the drop leaf.

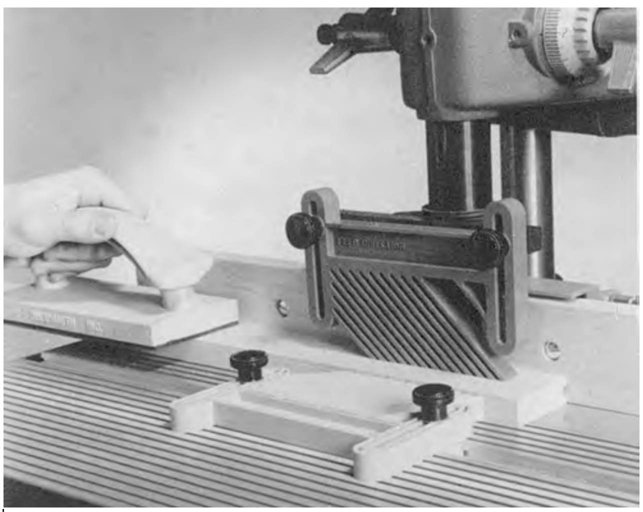


Figure 9-19. Using a 1/4" blank cutter to form a groove exactly centered in the edge of the stock.

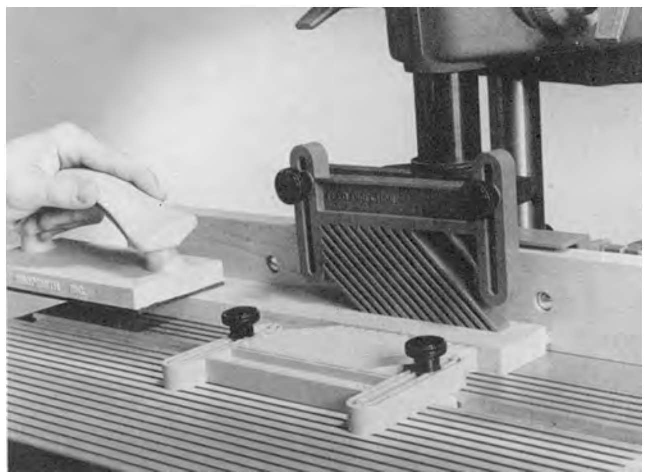


Figure 9-20. The same cutter is used to form the tongue. The shape is the result of opposing rabbet cuts made on the same edge.

With the special set of cutters, you can shape the edges of both the table and the leaf so they will match perfectly. The table edge is formed as shown in Figure 9-17. The shoulder doesn't have to be as wide as it is on the cutter; this will be dictated by the thickness of the tabletop and controlled by the height of the cutter in relation to the workpiece when making the pass. The full radius, however, should be formed since it will have an impact on the appearance of the joint when the leaf is raised. Figure 9-18 shows a leaf edge being shaped.

Tongue-and-Groove Joint

This joint is frequently used when joining boards edge-to-edge. The mating forms can be shaped by working with the set of cutters, one to form the tongue, the other the groove, but it's also possible to do both parts of the joint by working with a single blank cutter; it depends on the thickness of the stock. For example, if the stock is 3/4" thick and you have a 1/4" blank cutter, the work can be done as follows:

Set the height of the cutter to form a groove exactly centered in the edge of the stock. Organize the shaper fence so the groove will be as deep as the cutter is wide; then make two passes, the second one after the workpiece has been turned end-for-end (Figure 9-19).

The tongue is formed as shown in Figure 9-20. Once the cutter height has been adjusted, it's just a matter of forming opposing rabbets on each edge of the workpiece. Make the first cut. Do not make a change in depth of cut. Then turn the workpiece over and make the second cut. Be sure the tongue that results will be a nice sliding fit in the groove.

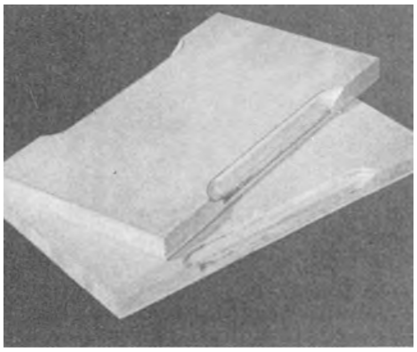


Figure 9-21. *Examples of stopped shaper cuts.*

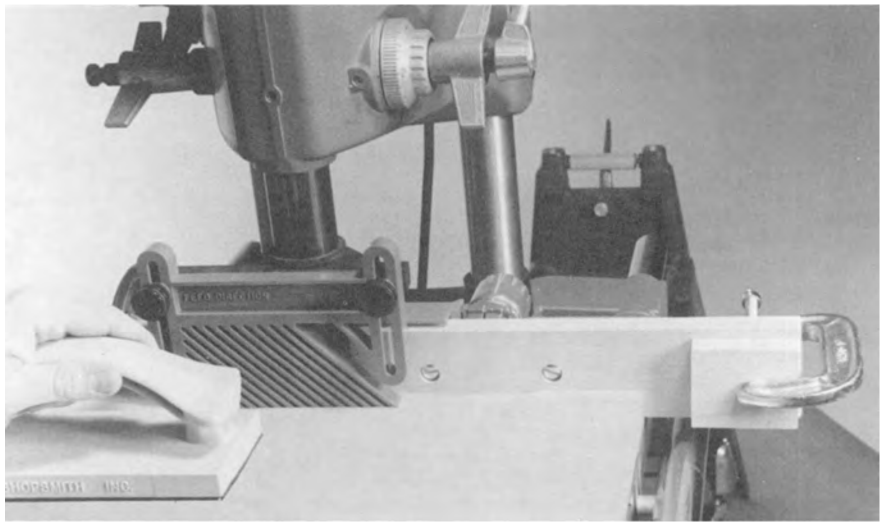


Figure 9-22. *The length of the cut is controlled by stop blocks clamped to the shaper fence.*

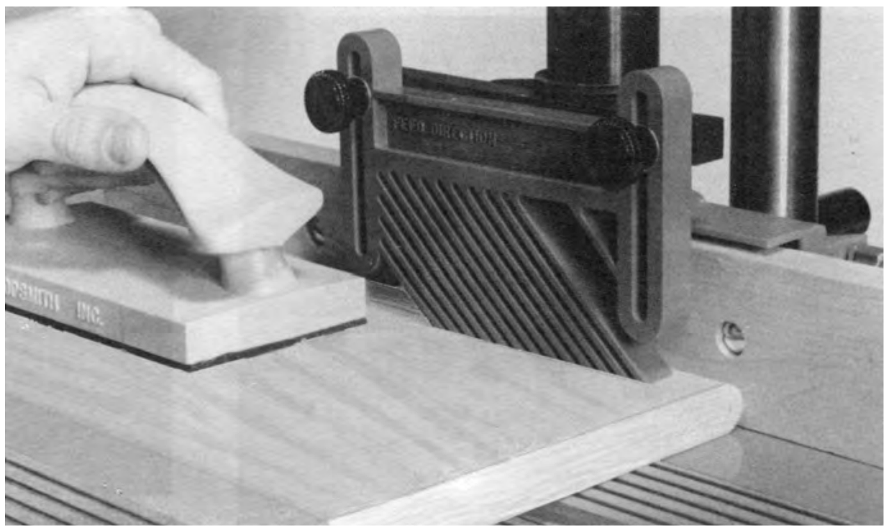


Figure 9-23. *The nosing cutter of a flute and nosing set of cutters is used here to round off the edge of a workpiece.*

Stopped Cuts

Figure 9-21 shows examples of stopped cuts made by using stop blocks. Stop blocks, spaced to suit the cut length, are clamped to the shaper fence as shown in Figure 9-22. Brace the end of the workpiece against the infeed stop block and then swing it slowly into the cutter until its edge is snug against the fence. Make the pass until the workpiece butts against the outfeed stop block. Turn off the machine and let it come to a complete stop. Carefully pull the trailing end away from the fence.

You can do this kind of work on pieces that are too long for the standard shaper fence by making special long fence boards like the standard fence boards.

Slim Moldings

Warning: Trying to form slim moldings by working on narrow pieces of wood is a dangerous practice. To make slim moldings, shape the edge of a large workpiece and then, working with either a hollow-ground or carbide-tipped saw blade, cut off as much as you need. This technique is also valuable because it enables you to form moldings you would otherwise have to buy (for example, half-rounds); and you can form the moldings in whatever kinds of wood you choose, an option not available through commercial supply houses.

Figure 9-23 shows the start of such an operation using the nosing cutter that is part of the flute and nosing set. After the edge is shaped, the half-round is removed by sawing (Figure 9-24).

Shaping Cross Grain

Cross-grain cuts are seldom as smooth as those made with the grain. To get the best results, use a very conservative feed rate and keep the workpiece moving steadily. If the cuts are deep, make more than one pass, adjusting the cutter after each pass until the shape is fully formed. ***Warning: If the workpiece is not wide enough to have sufficient bearing against the boards, use the miter gauge and safety grip to secure the workpiece while making the pass (Figure 9-25).***

If you are shaping a square corner, always make the cross-grain cut first. The second cut, made with the grain, will remove the slight blemish that is inevitable at the end of cross-grain cuts.

When you must shape all four edges of a workpiece, do the cross-grain cuts first, then the final cuts with the grain (Figure 9-26).

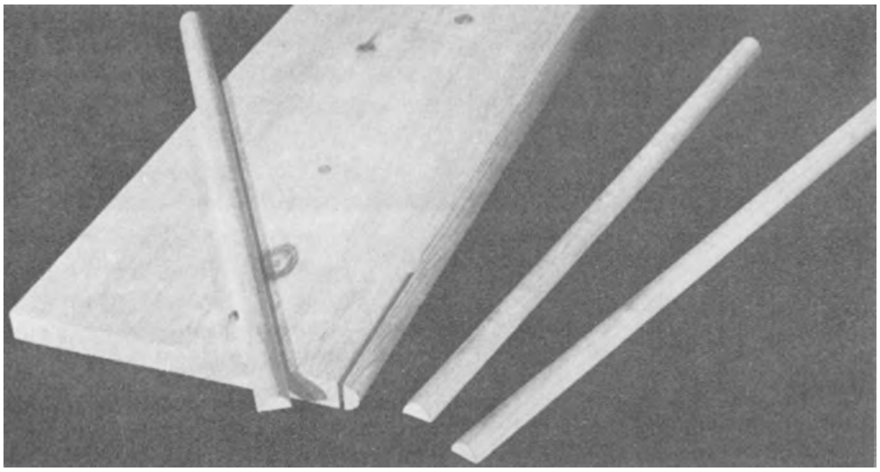


Figure 9-24. When the edge of the workpiece is sawed off, you have perfect half-round moldings.

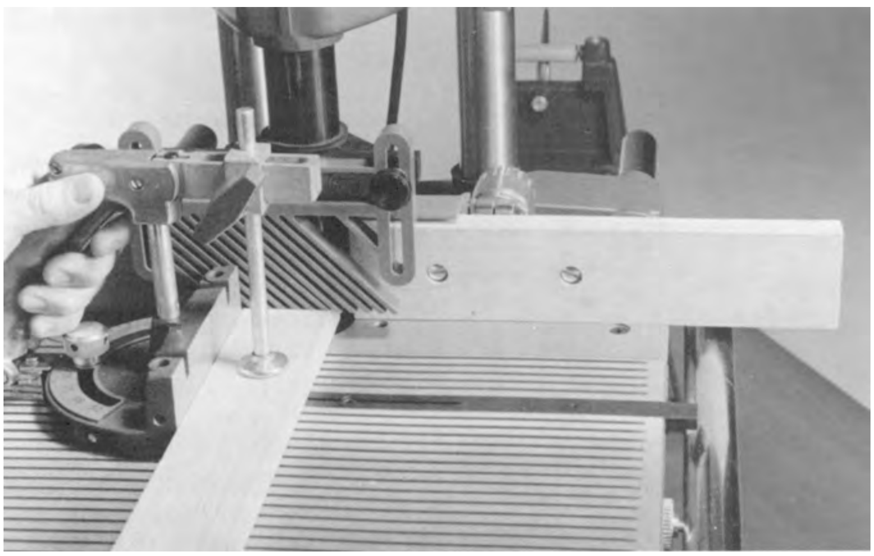


Figure 9-25. Unless the workpiece is wide enough to provide sufficient bearing surface against the fence boards, make all cross-grain cuts with the miter gauge and safety grip.

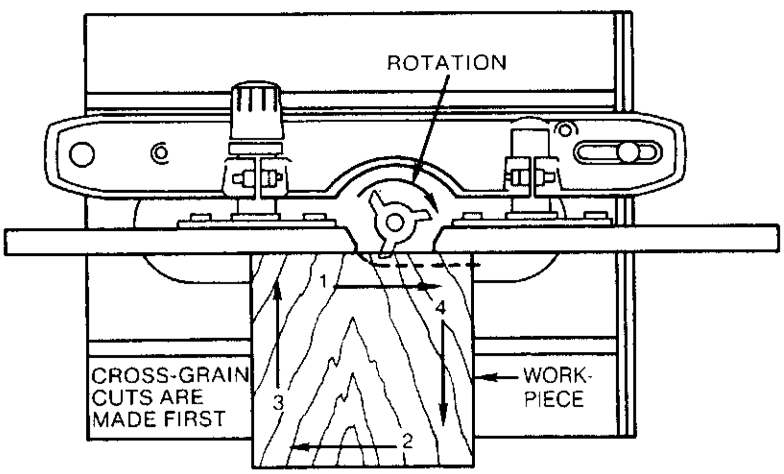


Figure 9-26. Make the cross-grain cuts first when shaping all four edges of a workpiece.

PIN SHAPING

Workpieces that are circular or have curved edges are done by pin shaping. This is a special procedure made possible by mounting collars on the arbor and using the shaper insert equipped with pins.

The collars, the pins and the table provide the bearing surfaces for the workpiece. The cutter may be over the workpiece or under it. You can use more than one collar of the same diameter to guide against thick stock. ***Warning: The important factor is the contact area between the workpiece and collars (Figure 9-27). A small amount of contact area (less than half the collar thickness) is not adequate; always organize for maximum collar contact so the work will have good support.***

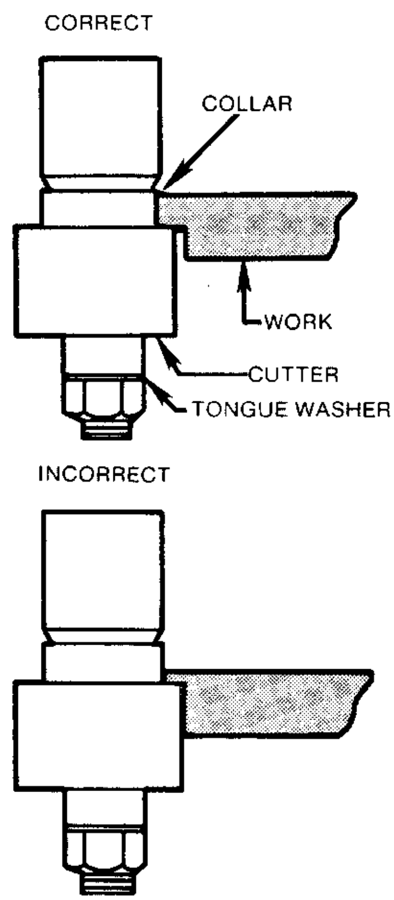
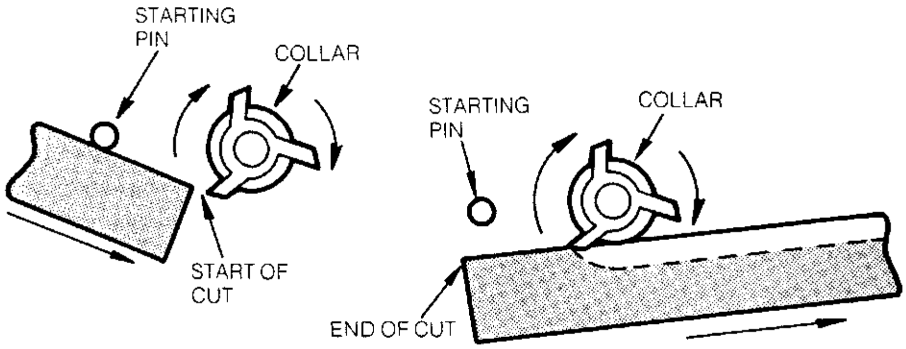


Figure 9-27. Collars control the depth of cut. Always be sure there is enough bearing surface between the workpiece and the collars.



STARTING A CUT

FINISHING A CUT

Figure 9-28. *The workpiece is first braced against the left pin and slowly advanced to contact the cutter.*

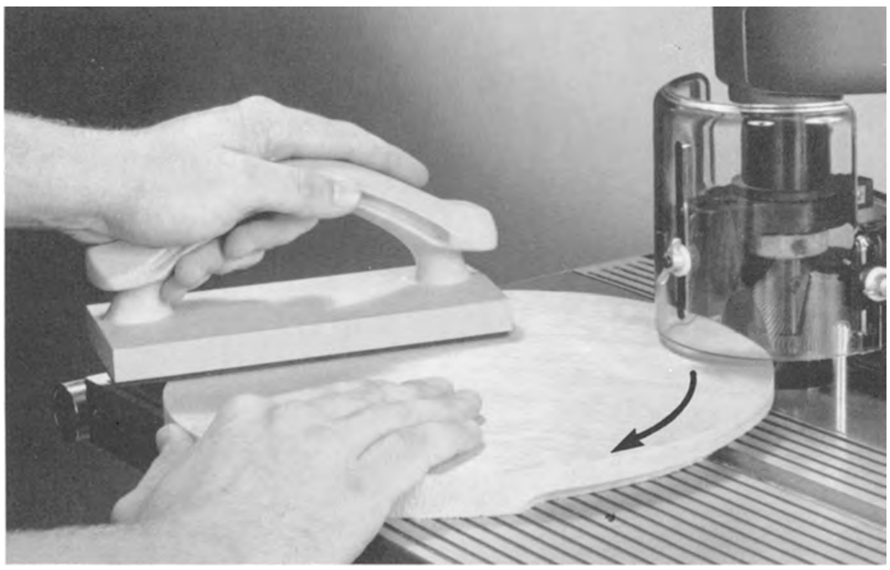


Figure 9-29. *The pass can be made with the workpiece against the collar. Move the workpiece slowly in a clockwise direction.*

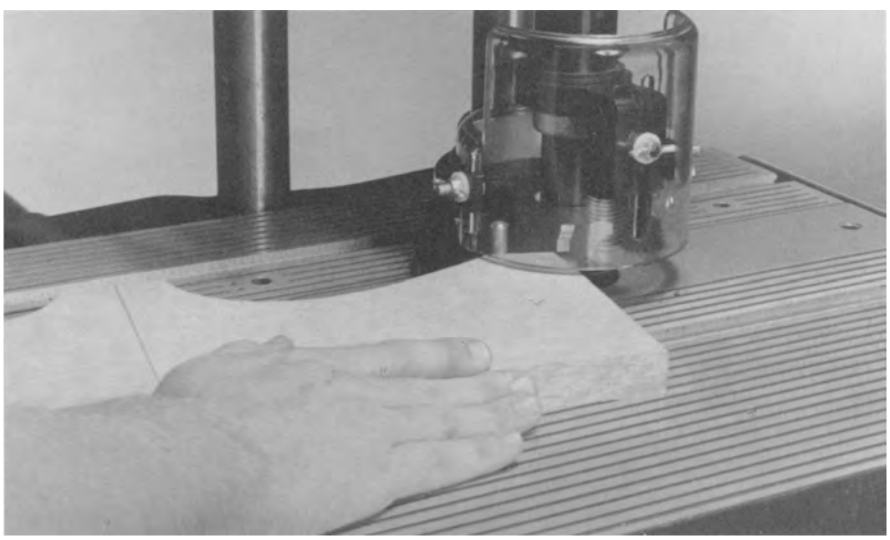


Figure 9-30. *The left-hand pin comes into play when shaping irregular edges. Be very careful when shaping small radii and sharp corners.*

Since the collars turn with the cutters, they can score or burn the work unless they are kept smooth and free of gum, dirt, or dust. When you bear against them, use only as much pressure as you need to maintain the contact.

The cutters will function whether they are over or under the workpiece. The cut is easier to see and, some operators feel, is easier to control when the cutter is on top. ***Warning: If the workpiece is tilted up at any time during the pass, the cutter will dig into it.*** Positioning the cutter under the workpiece is the safest way to operate. Also, slight accidental lifting of the work during the pass will do no harm.

Basic Procedure

The major factor to consider when pin shaping is the initial contact of the workpiece with the cutter. ***Warning: The workpiece, if moved directly into the cutter without support, will be kicked back.*** This is where the pins come into play. Start the pass by bracing the workpiece against the pin at the left of the cutter. With the workpiece firmly against the pin, slowly advance it to contact the cutter until it is solidly against the collars. Once the cut is well started, you can swing free of the left-hand pin and allow the workpiece to bear only against the collars (Figure 9-28). Toward the end of the cut, you can allow the workpiece to be supported by the right-hand pin.

Circles and Irregular Curves

Start shaping the edge of a circular workpiece by bracing it solidly against the left starter pin and then advancing it slowly to engage the cutter. After the workpiece bears firmly against the collar, you can choose to maintain the pin contact as you turn the workpiece clockwise (Figure 9-29) or

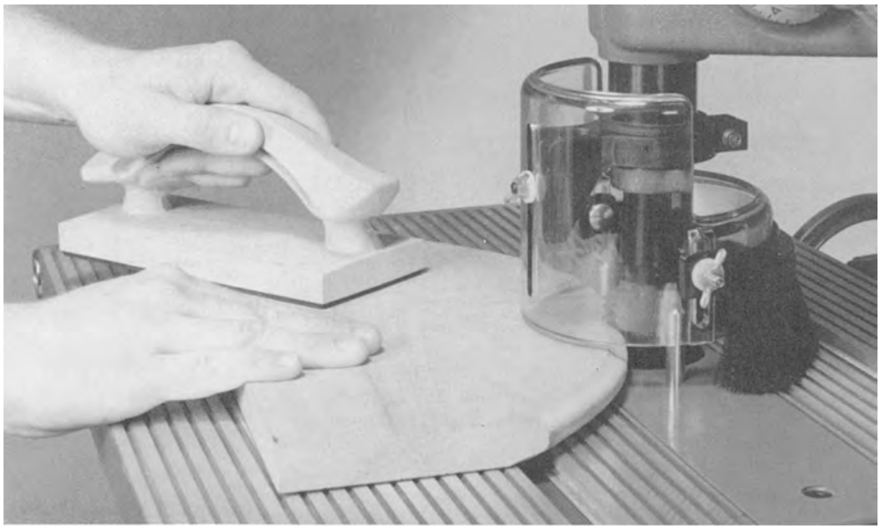


Figure 9-31. You can shape slim, curved moldings by working on the edge of stock large enough to be safely handled.

Figure 9-32. Use a scroll saw or bandsaw to cut off the part you need after the curved edge has been shaped.

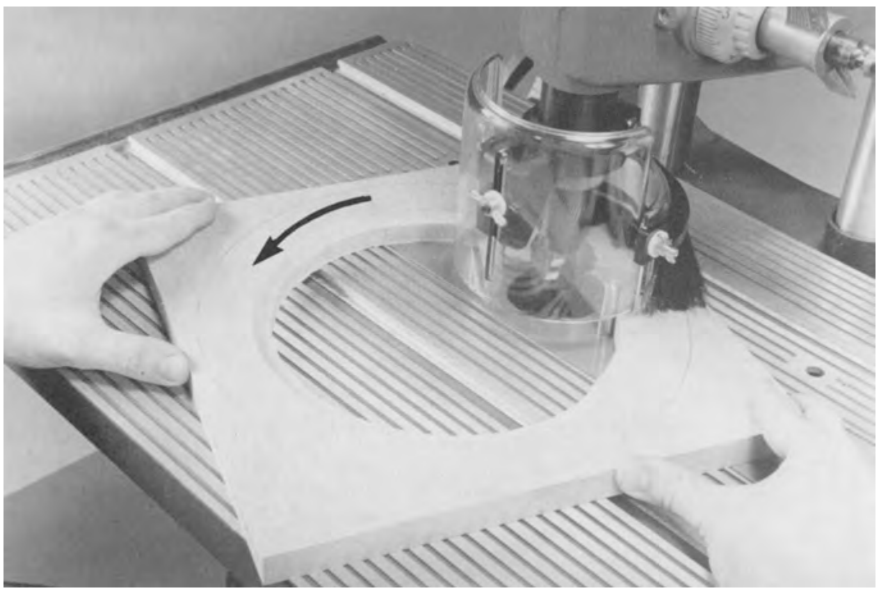


Figure 9-33. Cut out and contour all inside edges first. The workpiece is fed in a counterclockwise direction. Be especially careful with hand placement. After completing the inside contour, cut the outside contour and shape it.

swing it clear so only the work-to-collar contact is maintained. You can continue in this manner to complete the pass or, at the end of the cut, allow the right-hand pin to support the workpiece.

Irregularly curved edges, such as those on fancy picture frames, wall plaques, free-form tabletops, and so on, are shaped much like circular pieces except that you should judge when to accept support from the left-hand pin and when to allow the workpiece to bear only against the collar (Figure 9-30). Always start by bracing the workpiece against the pin. Work slowly and carefully, especially when you must turn a sharp corner. ***Warning: Keep your hands on the outside edges of the workpiece so they will be away from the danger zone.***

Slim, Curved Moldings

To safely work on slim, curved moldings, you must follow the principle that was described for slim moldings: shape the edge of a workpiece that is large enough to be safely handled (Figure 9-31). Obey the rules that apply to pin and collar support for the workpiece. After the shaping is finished, use a scroll saw or bandsaw to remove as much of the edge as you need (Figure 9-32).

Inside Edge Shaping

Shaping a rabbet on the inside perimeter of a circular picture frame to accommodate the glass is a typical example of inside edge shaping (Figure 9-33). The workpiece is placed in position before the cutter is extended for depth of cut. The workpiece is braced against the right-hand pin and then swung into contact with the cutter until it bears solidly against the collar. It is then rotated counterclockwise so the pass is made against the direction of rotation of the cutter (Figure 9-34).

This kind of work doesn't have to be limited to forming rabbets for glass in circular frames. By working the same way, you can add decorative internal edges on circular workpieces.

Special Techniques

For production runs on specially shaped pieces, it is good practice to create setups that provide ac-

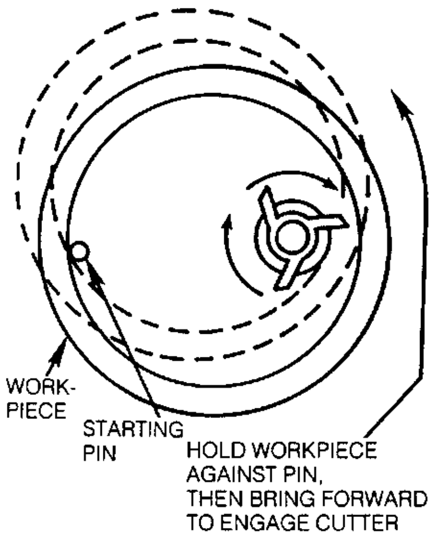


Figure 9-34. *You can shape inside edges as shown.*

curacy while allowing you to work safely. The ideas that are shown in Figure 9-35 are diagrammed just to demonstrate how fixtures can be used.

The fixtures may be cut to shape on a scroll saw or bandsaw, sanded, and then clamped to the worktable to serve as guides when feeding the work. Quite often it is possible to use the scrap material from a cut piece as the guide. For example, the scrap piece from a circular cutout might make a good guide for shaping the edge of a circular workpiece. This idea, of course, calls for very careful initial cutting.

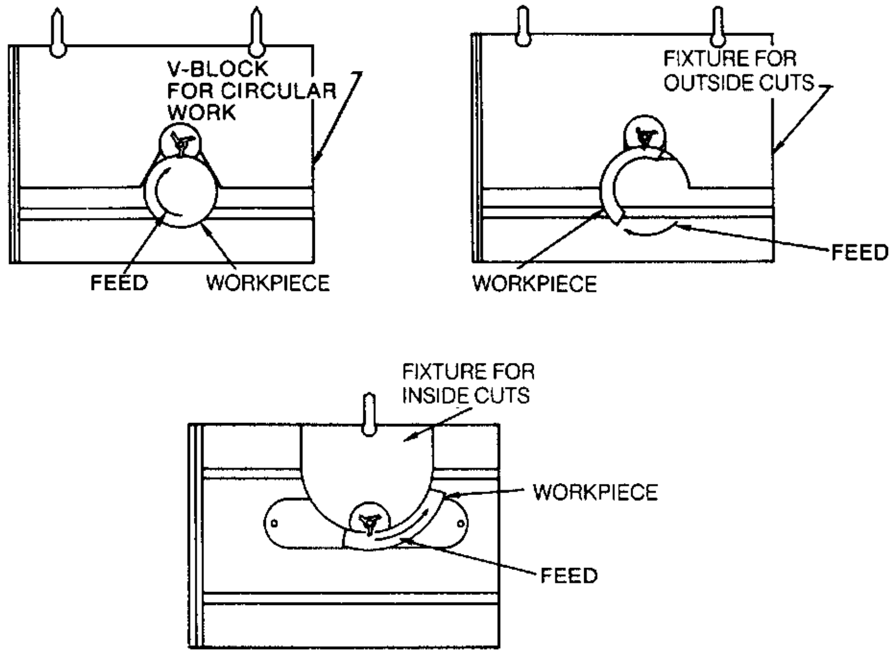


Figure 9-35. *Here are examples of special fixtures you can make when you have many similar workpieces to produce. Fixtures must be designed to suit the work you are doing. The position of the fixture determines how far the cutter penetrates the workpiece. The fixture control area must match the curve in the workpiece. Be sure the contact areas are sanded smooth.*

Chapter 10
Routing

The drill press mode of the Mark V can be used as a stationary router in both its vertical and horizontal positions. But to accomplish this, a special chuck is required to secure the high-speed bits because of the side thrust that is characteristic of routing operations. The chuck is locked firmly in place by securing its setscrew against the main spindle's tapered flat. Two setscrews lock the bits in the chuck. Router bits can be straight or, like the dovetail cutter, may have shaped cutting edges. The routing accessories are shown in Figure 10-1.

Routing cuts are made at high speed and with reasonable feed pressure so the bit can do its job without choking or burning. Always perform routing operations at "Fast" speed. Do not form excessively deep cuts in a single pass. Deep cuts are easier to make and the results will be smoother if you get to full depth of cut by making repeat passes no deeper than 1/4" or less, depending on the size of the bit.

ROUTING SAFETY

Warning: Before using the routing accessory, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V when routing extends 3" all around the bit and chuck and 5" in front of the bit. Always keep your fingers and hands out of the danger zone.

When you work at the router, pay attention to where you put your hands. Be certain they aren't in front of the bit when you advance the quill. Never reach in toward or in front of the bit to clear away scraps. Turn off the machine and let it come to a complete stop first.

Guard for the Router—The circular shield and brush assembly must always be used for router operations. It mounts to the quill and is adjustable to accommodate various thicknesses of stock.

- **Wear proper eye and ear protection.**
- **Tuck long hair under a hat or tie it up. Do not wear ties, gloves, jewelry or loose clothing. Roll sleeves up above your elbows. Wear non-slip footwear.**
- **Always mount the circular shield and brush assembly on the Mark V quill before performing routing operations.**
- **Always run the router at 'FAST' speed.**
- **Avoid taking deep cuts. With the exception of single-pass dovetail cuts, limit depth of cut to 1/4" for each pass when using bits up to 1/2" diameter. When using bits over 1/2" diameter, limit depth of cut to 1/8".**
- **Never freehand rout. Always use the rip fence or miter gauge when using bits without pilots, and a starter pin when using bits with pilots.**
- **Always feed the workpiece against the rotation of the bit. Otherwise a kickback will occur.**
- **Feed the workpiece slowly. Use extra care when routing**

Figure 10-1. The accessories that are used for routing are: (A) the circular shield and brush assembly, (B) router chuck, and (C) router bits. Also the rip fence and miter gauge are used to support and guide the stock.

stock that contains figured grain or knots, as these may cause kickbacks.

- **Use a push stick to feed a narrow workpiece. When it is necessary to push a workpiece underneath the shield, use a long piece of scrap wood.**
- **Cut with the grain when straight-line routing.**
- **Do not stand directly in-line with the workpiece. In the event of a kickback you could be hit.**
- **When routing across the grain of workpieces up to 10″ wide, always use your miter gauge with safety grip to control the workpiece.**
- **When stop routing, always use stop block(s) to control the length of cut. Failure to use stop block(s) will cause a kickback.**
- **When routing an oversize workpiece, always use at least one push block to help control the workpiece. Hold the workpiece firmly against the rip fence.**
- **When edge routing with a piloted bit, always use either a starter pin or a fence to start the cut and/or guide the workpiece.**
- **Set speed to 'SLOW,' turn off and unplug the Mark V before mounting router bits.**
- **Make sure the setscrew in the chuck is tightened against the flat of the main spindle and the bit is secured tightly in the chuck. Then remove the Allen wrench immediately.**
- **Listen for chatter or signs of looseness at start-up. If you hear, see or suspect problems, turn off and unplug the machine. Correct any problem before proceeding.**
- **Keep the bits clean, maintained and sharp.**

ROUTER BITS

Router bits come in a variety of shapes and sizes, each designed to perform a specific operation. Information about types of router bits that are available and their uses can be found in Chapter 22. You'll also find how to use decorative edging bits and how to perform additional routing operations.

GENERAL ROUTING

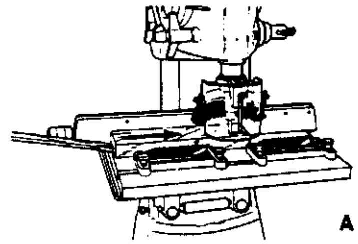
When routing, the distance from the outer edge of the workpiece to the bit determines the setup:

- When workpiece edge is 1″ or less from bit, use one feather board on the infeed side and an additional feather board on the outfeed side, both secured in the table slot. Use a push stick, or when it's necessary to push workpiece underneath the shield, use a piece of wood (Figure 10-2A).
- When workpiece edge is 1″ to 2-3/4″ from bit, use two feather boards as above or use one feather board centered to the bit, secured in table slot. Use a push stick or piece of wood to push the workpiece under the shield (Figure 10-2B).
- When workpiece edge is 2-3/4″ to 5-1/2″ from bit, use one feather board centered to the bit and secured to table with two C-clamps. Use a push block (Figure 10-2C).
- When routing across the grain of workpieces up to 10″ wide, use the miter gauge and safety grip. Workpiece must extend 5-1/2″ away from bit (Figure 10-2D).
- When routing an oversize workpiece, use a push block (Figure 10-2E).

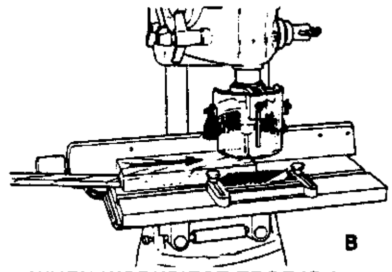
Router cuts made with the grain are smoother than cross grain or against the grain cuts, but you can't always work that way. When you can't, work with a slower feed rate and less depth of cut for optimum results.

The depth of single pass cuts should be limited as follows:

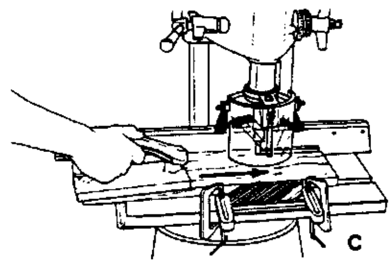
- 1/4″ maximum depth of cut for bits up to 1/2″ diameter.
- 1/8″ maximum depth of cut for bits over 1/2″ diameter.
- Less than the above limits when routing extremely hard wood.



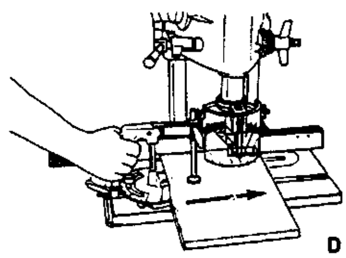
WHEN WORKPIECE EDGE IS 1″ OR LESS FROM BIT.



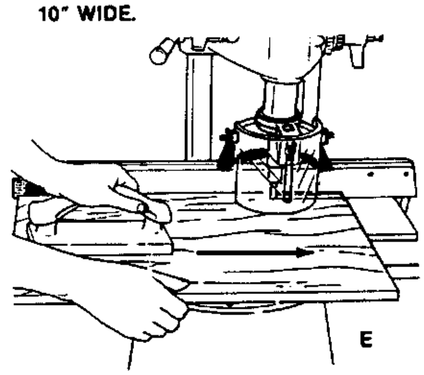
WHEN WORKPIECE EDGE IS 1″ TO 2-3/4″ FROM BIT.



WHEN WORKPIECE EDGE IS 2-3/4″ TO 5-1/2″ FROM BIT.



WHEN ROUTING ACROSS THE GRAIN OF WORKPIECES UP TO 10″ WIDE.



WHEN ROUTING AN OVERSIZE WORKPIECE, USE A PUSH BLOCK.

Figure 10-2. *The distance from the outer edge of the workpiece to the bit determines the setup.*

Feed the workpiece from left to right against the bit's direction of rotation (Figure 10-3). The action of the properly installed bit will help keep the workpiece against the fence.

When using auxiliary facings, it is a good idea to remember that when the fence is behind the bit, the pass is also made from left to right.

Make cross grain cuts by working with the miter gauge and safety grip (Figure 10-4). Some chipping will occur where the bit breaks through, so allow for it by making the cut on an extra-wide piece. Then you can remove the chipped edge using the table saw or jointer.

Stock edges are often routed to form rabbets. For this and similar kinds of work, make an auxiliary facing, as shown in Figure 10-5, that can be attached to the rip fence as shown in Figure 10-6. The relief area allows adjustments so the bit can project beyond the bearing surface of the facing. The depth of cut is controlled by quill extension; width of cut is controlled by how much the bit projects. If you need a wider cut, move the table or reposition the fence and make another pass.

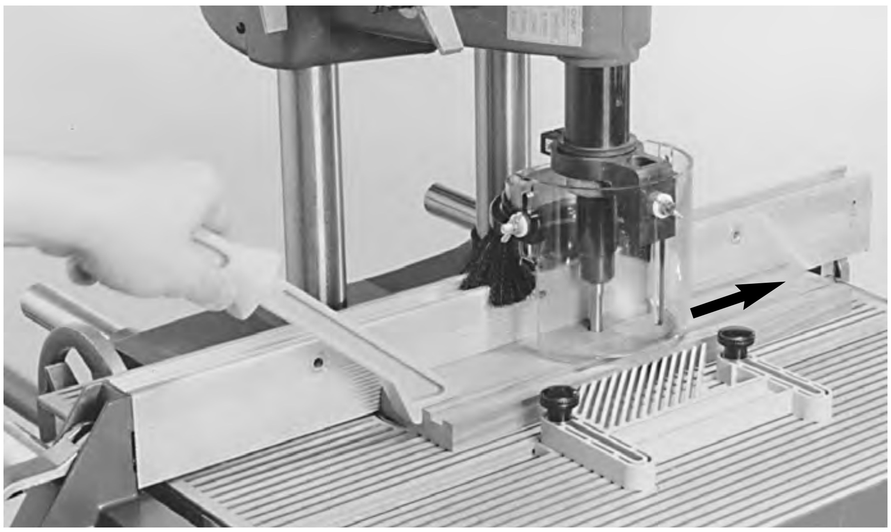


Figure 10-3. Feed the workpiece from left to right against the bit's direction of rotation. A slow feed with a shallow depth of cut will produce the best results.

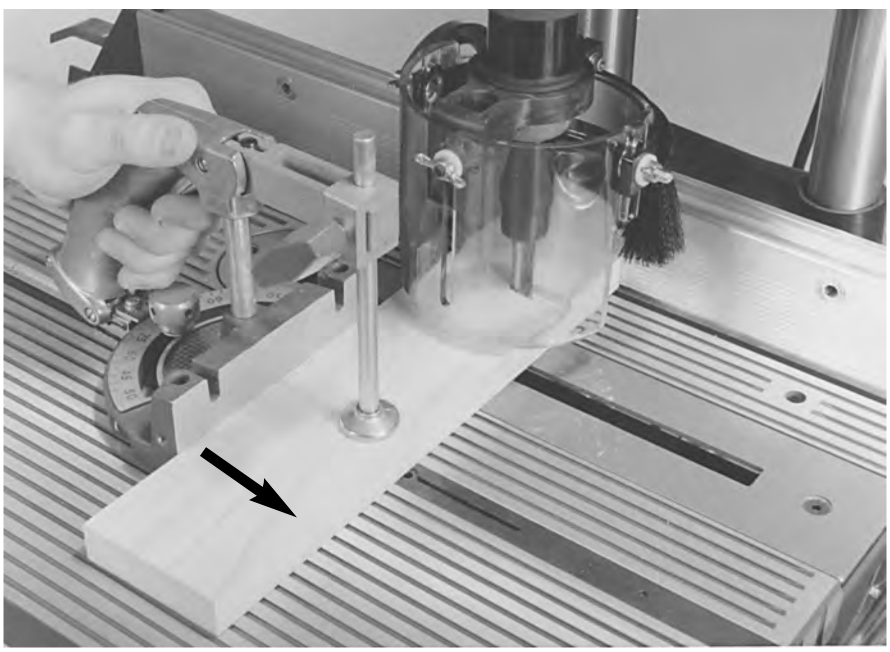


Figure 10-4. Make cross grain cuts by working with the miter gauge and safety grip.

MORTISES

Mortises with round ends can be formed with a router bit (Figure 10-7). Mark the stock where the mortise begins; clamp stop blocks to a fence extension to control the length of the mortise in both directions. Position the workpiece against the left stop block so the bit will be at the first mark, extend the quill to penetrate the workpiece, and lock it. Then move the workpiece until it contacts the right stop block. Mortise cuts are usually quite deep, so repeat passes will be necessary. The width of the mortise depends on the size of the bit.

Mortises formed this way will have round ends; therefore, the tenon must be shaped to fit (Figure 10-8).

Slots—Slots are formed the same way as mortises except that after the quill is extended and locked in position, the cut starts at the end of the workpiece and continues until it contacts the stop block (Figure 10-9).

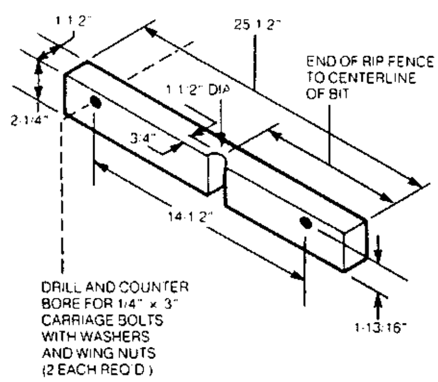


Figure 10-5. Construction details of the auxiliary facing.

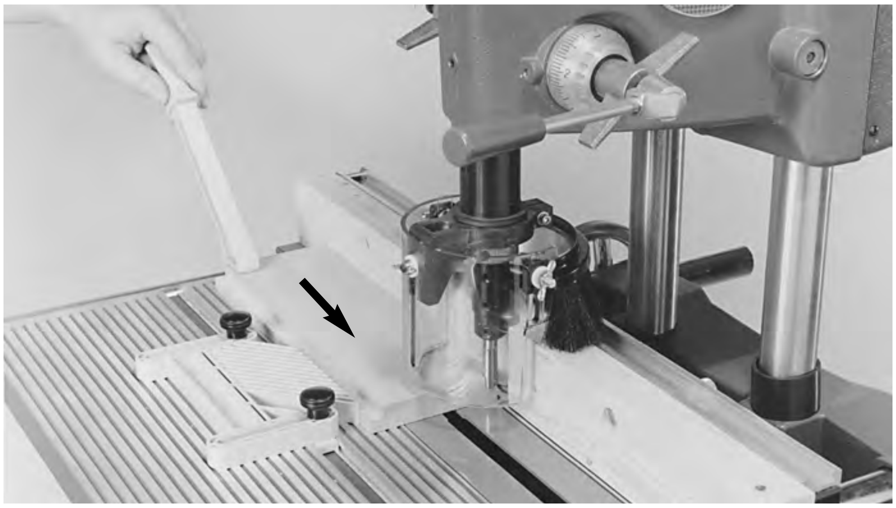


Figure 10-6. An auxiliary facing that can be bolted to the rip fence is a must for many routing operations. The relief area allows for setting the bit so cuts like the rabbet can be made.

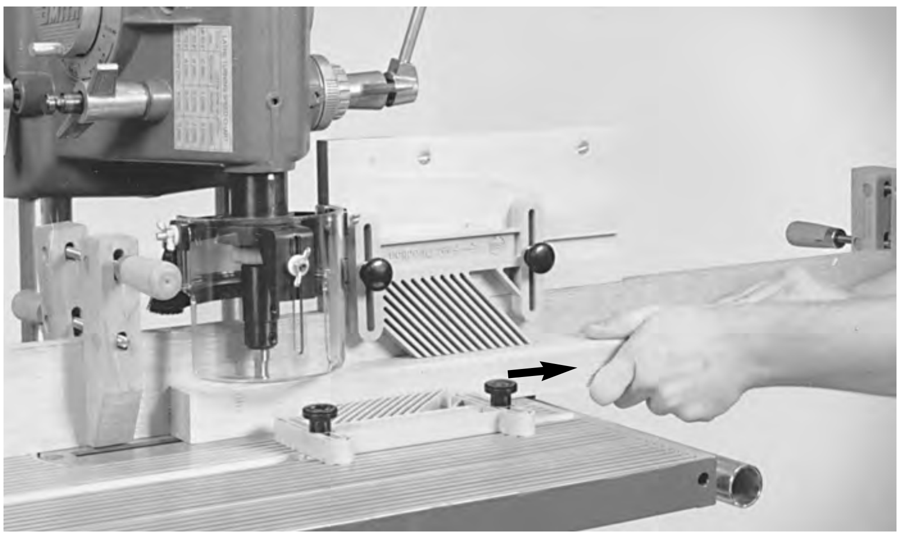


Figure 10-7. The stop blocks determine the length of the mortise. Full mortise depth is reached by making repeat passes.

DOVETAILS

A dovetail is one of the strongest joints in woodworking because it will resist a pulling strain in every direction but the one from which the tenons are inserted into the slots. Two common applications are shown in Figure 10-10.

The same dovetail cutter is used to form both the tenon and the slot. Mating the parts is a matter of positioning the cuts in proper relationship to each other.

Spacing of the cuts is determined by the size of the cutter and the design of the joint. One method is to mark the workpiece and align each cut with the cutter. Another method is to pencil mark the worktable so that the edge of the workpiece can be moved forward to a new mark after each cut. When you mark the worktable, first determine the centerline of the spindle; then mark the cutlines by measuring toward the worktable edges, front and rear. One technique is to use measuring tape which has a gummed side. This may be placed on the worktable and then removed when not in use.

To cut dovetail tenons as shown in Figure 10-11, position the worktable parallel to the way tubes. Use the table height lever (Model 500) or table height crank (Model 510) as a forward feed mechanism, the stop collars from the lathe tailstock

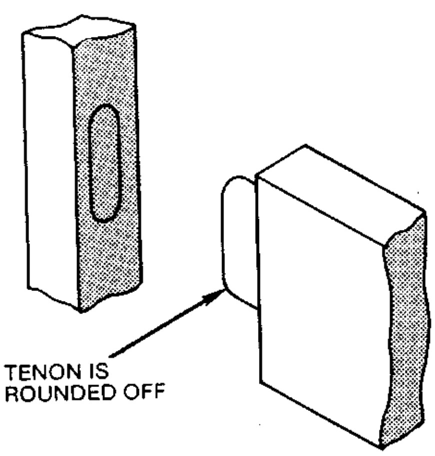


Figure 10-8. Mortises formed with a router bit will have round ends, so the tenon must be shaped to fit.

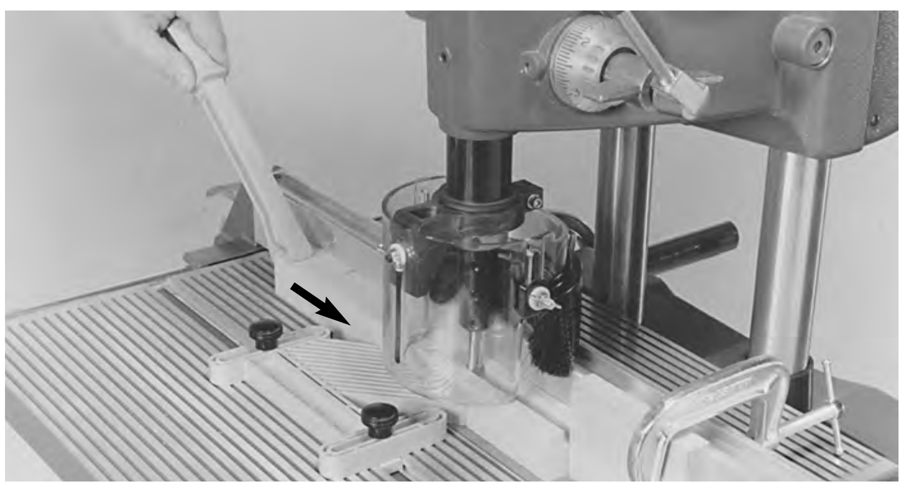


Figure 10-9. Slots are formed like mortises except that the cut starts at the end of the workpiece.

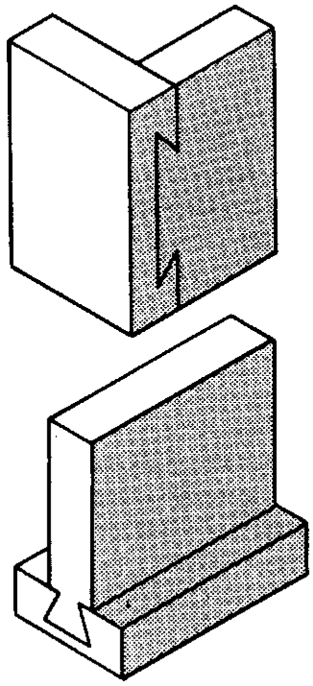


Figure 10-10. These are typical examples of dovetail joints.

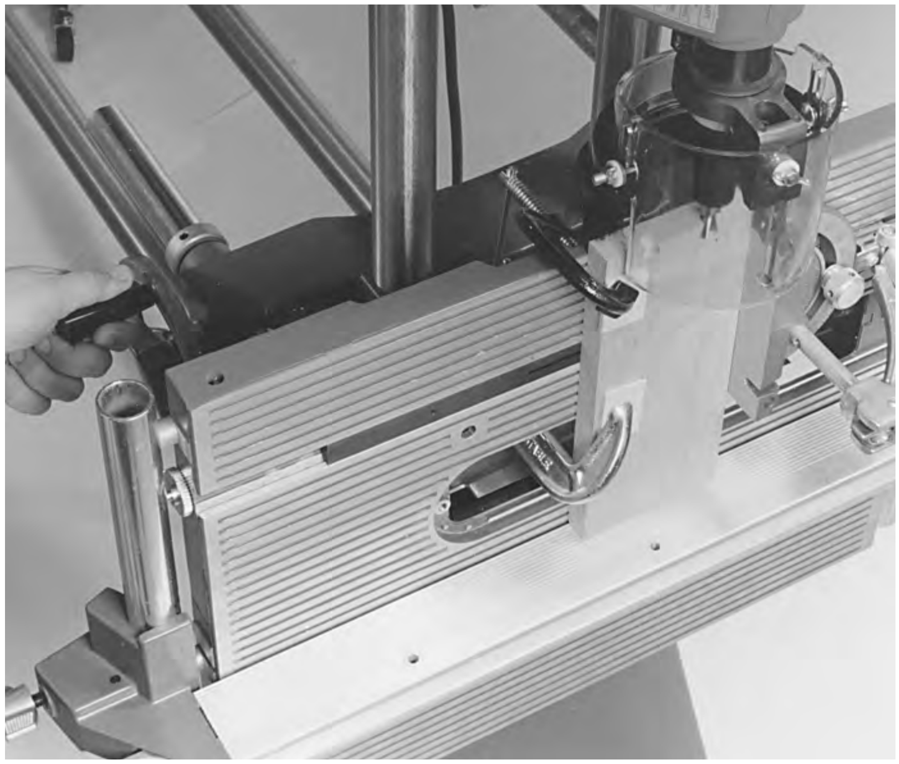


Figure 10-11. Dovetail tenons can be formed as shown. The table height lever (Model 500) or table height crank (Model 510) is used as the forward feed mechanism.

to control table movement, the quill feed lever to obtain exact depth of cut, the rip fence as a platform for the workpiece and the miter gauge to square the workpiece to the cutter. When feeding the workpiece forward against the cutter, move the worktable slowly, and be sure the workpiece is clamped securely in place. After the cut is made, turn off the Mark V and return the worktable to the starting position. If desired, place the workpiece for the next cut and repeat the procedure.

The mating cuts are formed with the worktable in the horizontal position and with the fence used as a guide (Figure 10-12). The table is brought up as close to the cutter as possible, and the final adjustment is made by extending the quill. The workpiece is fed forward against the cutter. A stop is clamped on the fence to control the length of cut. For spacing, the fence can be moved for each new cut or the worktable can be advanced—again by using the table height mechanism as a forward feed device. When feeding the work-

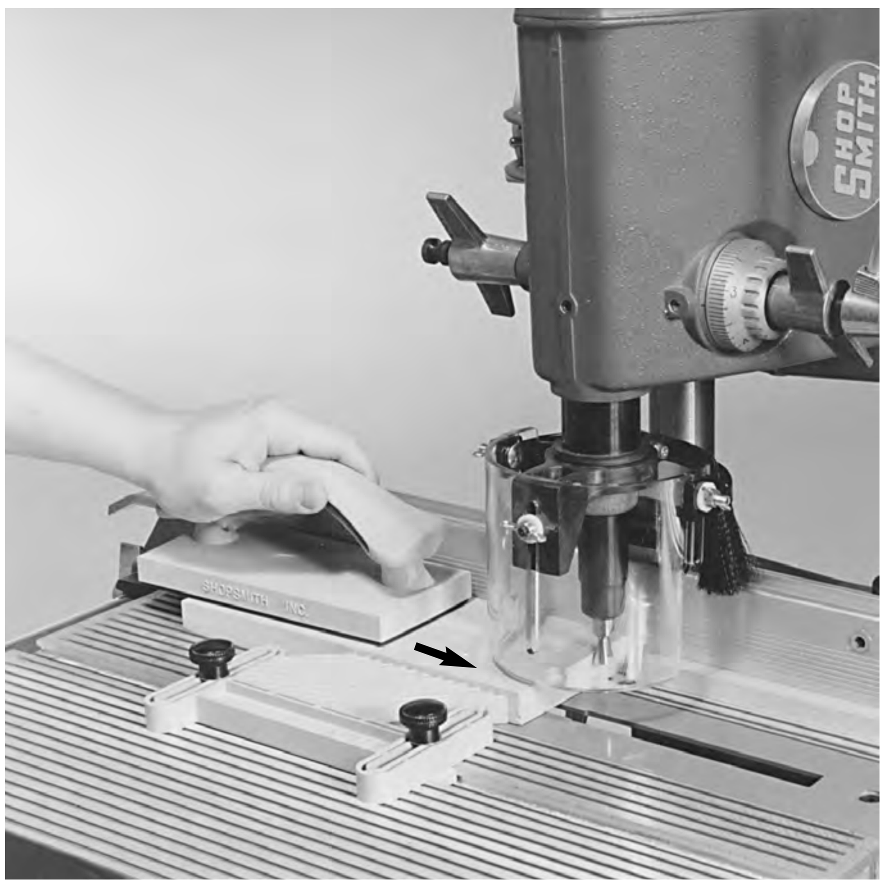


Figure 10-12. Make dovetail slots using a feather board and push block.

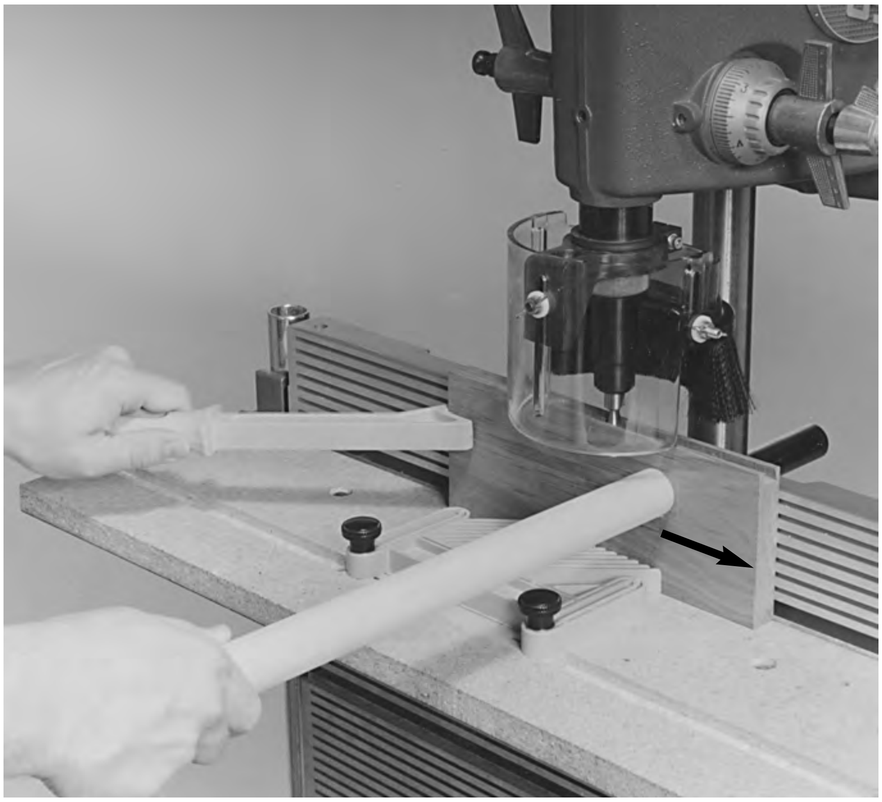


Figure 10-13. *This long dovetail slot might be required for a sliding assembly. Note the position of the worktable and the rip fence and the use of the feather board and fence extension.*

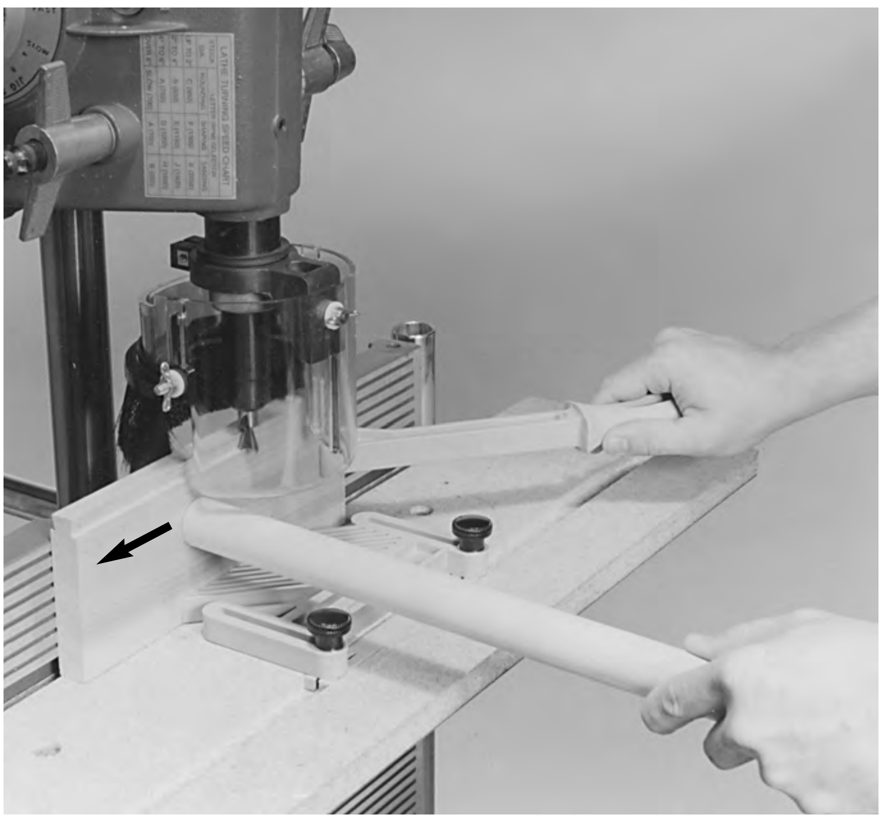


Figure 10-14. *A dovetail tenon is formed in two passes, one on each face of the stock.*

piece against the cutter, hold it firmly on the worktable and push it slowly. *Caution: If the cut is for a through dovetail, use a scrap block between the work and the table.*

The tenon on a single, wide dovetail is formed by making two cuts, one on each end of the stock. The mating part is formed the same way, with the waste stock cut away by running the work across the cutter within limits set by the two end cuts and stop blocks. Care must be exercised in positioning the pieces for successive cuts, but testing in scrap wood before cutting will make this easier. By using the setups shown in Figures 10-13 and 10-14, you can join boards edge-to-edge or provide a sliding arrangement.

Cut the slot in one pass by placing the table as shown and adjusting it so the cut is made directly down the centerline of the board (Figure 10-13). Depth of cut is set by lowering the quill and locking it in position. Feed the workpiece slowly and keep it flat against the table. Don't force the workpiece.

The tenon requires two passes. The workpiece is positioned so the cutter forms the tenon on one side of the board. Then the workpiece is turned and the second pass is made; thus, the cutter completes the forming of the tenon on the opposite surface of the board (Figure 10-14). Here, even more than elsewhere, be sure the workpiece is held firmly and flat against the table. Construction details for the fence extension are shown in Figure 5-10.

Wide stock that must be grooved across the grain requires a sliding table arrangement to which the work can be clamped (Figure 10-15). The fixture is constructed as shown in Figure 10-16, with the runners situated so the platform will slide smoothly on the table. The table is raised to an approximate position and the final adjustment for depth of cut is made by using the quill feed lever.

Figure 10-15. *A sliding table greatly simplifies cutting a dovetail slot in an extra-wide piece.*

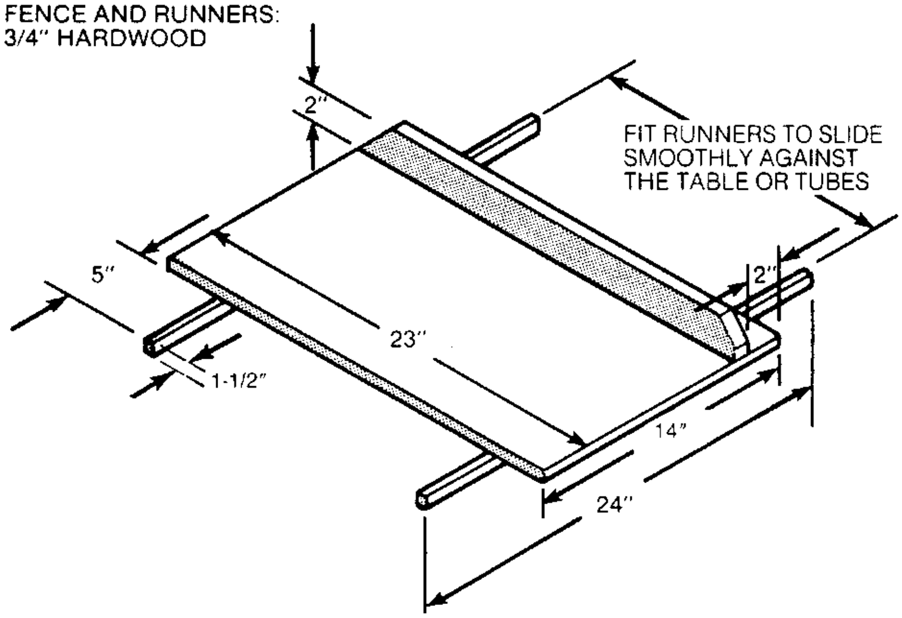


Figure 10-16. *Construction details of the sliding table. Runners should fit snugly against the edges of the table (Model 500) or the table tubes (Model 510).*

With this arrangement the length of cut is limited to the distance from the cutter to the tubes. On narrow stock the groove can be completed in one pass by using a spacer board between the workpiece and the fence. Wide boards require two cuts from opposite sides of the board on a common centerline. Alignment is important. Locate the cutter center by marking a pencil line on the fence of the sliding table. Mark lines on the workpiece to locate the centerlines of the grooves. Align these with the mark on the fence. Since the first half-cut (on wide boards) removes the line, it is necessary to use a straightedge to realign the workpiece with the mark on the fence before completing the cut (Figure 10-17). This method is not limited to dovetail grooves; straight grooves are cut with router bits, and the procedure is exactly the same.

HORIZONTAL ROUTING

As shown in Figure 10-18, grooves are cut with the Mark V in the horizontal position. A fence extension and feather board provide guidance and support as the workpiece is fed through. Construction details for the fence extension are found in Figure 5-10.

Figure 10-17. *Two passes are needed on an extra-wide workpiece. Be sure to align the bit with the kerf.*

The depth of cuts given in "General Routing" apply. If it's tough to feed the workpiece, the workpiece chatters, or the cut is rough, you are probably cutting too deep. Back off and make repeat passes instead. The same setup can be used to form rabbets or tongues.

Handle cross grain cuts by working with the miter gauge and using the miter gauge stop rod to determine the depth of cut (Figure 10-19). There will be some feathering at the end of the cut, so work on a piece that is wider than you need. Remove the chip by making a light jointer cut or by sawing.

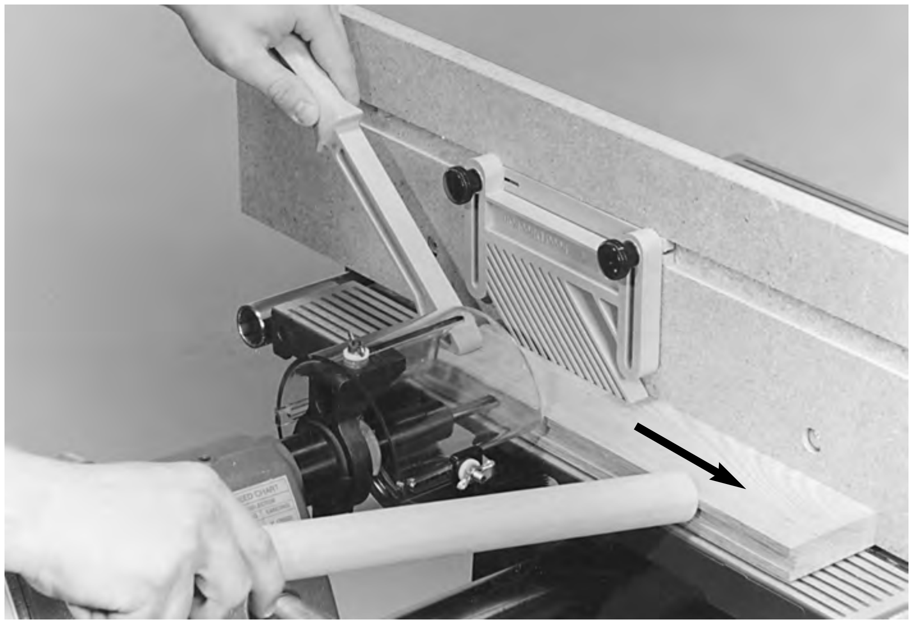


Figure 10-18. *A router bit can be used to form edge grooves if this setup is employed. The feather board keeps the workpiece flat on the table.*

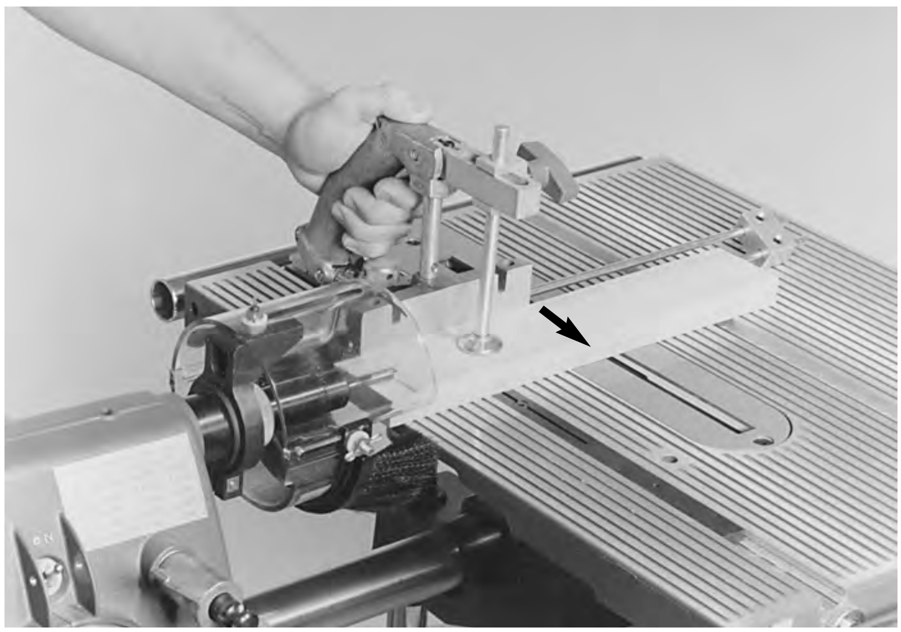


Figure 10-19. *Use the miter gauge and miter gauge stop rod when doing cross grain work. Feathering at the end of the cut is characteristic but is easily removed by jointing or sawing.*

Chapter 11
Horizontal Boring Machine

When the Mark V is set up in the horizontal boring mode, it becomes a machine that enables you to do a variety of standard and specialty operations easily and with great accuracy. It allows you to make holes in large or long pieces that you ordinarily couldn't drill. It also simplifies a number of other operations normally performed with a hand-held drill, such as drilling end grain or doweling boards edge-to-edge.

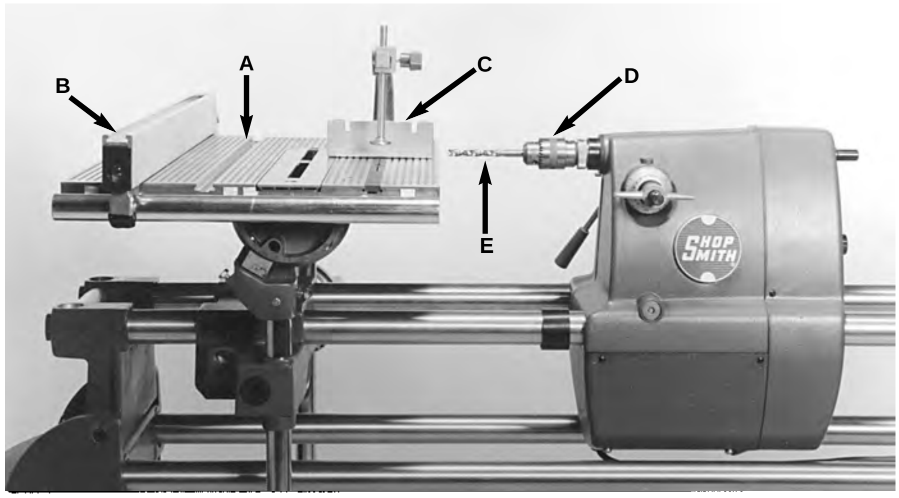


Figure 11-1. *The accessories that are used for horizontal boring operations are the (A) worktable, (B) rip fence, (C) miter gauge, (D) drill chuck, and (E) drill bit. The Model 510 is shown.*

HORIZONTAL BORING MODE—SETUP AND FEATURES

Use the accessories shown in Figure 11-1 for boring operations. To set up your Mark V in the horizontal boring mode, follow the instructions in the Owners Manual that came with your machine.

As you work in the boring mode, you'll find that the Mark V is an extremely capable horizontal boring machine. It has the same features as the drill press mode plus these special features:

- With a 5-1/2″ long bit mounted in the chuck and using the rip fence as a backstop, you can bore workpieces up to 30″ long or wide (Model 500) or 55″ (Model 510 with the extension table system). Without the rip fence, you can bore as large or wide a workpiece as you can safely and easily control (Figure11-2).
- With the table tilt at "0" and the table height as low as it will go, the table drops 2-3/8″ beneath the center of the main spindle. This allows you to bore to the center of stock up to 4-3/4″ thick.
- The table tilts from 90° left to "0" in this mode (Figure 11-3).

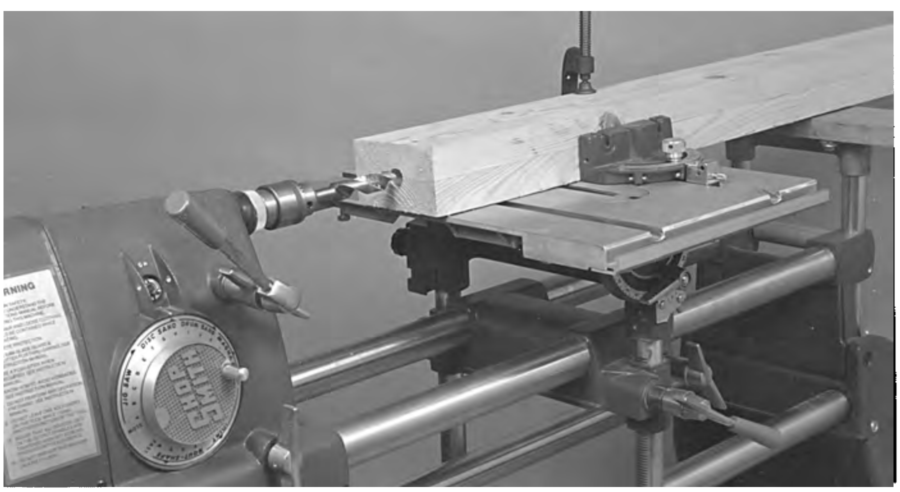


Figure 11-2. *Without the rip fence, you can bore as large or wide a workpiece as you can safely and easily handle.*

HORIZONTAL BORING SAFETY

Warning: Before using the horizontal boring machine, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V in the horizontal boring mode extends 3″ all around the bit and chuck and 5″ in front of the bit. Always keep your fingers and hands out of the danger zone.

When you work at the horizontal boring machine, be certain your hands and fingers aren't in front of the bit when you advance the quill. Never reach in toward or in front of the bit to clear away scraps. Turn

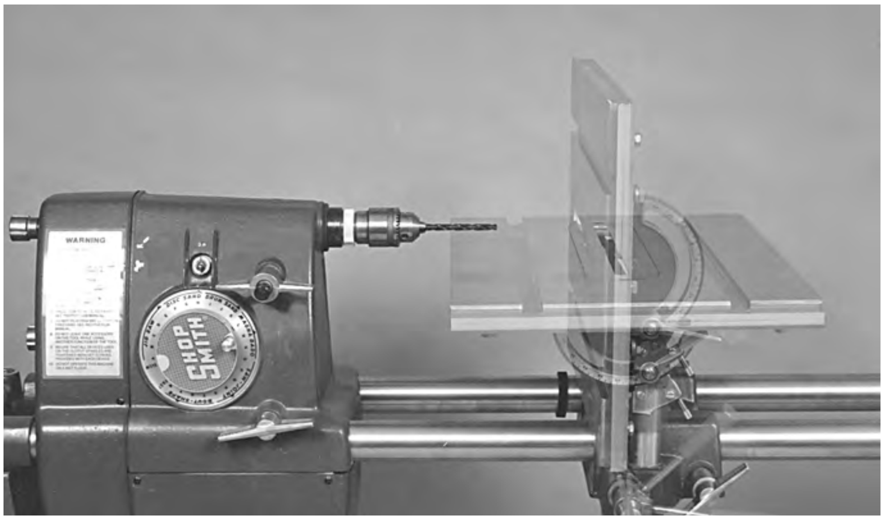


Figure 11-3. In the horizontal boring mode, the table tilts from 90° left to "0."

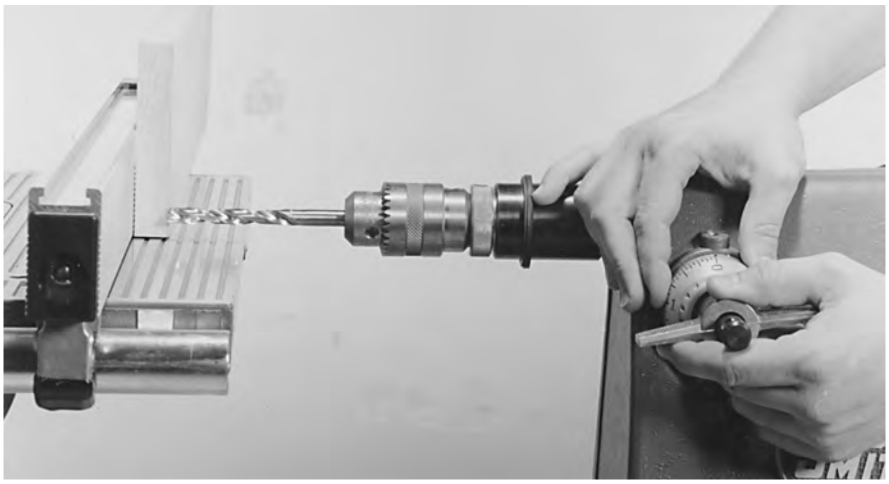


Figure 11-4. When boring through a workpiece, use the depth control to keep the bit from biting through the scrap and into the fence.

Table 11-1: Horizontal Boring Speed Chart

Size of Hole	Hardwood	Softwood
1/4" and less	H (1600 RPM)	I (1750 RPM)
1/4" to 1/2"	F (1300 RPM)	G (1450 RPM)
1/2" to 3/4"	D (1050 RPM)	E (1150 RPM)
3/4" to 1"	B (850 RPM)	C (950 RPM)
Over 1"	SLOW (700 RPM)	A (750 RPM)
Boring metals (twist bits only) — Slow (700 RPM)		

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

off the machine and let it come to a complete stop first.

- **Wear proper eye and ear protection.**
- **NEVER leave the key in the chuck. Remove the key from the chuck IMMEDIATELY after securing or removing the bit.**
- **Never wear jewelry, gloves, ties, loose clothing or clothing with long sleeves. Keep long hair tucked under a hat. Jewelry, gloves, ties, clothing and hair could become entangled in the bit.**
- **Use the rip fence as a backstop and hold the stock firmly against both the worktable and the fence. If you can't use the rip fence, use the miter gauge or clamp the stock to the worktable.**
- **Use only accessories and bits designed to be mounted in power drills.**
- **Never drill or bore metal freehand. Always clamp the metal to the worktable and back-up stock, or the rip fence and back-up stock.**

BITS AND SPEEDS

Because boring is so similar to drilling, you can use the same bits and the same speeds. To help select the proper bit for a particular job, refer to "Drill Bits" in Chapter 7. To adjust the Mark V to the correct speed, refer to Table 11-1.

GENERAL BORING

As you might suspect, the procedure for boring is very similar to the procedure for drilling. The basic types of boring operations are also similar—you can either bore all the way through a piece or partway into it.

Boring Through

To bore through stock, first mount a bit in the chuck. Be sure that you remove the chuck key.

Mount the rip fence on the table to use as a backstop, and adjust it so that it will hold the workpiece 1/4" to 1/2" away from the tip of the bit. To accurately position the hole, adjust the table height. *Caution: Place a long scrap of wood against the rip fence to keep the bit from boring into the fence after it goes through the workpiece. This scrap should be 3/4" to 1" thick and taller than the workpiece to properly back up the piece when boring.*

Extend the quill so that the cutting flutes of the bit touch the scrap wood. Set the depth control to approximately 1/8", and tighten the depth control lock (Figure 11-4). Then let the quill retract. When you bore the hole, the depth control will keep the bit from biting through the scrap and into the fence.

Stand at the front of the machine so that you can easily reach the power switch. Place the workpiece on the table and position it in front of the bit. Hold it firmly against the table and rip fence. Extend the quill with the machine off to be sure the bit will bore a hole right where you want it (Figure 11-5).

If the bit lines up correctly, retract the quill. Turn the Mark V on and set the speed dial. Feed the bit into the wood slowly and evenly (Figure 11-6). Don't force the bit; just maintain a light, steady pressure as you do when drilling. When boring deep holes, it may be necessary to retract the bit occasionally to clear chips from the hole.

When you feel the depth control stop the quill, retract the bit. Turn the speed dial to "Slow," turn off the machine and let it come to a complete stop, then remove the workpiece.

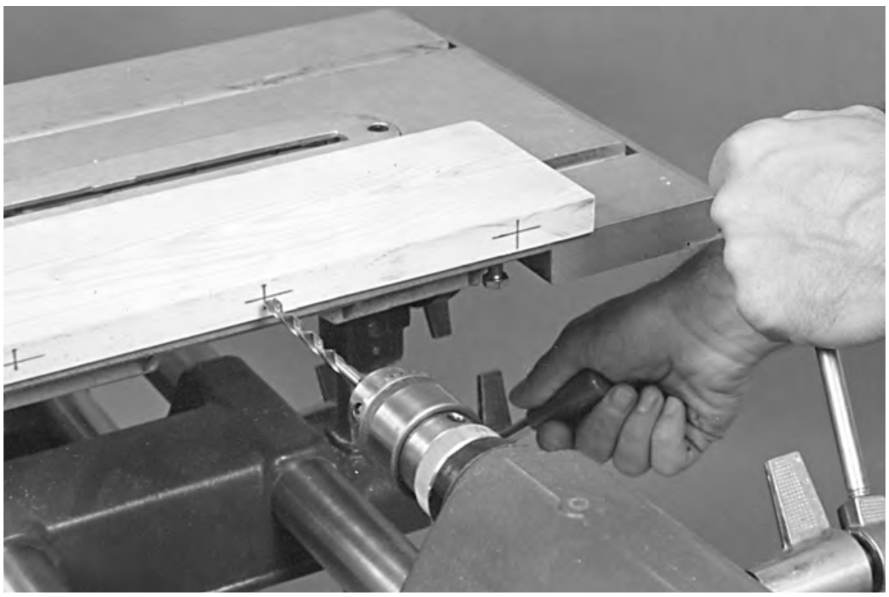


Figure 11-5. *Before boring, extend the quill with the machine turned off to be sure the bit will bore a hole where you want it.*

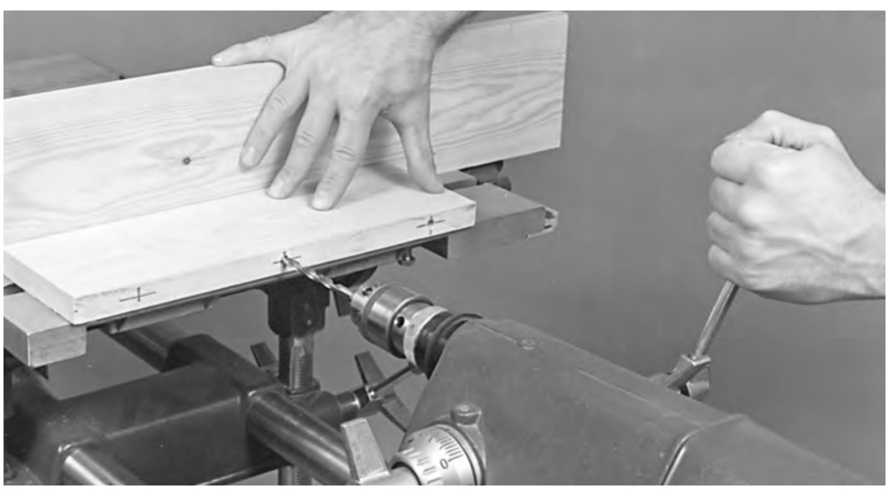


Figure 11-6. *Feed the bit into the wood slowly and evenly, maintaining a light, steady pressure. Stop when you feel the depth control halt the quill.*

Boring Partway

To bore a hole only partway through a workpiece, extend the quill until the cutting flutes of the bit just touch the workpiece. Set the depth control at the desired depth and lock it in place. Bore the holes you need. The depth control will stop the quill when the bit reaches the proper depth in the stock. All the holes you bore at any one depth control setting will be exactly the same depth. *Note:* When you need to bore a number of holes all at the same height (doweling boards edge-to-edge) on Model 500, use an accurate centerline as a guide.

BORING END GRAIN

When boring end grain, use the miter gauge to align the workpiece with the bit. Adjust the safety grip to the thickness of the stock. *Note:* When boring end grain, adjust the speed one to two letters slower than you normally would. End grain is much tougher than edge grain.

If the workpiece is less than 30" long (Model 500) or 55" long (Model 510), mount the rip fence on either the table or the extension table and use it as a backstop. If the piece is longer than 30" or 55" and you have to work without a backstop, clamp the workpiece to the table.

Adjust the table height and depth control as desired, make a four-point check. The power plant, carriage, table height and table tilt locks must be secure. As you feed the bit, don't be alarmed if it takes more pressure than usual to bore the hole.

BORING AT AN ANGLE

To bore a hole at an angle, simply tilt the table at any angle you desire, from 90° left to "0," in toward the power plant. If possible, mount the rip fence on the table and use it as a backstop (Figure 11-7). If the workpiece is very large, you'll have to clamp it to the table to prevent it from slipping. *Caution: If the angle is acute and you're boring through the workpiece, remember to protect both the table and the rip fence with a scrap block.*

Another way to bore at an angle, is to use the miter gauge. Figure 11-8 shows boring at an angle using the miter gauge stop rod to keep the bit from pushing the stock out of alignment.

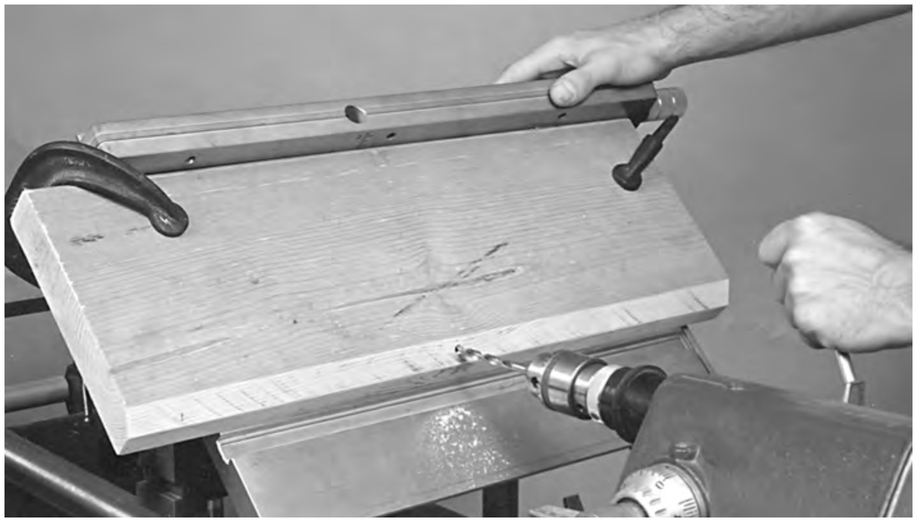


Figure 11-7. *To bore a hole at an angle, tilt the table. Use the fence as a backstop or clamp the workpiece to the table.*

BORING FOR DOWELS

Dowels are often used to reinforce various types of joints. They even sometimes substitute for the mortise and tenon joint. A more routine application is reinforcement with dowels when narrow boards are joined edge-to-edge to form wide workpieces. The combination of worktable surface, rip fence, and depth control makes the hole-boring operation purely mechanical. To establish hole spacing, the boards can be stacked and marked with a square —refer to "Laying out the Work" in Chapter 7. The edge distance of the holes is established by table height. The holes do not have to be exactly centered, but must be in line with each other. Mark the bad surface of each piece and be sure it faces up when you bore.

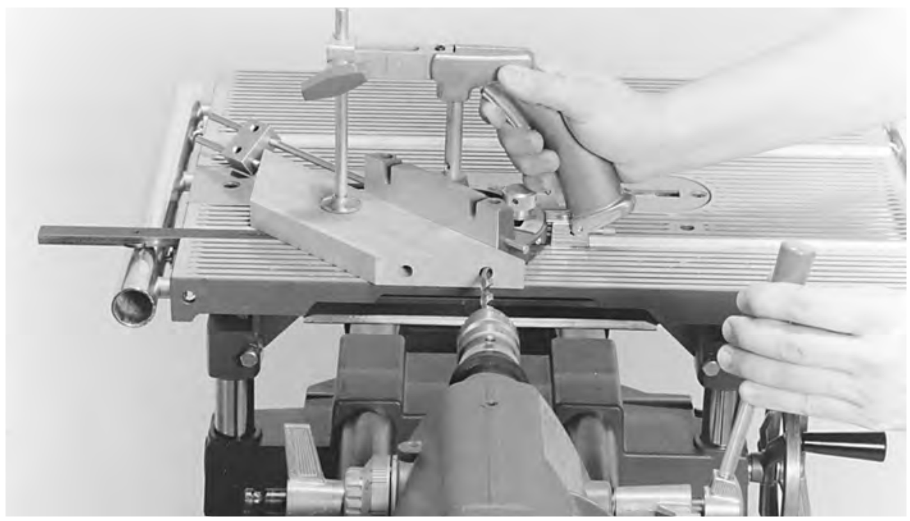


Figure 11-8. *You can also bore at an angle by using the miter gauge. The miter gauge stop rod can be used to keep the bit from pushing the stock out of alignment.*

Hole spacing can be controlled automatically if you make the hole-spacing guide that is shown in Figure 11-9. The important part of the construction is getting the guide pin holes exactly on the bit's horizontal centerline. To determine dimension "A", assemble the guide and secure it to the way tubes. Then, with a bit secured in the chuck, advance the quill so the point of the bit will mark the guide. Use a square to mark this point across the guide and, on this line, bore the holes for the guide pin.

When you use the guide, the guide pin engages the last hole that was bored and so positions the workpiece for the next hole (Figure 11-10). Hole spacing is variable because of the set of holes in the guide and, since the guide pin has a 3/8" diameter bushing at one end (Figure 11-11), you can bore either 1/4" or 3/8" holes. By making an assortment of guide pins, you can set up the guide for boring holes of whatever diameter you wish.

Boring Dowel Holes in Miters— Miter joints are often strengthened with dowels. The important factor is for the holes to enter at right angles to the cutline. The miter gauge holds the workpiece at the correct angle; the rip fence, with a spacer attached, is set to suit the length of the workpiece. The miter gauge safety grip holds the workpiece securely in position as the hole is bored. When the workpiece is extra-long, use the miter gauge to hold it at the correct angle and a clamp to secure it to the table (Figure 11-12).

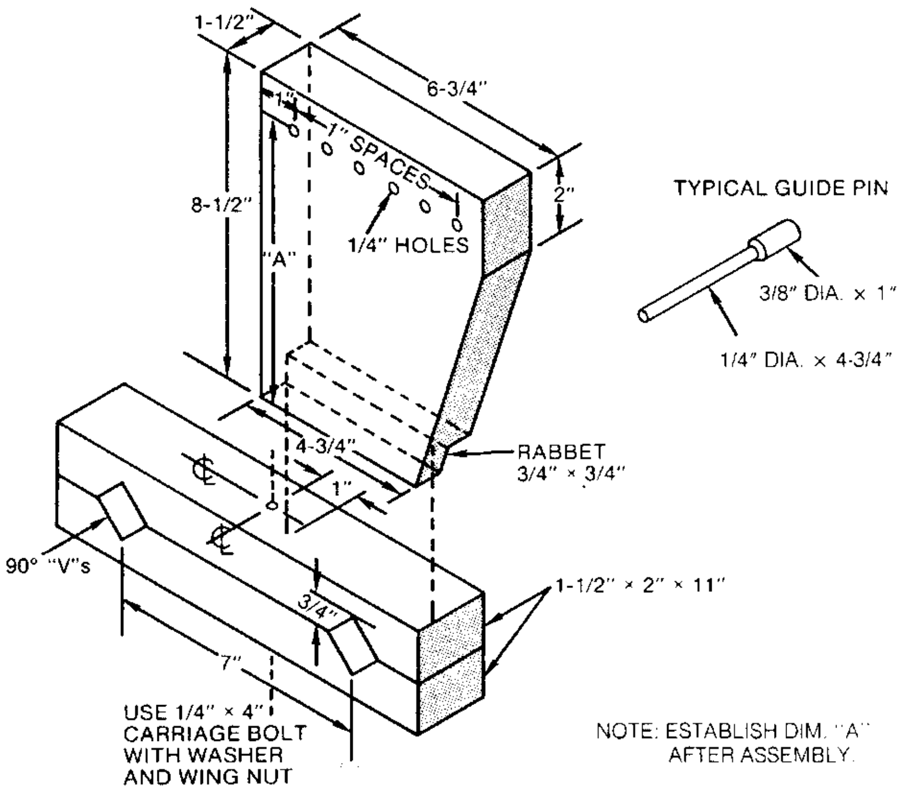


Figure 11-9. *Construction details of the hole-spacing guide. The text tells how to accurately determine dimension "A."*

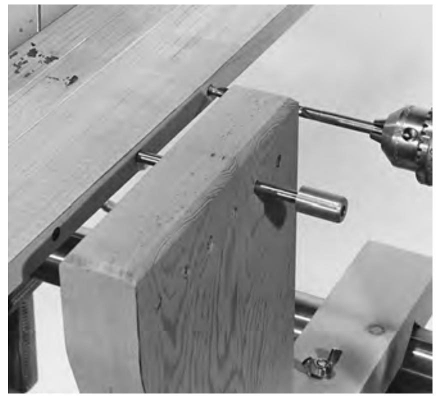


Figure 11-10. *If you use a hole-spacing guide, you can do accurate work without needing layout. After you bore each hole, engage the pin. This positions the workpiece for the next hole. Spacing is determined by placing the guide pin in the appropriate hole in the guide.*

Figure 11-11. *Since the guide pin has a bushing of 3/8" diameter at one end, you can bore either 1/4" or 1/2" holes. You can make an assortment of pins for various hole sizes if you wish.*

FORMING A PEGGED JOINT

This is an excellent joint to use on drawer front to drawer side connections since it has the characteristics of the dovetail, but it is much easier to accomplish. First, cut the side and front of the drawer to size and then set the pieces in position as shown in Figure 11-13A. The miter gauge positions the work square to the spindle; the fence acts as a backup; and the table height is adjusted for edge distance. Bore the first hole and insert a dowel in it (Figure 11-13B) so the parts will be held in correct position for the holes that follow (Figure 11-13C). This method can be used for box corners as well as drawers (Figure 11-14).

BORING ODD SHAPES

An odd-shaped piece, like a curved segment, can be set up for boring by simply positioning it correctly and then clamping it in place on the table. However, if you have many similar pieces to bore, you can make a guide that will place each piece in exactly the right position. This lets you work more accurately since it eliminates the possibility of human error. An example guide, shown just to demonstrate the concept, is shown in Figure 11-15.

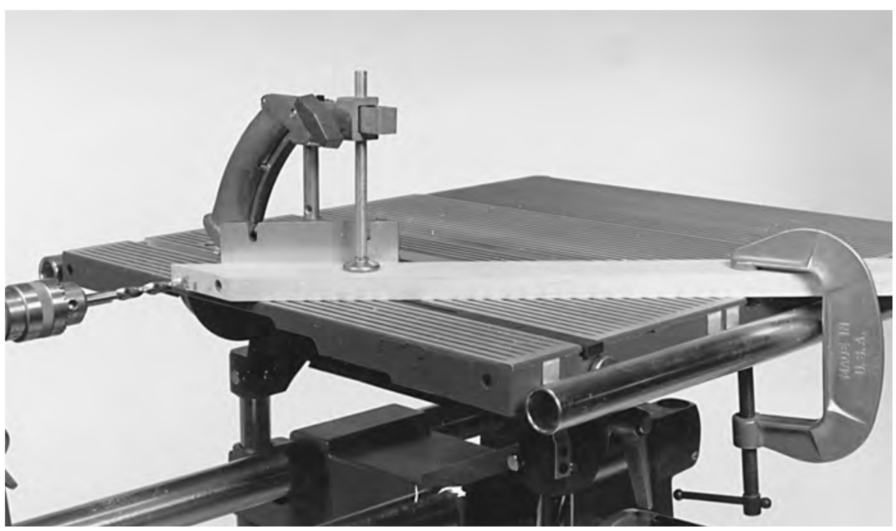
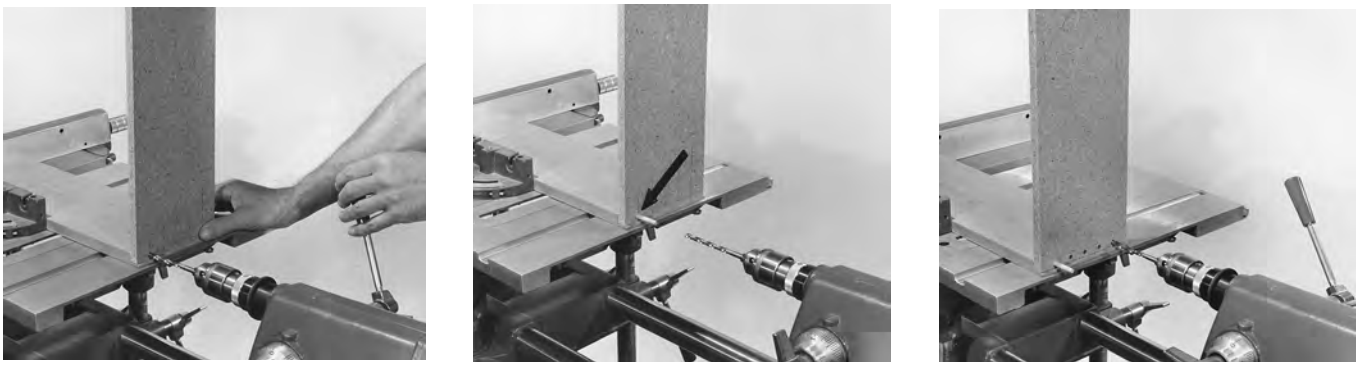


Figure 11-12. *When the workpiece is extra-long, use a clamp to secure it to the table.*



A B C

Figure 11-13. (A) When preparing to bore holes for the pegged joint, cut the side and front of the drawer side connections and position them. (B) Insert a dowel in the first hole so the pieces will be held in the correct position for the holes that follow. (C) Continue boring, controlling the depth of the holes with the depth control.

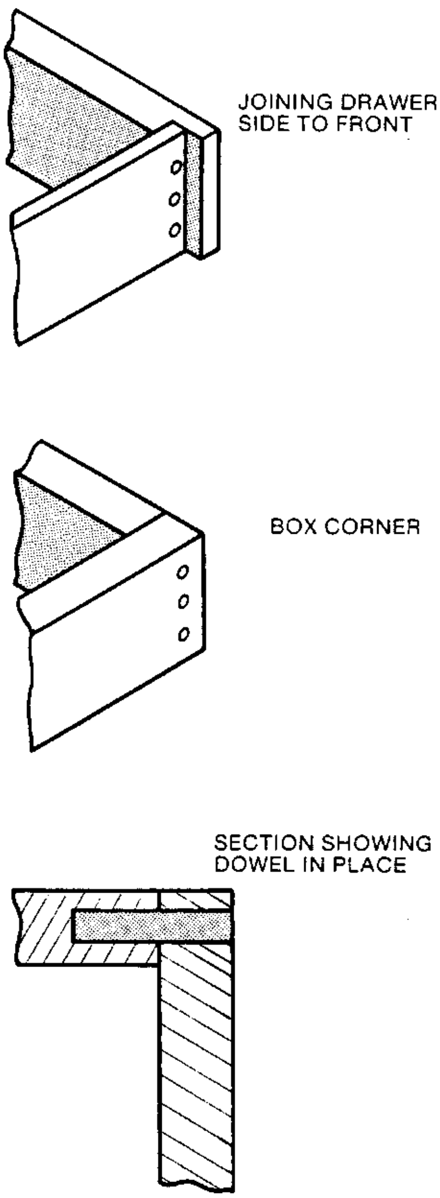


Figure 11-14. The pegged joint may also be used for box corners.

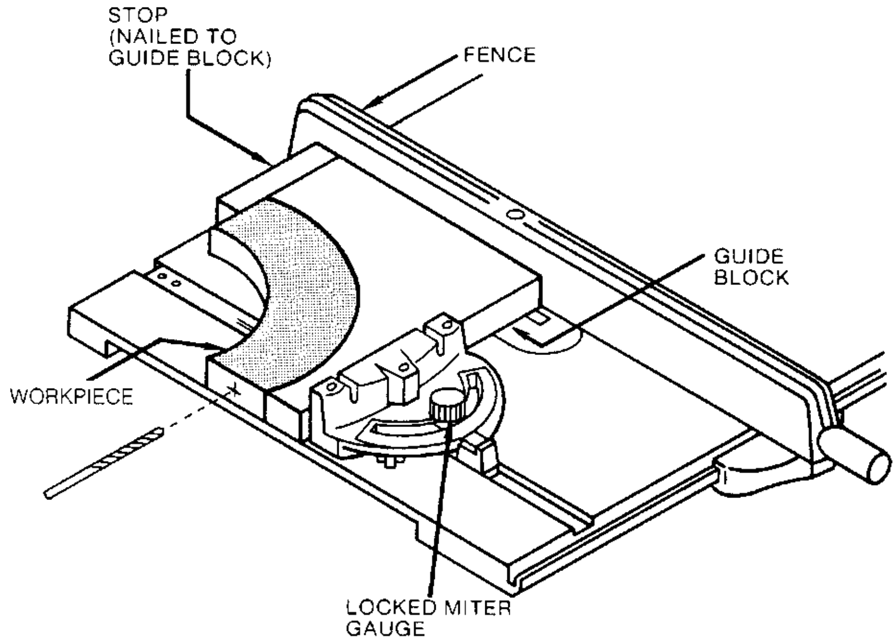


Figure 11-15. An example of a guide used for boring odd-shaped pieces.

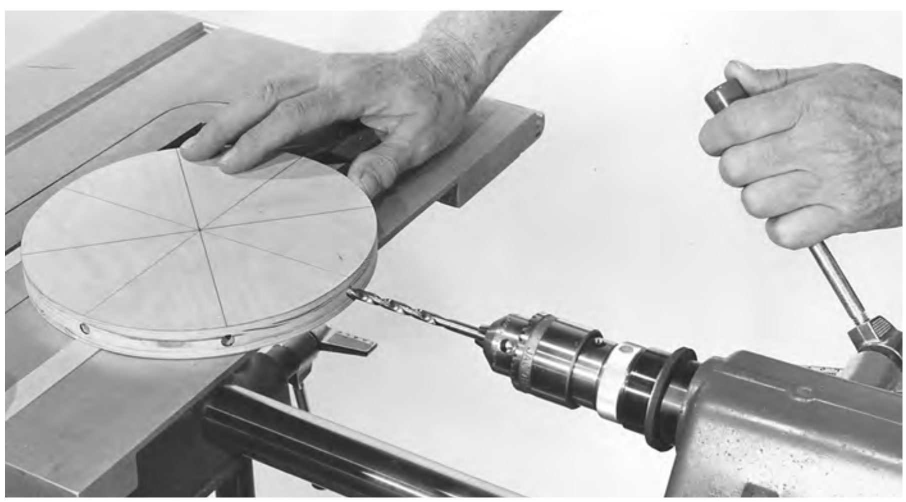


Figure 11-16. Using the pivot method to bore radial holes into the edge of a circular workpiece.

PIVOT BORING

Radial holes into the edge of circular workpieces can be bored accurately by working as shown in Figure 11-16. This procedure is known as pivot boring. A strip of wood, sized to fit the table slot and with a short nail driven through it at an approximate midpoint, is clamped to the table so the nail is aligned with the spindle's center. The workpiece, marked off in degrees for the holes that are required, is centered over the pivot nail and rotated to position it for each hole. Set the depth control to limit quill extension.

The indexing device that is shown in Figure 7-44 of Chapter 7 for drilling surface holes on a circumference may also be used for this application. You don't have to do the layout on the workpiece if the boring position is established with the indexing jig. Flexibility of hole spacing will be determined by how the device is designed.

CONCENTRIC BORING

A round or a square workpiece, if it is not too long, can be positioned for accurate concentric holes by using the miter gauge and the fence as shown in Figure 11-17. The table height is adjusted so the drill point will be on the workpiece's horizontal centerline. The miter gauge, locked in place, maintains the workpiece's alignment; the fence serves as a backup.

Another method requires the use of a V-block (Figure 11-18) which cradles the workpiece as demonstrated in Figure 11-19. When the workpiece is shorter than the V-block, use a length of scrap wood between the workpiece and the fence. The V-block can also be used to hold square workpieces (Figure 11-20).

For extra-long workpieces, use an extension V-block as shown in Figure 11-21. The V-block is also used to grip short workpieces (Figure 11-22). The V-block, held in place by being clamped to the locked miter gauge or clamped to

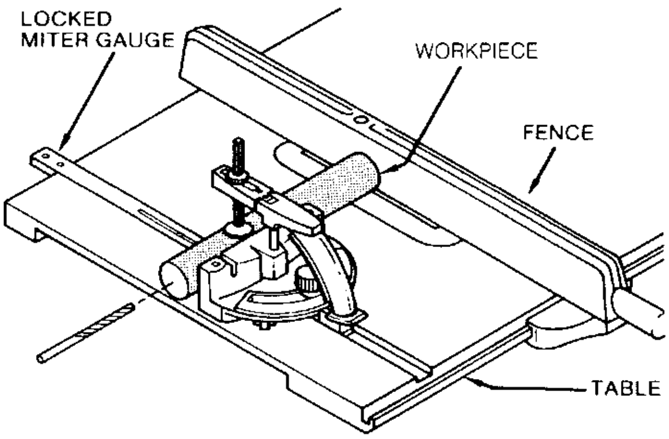


Figure 11-17. A simple way to set up for boring concentric holes.

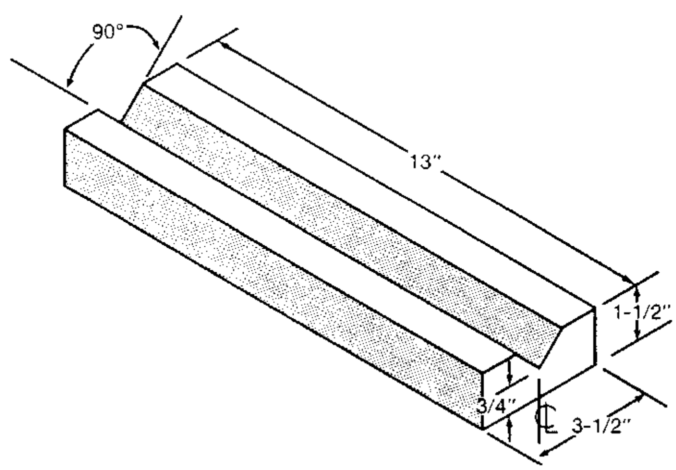


Figure 11-18. A V-block can also be used when doing concentric boring.

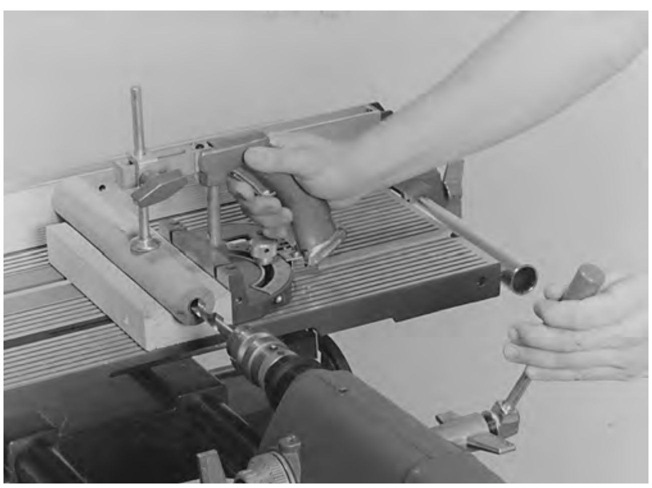


Figure 11-19. A V-block is used to hold the workpiece as shown here. Use the fence as a stop block and use a spacer when the workpiece is too short to reach the fence.

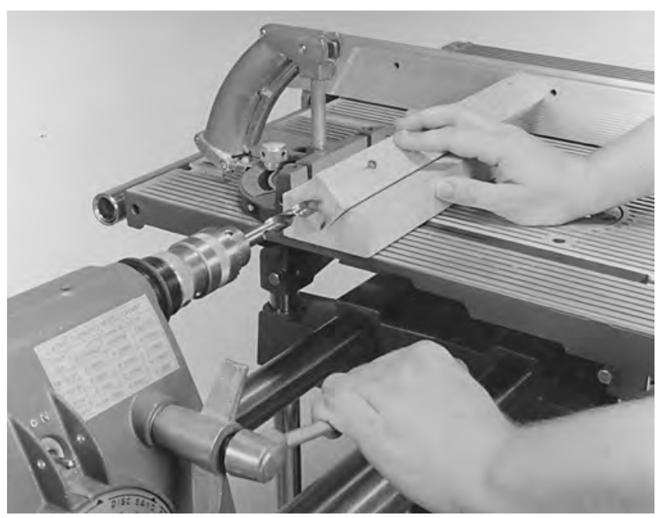


Figure 11-20. The V-block can also be used to position a square workpiece for concentric boring.

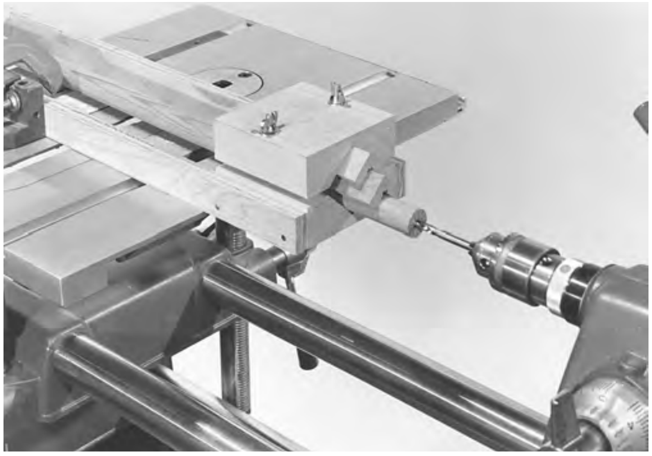


Figure 11-21. *An extension V-block is used for extra-long workpieces.*

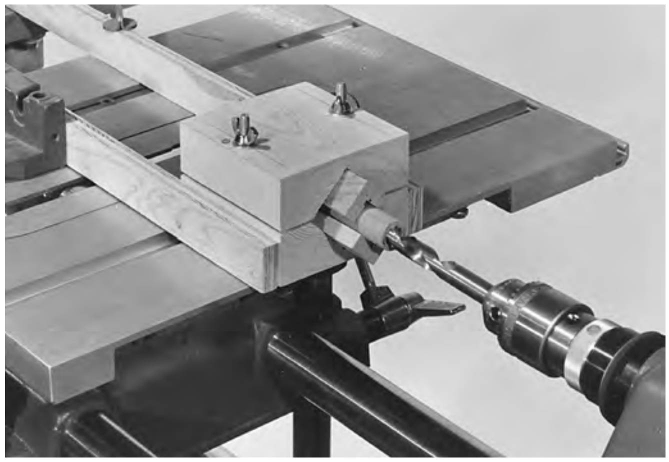


Figure 11-22. *The extension V-block can also be used to grip short workpieces. Auxiliary V's are used when the stock's diameter is too small to be gripped by the basic V-block.*

the extension table, is positioned so the vertical centerline of the spindle bisects the "V." Table height is adjusted in relation to the diameter of the workpiece. Small auxiliary V's are used when the workpiece is too small to be gripped by the basic V-block. Figure 11-23 shows how the extension V-block and the auxiliary V's are made.

BORING EXTRA-DEEP HOLES

Holes that are deeper than you can form by using a conventional bit can be bored with an extension bit (Figure 11-24), a special tool that in many cases is no more than a regular drill bit that has been brazed onto a rod. The procedure is to bore to the quill's maximum extension and then, after retracting the quill, to move either the table or the power plant so the drill will reach the bottom of the hole. Thus you can deepen the hole by again extending the quill. Since the rod part of the extension doesn't have flutes, you must retract frequently to clear waste chips from the hole.

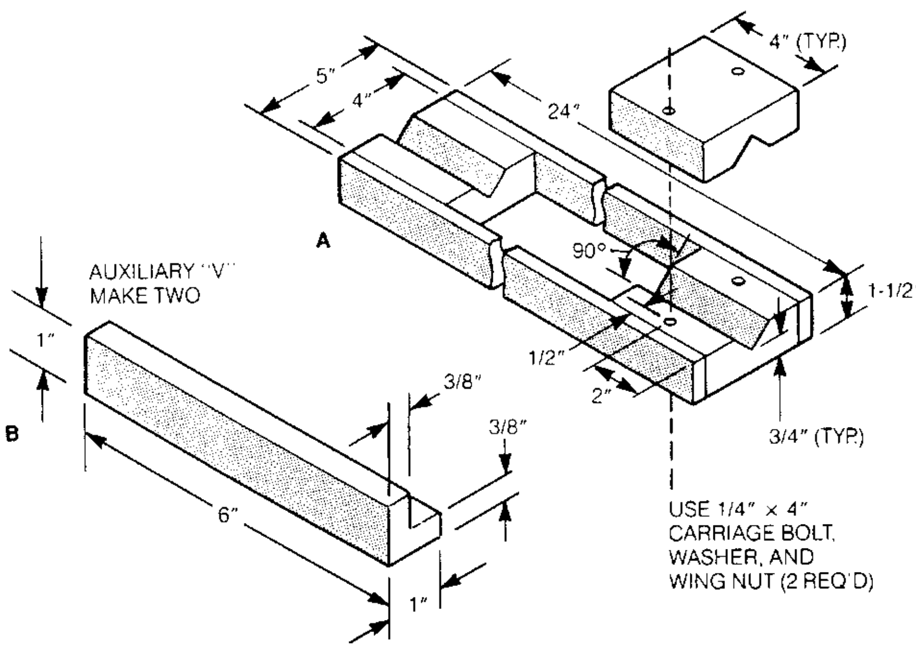


Figure 11-23. *Construction details of the (A) extension V-block and (B) the auxiliary V's. The shape needed is actually a rabbet cut.*

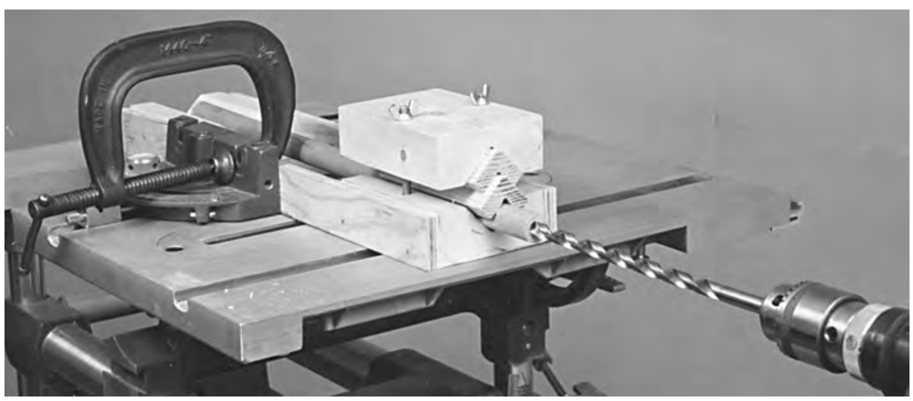


Figure 11-24. *Using an extension bit to form an extra-deep hole.*

Chapter 12
Lathe

Lathe turning is perhaps the only woodworking operation in which, after stock is cut to size, you can start and finish a project in just one mode of the Mark V. But it also demands a good deal more skill and patience than other operations. If you're just beginning, don't be discouraged. Turning takes a little practice, but once you get the hang of it, it's one of the most satisfying woodworking techniques.

The lathe hasn't changed in principle since it was a primitive, bow-powered tool that is said to have been invented in ancient Egypt. It remains a means of turning stock at controlled speeds so sharp tools may be pressed against it, shaping it symmetrically. Electric motors have replaced the various hand powered or foot powered devices originally used, but the quality of the output still depends on the operator's skill in manipulating the chisels used to form the stock.

There are two basic kinds of lathe turning: spindle turning and faceplate turning.

Spindle turning is turning stock between two centers—the drive center and the cup center (Figure 12-1). Usually the end product is a long cylinder, like a table leg or a candlestand.

Faceplate turning is turning with the stock mounted to a faceplate (Figure 12-2). This faceplate is, in turn, mounted to the main spindle. The end product is usually shorter and wider than spindle turning, like a platter or bowl. Shopsmith offers two faceplates, 3-3/4" and 6" in diameter.

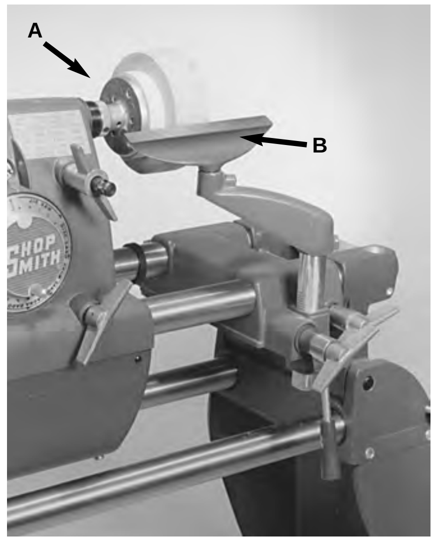


Figure 12-2. *The accessories that are used for faceplate turning are the: (A) faceplate, and (B) tool rest.*

LATHE MODE — SETUP AND FEATURES

To set up your Mark V in the lathe mode, follow the instructions in the Owners Manual that came with your machine.

As you work in the lathe mode, you'll find that the Mark V is an extremely capable lathe with several special features.

- It has a swing of 8-1/8", so that you can turn stock up to 16-1/4" in diameter. It will hold a spindle up to 34" long between the center—long enough to turn table legs.
- The quill feed holds the spindle in place between the centers.
- The tool rest is 8" long and swivels a full 360°. It adjusts up or down with the table height mechanism and sideways by sliding the carriage along the way tubes. The Model 510 tool rest arm has a center post position that is used when turning heavy stock.
- The speed dial provides a broad range of speeds for a variety of lathe operations from rough shaping to finish sanding.
- The tailstock has an eccentric mount to aid in turning tapers.

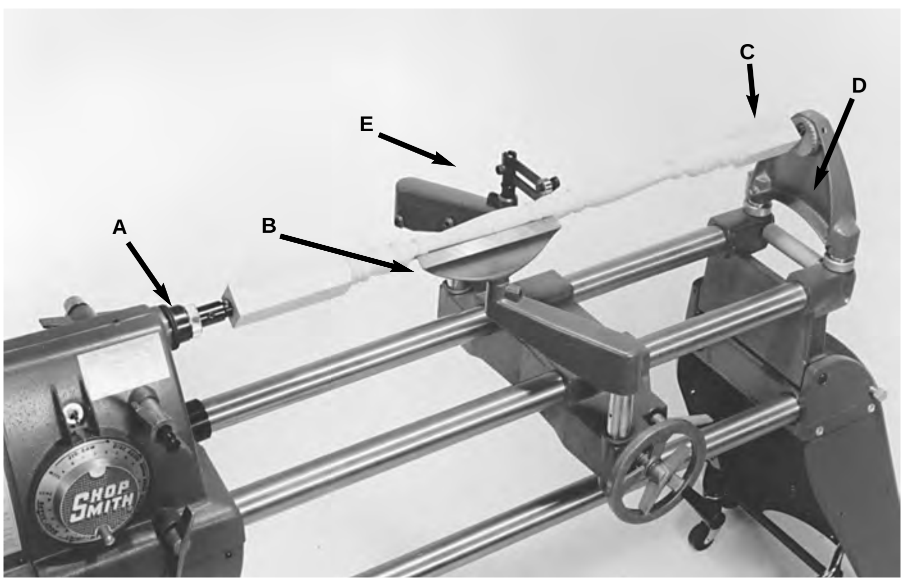


Figure 12-1. *The accessories that are used for spindle turning operations are the: (A) drive center, (B) tool rest, (C) cup center, (D) tailstock, and (E) optional steady rest. The steady rest helps to reduce whip and vibration.*

• A lathe steady rest is available that helps to reduce whip and vibration of the spindle stock.

LATHE TOOLS

There are four basic tools that you need when doing lathe work (Figure 12-3).

• *Gouges* are used to round the stock and to make concave curves called "coves," mostly in spindle turning.

• *Roundnose chisels* are also used to make coves, mostly in faceplate turning.

• *Skew chisels* are used to make convex curves called "beads." They can also be used to cut straight or tapered cylinders.

• *Parting tools* are used mostly for sizing and parting operations.

A basic lathe tool set includes 1" and 1/2" gouges, a 1/2" roundnose chisel, a 1" skew chisel, and a 1/8" parting tool. These five tools can be used for all types of turning.

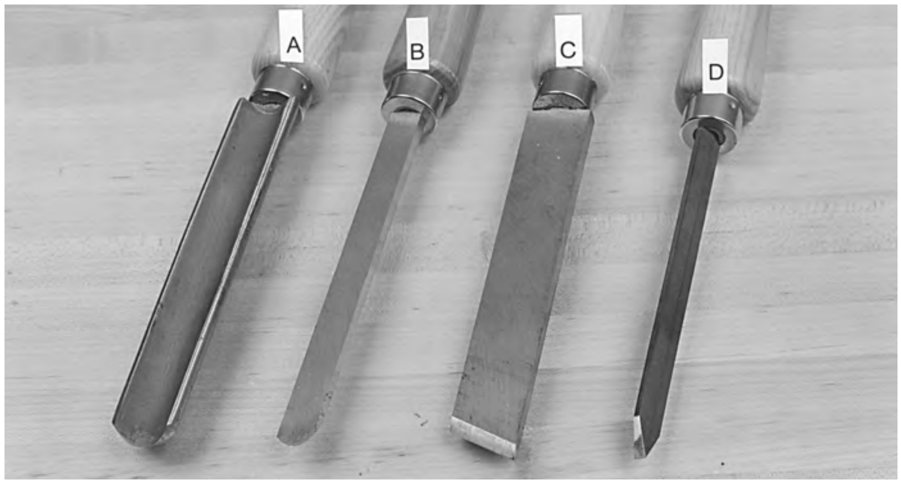


Figure 12-3. *There are four basic types of lathe tools: (A) the gouge, (B) the roundnose chisel, (C) the skew chisel, and (D) the parting tool.*

Figure 12-4. *Two ways to hold lathe tools.*

HOLDING LATHE TOOLS

Two ways to grip lathe tools properly (reverse if left handed) are demonstrated in Figure 12-4. The left hand is usually placed on top of the blade, with the little finger toward the stock. The butt of the hand or little finger rides against the finger ledge. The right hand holds the handle of the tool and provides the movement which determines the cut. The part of the hand that rests on the finger ledge also acts as a gauge.

An alternate method of holding the lathe tools consists of placing the left hand on the blade with the thumb on top. The back of the hand rests on the finger ledge and the fingers are placed comfortably around the tool or on the finger ledge. The right hand serves the same purpose in this holding method as it does in the method mentioned previously.

When making smoothing cuts or when roughing stock to size, the tool may be moved along the tool rest parallel to the work, taking a bite that remains constant because the left hand butts against the tool rest ledge and acts as a control.

The feed of the chisel, which determines the amount of wood removed, should be slow and steady—never forced, never jabbed into the work. After the tool is in position, start the cut by advancing the tool slowly until it touches the wood.

Three Cutting Actions

Each of the lathe chisels act in the three ways shown in Figure 12-5, depending on how you hold them.

Scraping—Scraping is the easiest and safest of the three actions and the best for the beginner to use. Many experienced operators use this action almost exclusively because it gives good results.

A scraping action with a roundnose chisel is shown in Figure 12-6. Notice that the hand position hasn't changed except for the fingers. Placed as shown, the thumb and forefingers do most of the gripping and help to bring the cutting edge of the chisel close to a horizontal plane. This position is maintained while the chisel is advanced to the depth of the cut and then moved slowly from side to side to increase the cut's width if necessary. Full depth does not have to be reached at once. The chisel may be moved forward a slight amount and then moved from side to side as the pivot point is maintained. The procedure is

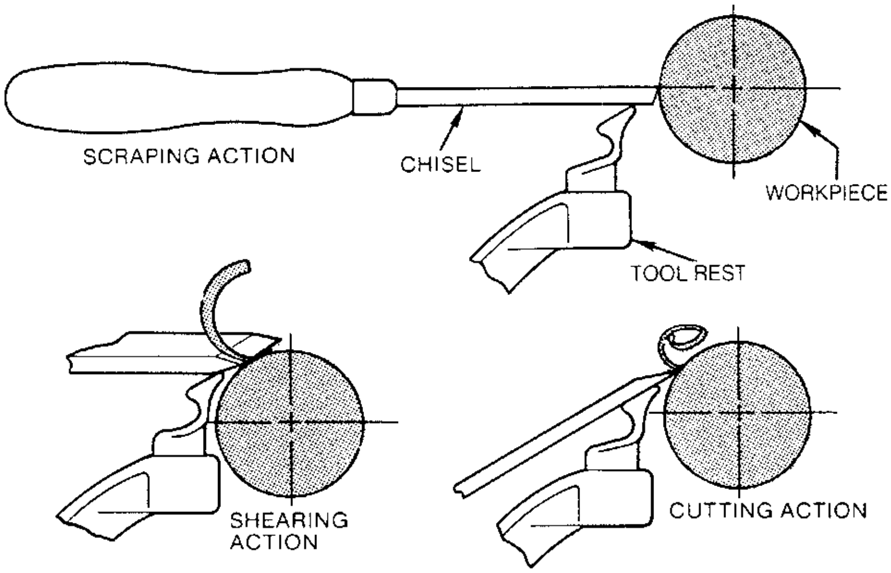


Figure 12-5. *The three basic chisel actions—scraping, shearing and cutting. The scraping action has many applications and is the first technique for you to master.*

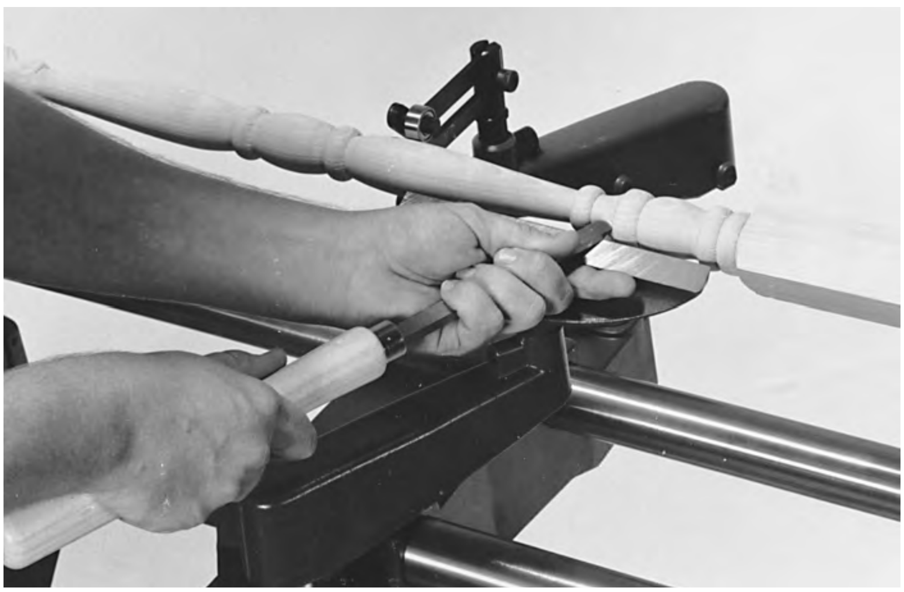


Figure 12-6. *A scraping action with a roundnose chisel moved directly forward produces a cove equal to the size of the chisel. Position of hand, tool rest, and chisel are shown here.*

Figure 12-7. *The start of a shearing action with a gouge. The tool is at a slight angle with its cutting edge tangent to the work.*

Figure 12-8. *The shearing action of cutting beads with a skew.*

repeated until the full shape is formed. Each "pass" removes a little more wood.

Cutting—This action calls for bringing the tool edge into the surface almost as if it were a knife.

The feed should be slow and the cut should be light. ***Warning: If you jab the chisel into the workpiece suddenly or deeply, the chisel will be wrenched from your hands. You could be seriously injured.*** At the very least you will ruin the workpiece by cutting and lifting a large splinter from it. Don't use the cutting action until you have practiced enough with the scraping action to be thoroughly familiar with each tool and what it can do. Once you have become proficient with the cutting action, you'll find that it leaves a surface smooth enough to finish with a little touch-up.

Shearing—The shearing action is usually limited to the skew and gouge. It is a cutting action with the tool edge moved parallel to the work, taking a constant bite, shearing away a layer of wood from the surface of the stock. A shearing action with the gouge is illustrated in Figure 12-7. The shearing action of cutting beads with a skew is shown in Figure 12-8. Shearing a cove is one of the easier cuts. Since the tool is held on edge, move your thumb behind it to steady it while making the cut. When the gouge is sharp and properly held, wood is removed rapidly and the surface is left smooth.

While each of the tools does certain operations better, the overlap is so great that no hard-and-fast limitations can be set down for each one. Each tool will

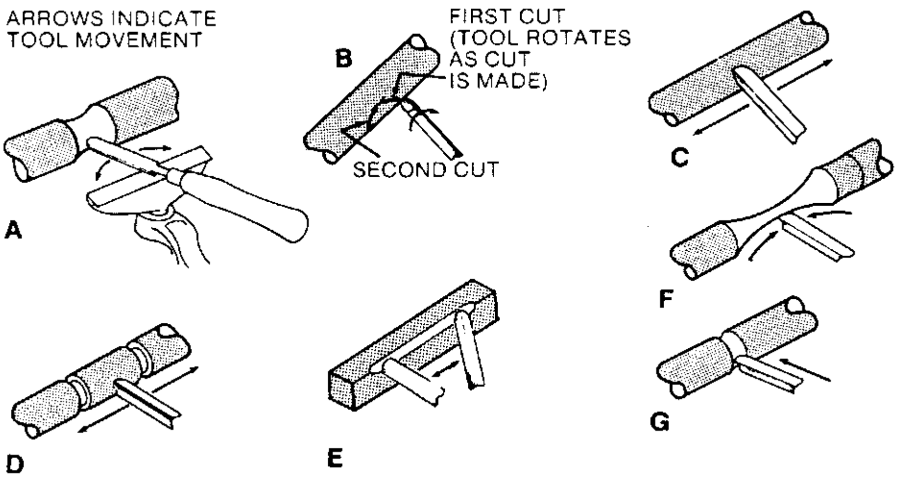


Figure 12-9. *The gouge is a very versatile lathe tool. It can be used to: (A) shape a cove (scraping action), (B) shape a cove (cutting action), (C) smooth a cylinder, (D) cut away stock between shoulders, (E) round, (F) shape, and (G) make small coves (determined by the size of the gouge—scraping).*

Figure 12-10. *Use the gouge for rounding operations. Work from a midpoint toward each end of the stock.*

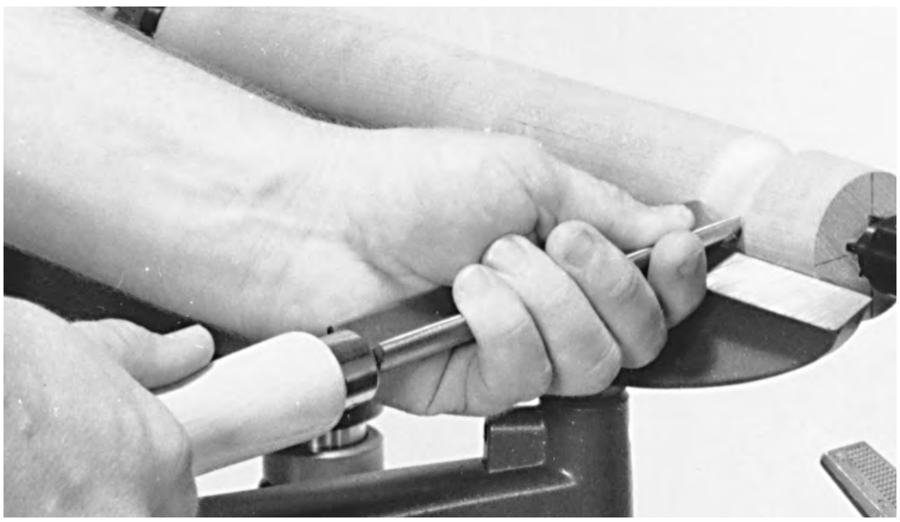


Figure 12-11. *The gouge, when used with a scraping action, will form a cove that duplicates the size and shape of the gouge's cutting edge.*

cut differently, depending on the action, the angle, and the way it is moved. Practice with each tool until you have the feel of each of them. When you arrive at this point, habit will take over and your use of the tools will become an individual application that is standard with you.

Using the Gouge

The gouge, one of the more versatile turning tools, can be used with any of the three cutting actions. At times it is applied so all three cutting actions come into play (Figure 12-9).

It is the only tool to use when doing initial rounding (Figure 12-10). This is essentially a shearing cut with the gouge held on its side and moved parallel to the work. Depth of cut is maintained by a finger resting against the tool rest ledge.

Rounding should be started somewhere along the length of the stock with the gouge moved in the direction indicated by the arrows in Figure 12-9E. You'll find it is easier to work from a midpoint toward each end of the stock instead of making one continuous cut from end to end.

To make rounding cuts in a limited area, use the gouge between sizing cuts made with the parting tool or marks penciled on the workpiece.

Figure 12-11 shows how you can use the gouge in a scraping action to form a cove whose size and shape is dictated by the tool. The gouge is held in a horizontal position and slowly moved directly forward. ***Warning: Do not remove too much material at once.*** Retracting the gouge frequently will allow waste material to fall away.

The shearing action is a more advanced way to form a cove with the gouge. Begin with the gouge on its side as if you were preparing for a rounding cut. Feed the gouge forward to contact the stock; then rotate it on the tool rest as you move it toward the center of the cove (Figure 12-12). Work this way from both sides of the cove toward its center. As the gouge is manipulated, the action changes from shearing to scraping (Figure 12-13), which occurs at the full depth-of-cut point only.

Using the Skew Chisel

Typical applications of the skew chisel are shown in Figure 12-14. While professionals use the skew mostly in a shearing action, it can function efficiently while cutting or

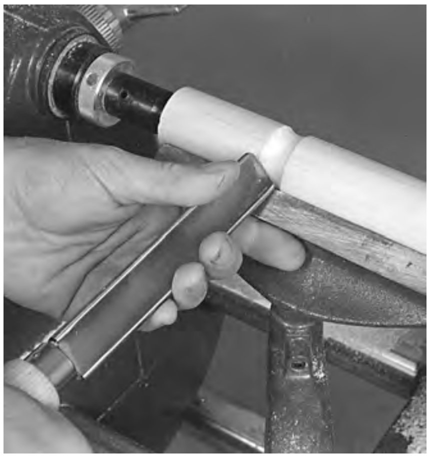


Figure 12-12. In a shearing action to shape a cove, the gouge is slowly rotated as it is moved toward the shape's centerline.

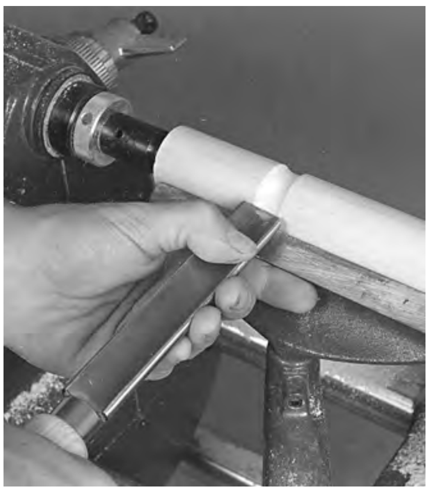


Figure 12-13. At the end of the cove cut, the gouge is in a scraping position.

scraping. A common scraping action is shown in Figure 12-14E with the chisel held to square off the end of a cylinder. When held this way, the chisel's sharp point removes material quickly and leaves a reasonably smooth surface. The same result is obtained by using the point of the skew in a cutting action (Figure 12-14B). When used this way, the skew works like a knife, severing wood fibers and leaving a surface that requires little sanding.

Tapers are formed by starting the cut with the heel of the blade and raising the handle as you slide the chisel along the tool rest. To smooth a taper that was formed with another tool, use the skew as shown in Figure 12-14A or F. This can be a scraping or a shearing action. If you move the skew so only its heel contacts the workpiece, it will shear. If you position the skew so its edge is parallel to the workpiece and then advance it while maintaining tool-to-workpiece contact, the action will be scraping.

Probably the smoothest surfacing cut of all is shown in Figure 12-14H where a shearing cut is being used to smooth a cylinder. The cutting edge of the skew is held at an angle to the longitudinal axis of the workpiece. When done correctly, the surface of the workpiece is smooth with a finish that looks burnished. It will take practice.

The skew is used to form beads. Like a cove, the bead requires three marked or imagined dimension lines: one to indicate the bead's center and one on each side of the center to indicate total bead width.

Start by placing the heel of the skew lightly on the bead's centerline so its edge is tangent to the curve you want to form. Move the skew into the workpiece. At the same time, rotate and lift the handle to follow the curve of the bead. It will take several passes to form one-half of the bead (Figure 12-15). Follow the same procedure, but work in the opposite direction, to form the other half of the bead (Figure 12-16).

Using the Roundnose Chisel

The roundnose chisel is always used in a scraping action (Figure 12-17) and is the only tool to use for hollowing. In the latter application, the tool rest must be positioned to provide maximum sup-

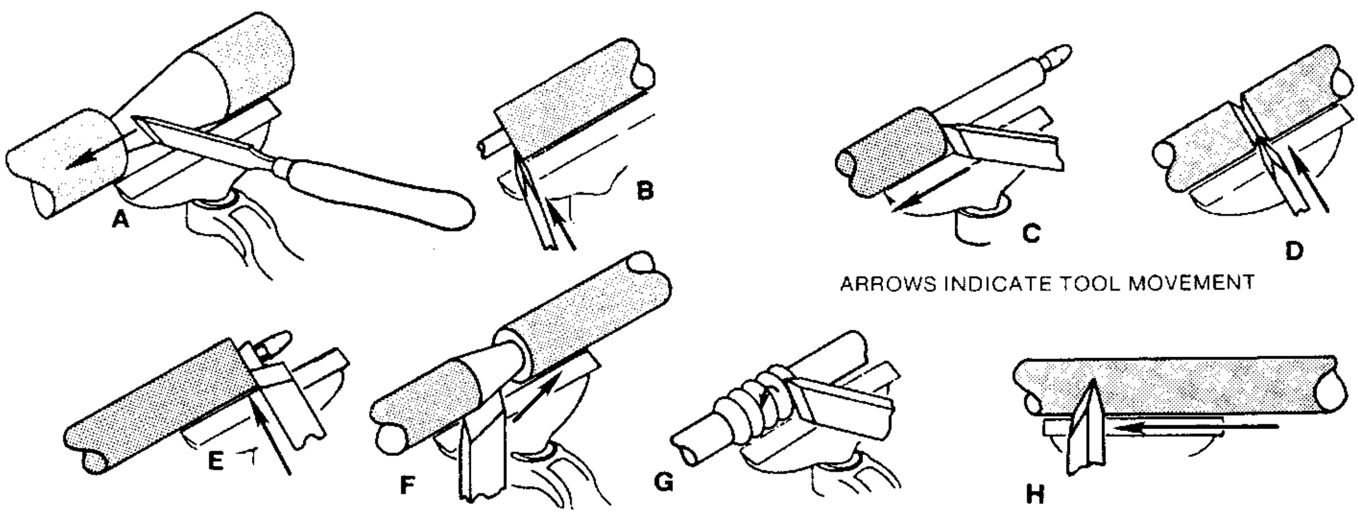


Figure 12-14. Here are some of the ways a skew can be used: (A) to form and smooth a taper, (B) to trim ends, (C) to square a shoulder, (D) to make V-cuts (also with heel of skew), (E) to square ends of stock, (F) to smooth a taper, (G) to form beads, and (H) to smooth a tapered cylinder.

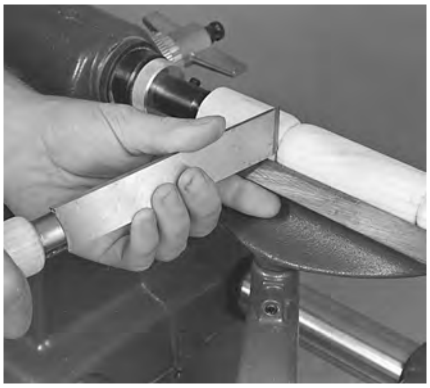


Figure 12-15. To form a bead with a skew, start the cut on the shape's centerline. Cut toward one side of the bead.

Figure 12-16. Finish the bead by repeating the procedure, this time working in the opposite direction. It takes practice to do this kind of shaping efficiently.

port for the chisel even if it has to be placed inside the hollow that is being formed.

Using the Parting Tool

The parting tool is most often used in a scraping action with the edge of the blade resting on the edge of the tool rest and with blade feed directly forward, whether the cut is square or at an angle to the workpiece (Figure 12-18).

The parting tool is often used to determine the depth of cut or the diameter of the final shape. To speed up the procedure when making preliminary sizing cuts, handle the tool as shown in Figure 12-19. Start with the tool horizontal, then slowly raise and lower its cutting edge as the cut deepens.

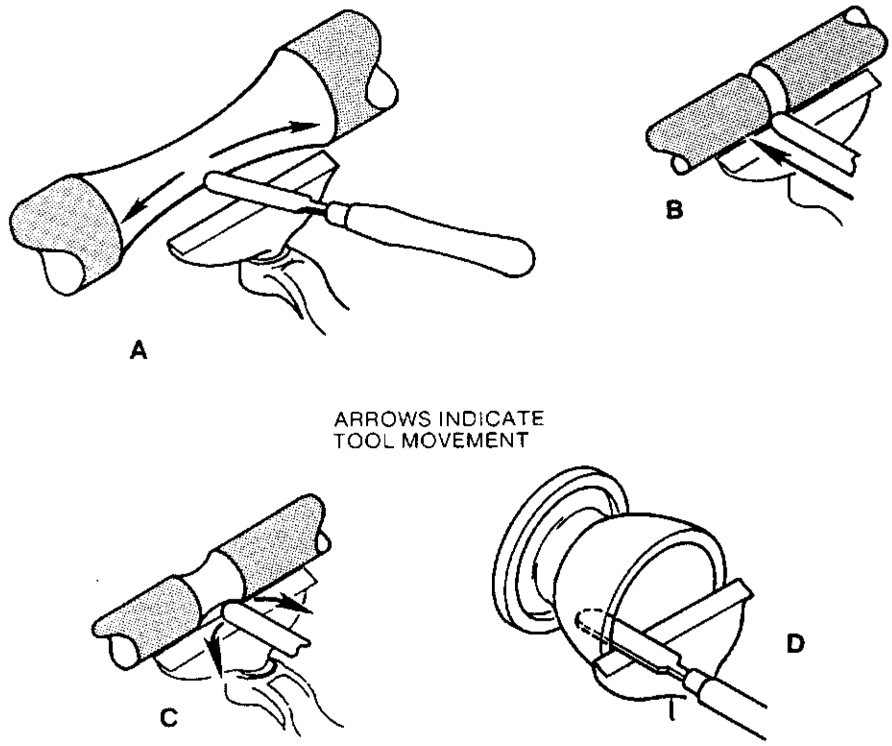


Figure 12-17. The roundnose tool is the easiest chisel to use. It is always used in a scraping action. It can be used to: (A) form, (B) make small coves, (C) make large coves, and (D) hollow.

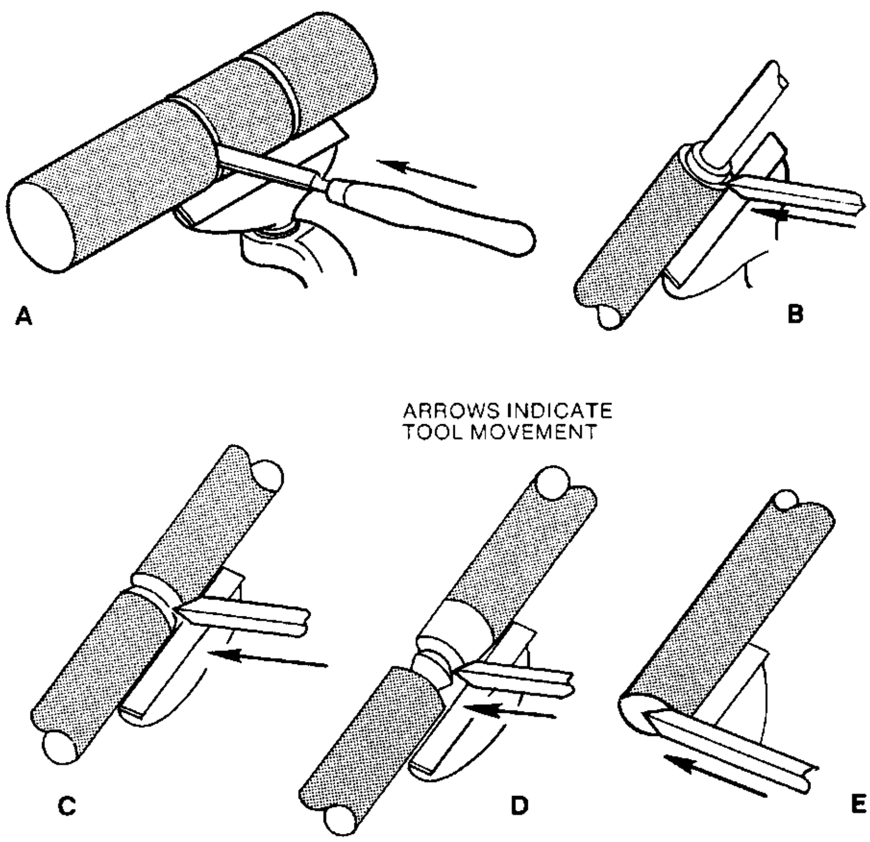


Figure 12-18. Employ a scraping action with the parting tool. Some of its uses are: (A) sizing cuts and grooves, (B) making shoulders, (C) cutting V's, (D) cutting V's on taper where other tools may not fit, and (E) cleaning ends.

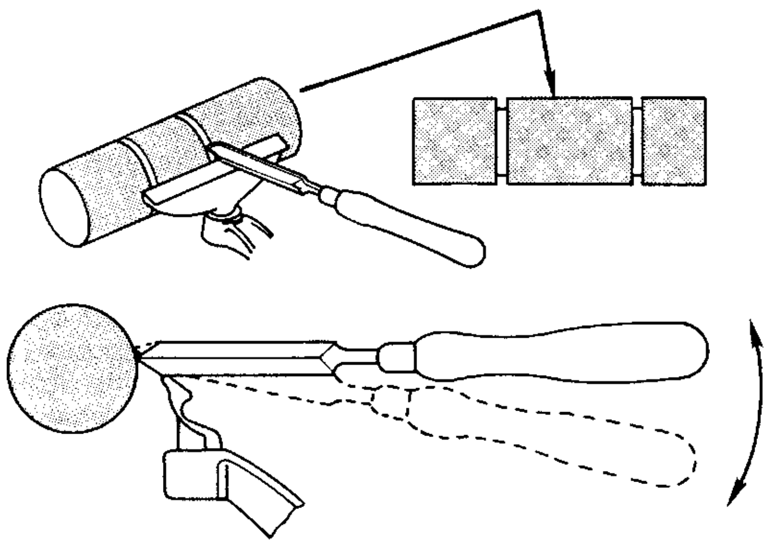


Figure 12-19. *Sizing cuts, to determine the diameter of a turning at any point, are done with a parting tool.*

PLANNING THE DESIGN

Before you attempt to form a turning, you must first plan the design. Otherwise you may end up with an unattractive project.

The best way to plan the design is to draw a full-size plan with the shapes and dimensions marked, so that before you start you will know exactly what shapes you are going to cut and where.

Here's an example of how to plan the design for a spindle turning 12″ long and 3″ in diameter: Draw a rectangle 12″ by 3″ on a piece of paper. Draw a centerline down its length. Break up the length into design areas by drawing horizontal lines that are proportional and pleasing. Let the base design occupy the bottom 3″; use 7″ for the transition from base to top and leave the remaining 2″ for the top.

LATHE SAFETY

Warning: Before using the lathe, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V in the lathe mode changes as the turning progresses. Before the stock has been rounded, the danger zone extends 3″ out from the stock in all directions. After the stock is rounded and while it's being shaped, the danger zone extends 1″ out. After the stock is completely shaped and the tool rest has been removed, you can safely put your hands near enough to the workpiece to sand it on the lathe.

Always keep your fingers and hands out of the danger zone. When you work at the lathe, be careful not to touch the stock as it turns, until you have finished shaping it. In particular, be careful not to let your fingers or hands slip between the workpiece and the tool rest. Keep both hands on the tool you're using and in front of the tool rest.

Before sanding your workpiece on the lathe, turn off the machine, let it come to a complete stop, and remove the tool rest.

Balance—This is extremely important when turning glued-up stock, long stock and stock more than 3″ in diameter. Check the balance of your spindle and face plate stock after you've marked the centers.

To do this, drive a standard 8 penny nail straight into each center. Use suitable string to hang the stock in a level position from the front bench tube of the Mark V or a saw horse. The ends of the string should be looped around the nails (Figure 12-20). Gravity will pull the heavy side down. Use a jointer, bandsaw or hand plane to remove no more than 1/32″ at a time from the heavy side until the stock remains stationary when rotated to three positions 90 degrees apart.

- **Wear proper eye protection and a dust mask.**
- **When turning glued up stock, make sure glue joints are strong. Glue the stock and leave it clamped for at least 24 hours prior to turning.**
- **Do not wear jewelry, gloves, ties, loose clothing or clothing with long sleeves. Keep long hair tucked under a hat. Jewelry, gloves, ties, clothing and hair could become entangled in the stock.**
- **Do not turn stock with splits, loose knots, or other defects that could cause the stock to break, splinter or come loose while turning.**
- **Cut stock that's larger than 3″ × 3″ into an octagon. This removes excess stock and makes turning safer and easier.**
- **When mounting stock between the centers, the spurs of the drive center and the cup of the cup center must penetrate at least 1/16″ into the stock. Do not use a center if the point is damaged. The stock could be thrown from the lathe.**

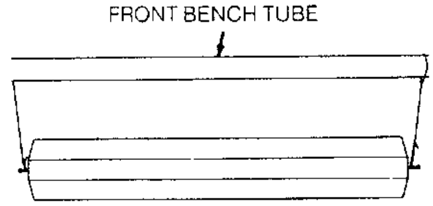


Figure 12-20. *Check the balance of your spindle or faceplate stock by hanging the stock in a level position from the front bench tube of the Mark V.*

• Wax or soap the end of the stock that mounts to the cup center. This lubrication helps keep the cup center from wearing into the stock and causing the stock to loosen on the lathe.

• When mounting stock to a faceplate, use #12 × 1-1/4″ long screws. The screws must penetrate at least 3/4″ into the stock. If the screws are being driven into the end grain, the screws must penetrate at least 2″ into the stock. Use #12 × 2-1/2″ long wood screws. Before mounting stock to a faceplate, to minimize imbalance cut the stock round.

• Position the tool rest no more than 1/4″ from the stock. Maintain this distance while turning. Before turning on the machine, rotate the stock by hand to make sure it clears the tool rest. Never turn without the tool rest. Rest the tool on the tool rest before cutting, shearing, or scraping.

• During turning, periodically turn off the machine and check to make sure the stock remains securely mounted.

• Do not lean across or reach underneath the lathe while it is running.

• Do not touch the rotating stock while the tool rest is mounted.

• Round all stock at "Slow" speed. Large heavy stock will fly off the lathe if you try to round at too high a speed.

• Feed the tool very slowly into the stock. Never force the tool or remove too much material in one pass. Hold the tool firmly in both hands and against the tool rest.

• Never try to stop the lathe by grabbing the stock or any part of the machine.

• Do not part the stock completely or turn the spindle down to such a small diameter that it snaps.

• Always remove the tool rest before sanding the turned stock on the lathe.

• When turning large heavy stock, use the center post position on the tool rest arm (Model 510 only).

• Always use the proper speed for the stock size and operation.

LATHE SPEEDS

Before you mount stock on the lathe be sure the speed is set at "Slow." After the stock is mounted, turn on the machine, set the speed dial to the proper speed and let the lathe come up to speed.

The operating speeds for lathe turning are determined by the size of the stock you're turning and the operation you're performing — whether you're rounding the stock, shaping it, or finish sanding. Generally, you can use slightly faster speeds as you progress from rounding to shaping to sanding. You can also use slightly faster speeds with smaller stock. The larger the workpiece, the slower the speed should be for each operation.

To help determine the right speed for the job, use Table 12-1.

Table 12-1: Lathe Turning Speed Chart

Size of Stock	Rounding	Shaping	Sanding
Up to 2″ dia.	C (950 RPM)	F (1300 RPM)	K (2050 RPM)
2″ to 4″ dia.	B (850 RPM)	E (1150 RPM)	J (1900 RPM)
4″ to 6″ dia.	A (750 RPM)	D (1050 RPM)	H (1600 RPM)
Over 6″ dia.	Slow (700 RPM)	A (750 RPM)	B (850 RPM)

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

SPINDLE TURNING

All spindle turning projects involve these six basic steps:

1. *Mounting.* Mounting the stock on the lathe is an extremely important operation. ***Warning: Improperly mounted stock is dangerous and difficult to turn.***
2. *Rounding.* The first step is to turn the stock down to a rough cylinder.
3. *Sizing.* Once the stock has been rounded, mark the positions of the shapes you want to make and turn them down to their approximate diameters.
4. *Shaping.* Turn the beads (convex curves) and coves (concave curves) in your design.
5. *Sanding.* After the stock is shaped, remove the tool rest and sand the workpiece smooth.
6. *Parting.* After the final sanding, reinstall the tool rest and remove the waste stock (if any) from the turning.

Mounting

To mount stock between the lathe centers, you must first find the center of the stock. To find the center of a square workpiece, use a straightedge and draw two diagonal lines on each end of the workpiece, from corner to corner (Figure 12-21). Where these two

Figure 12-21. *To find the center of a workpiece, draw two diagonal lines from corner to corner. Where the lines intersect marks the center of the stock.*

lines intersect marks the center of the stock. To find the center of a round workpiece, use a center finder.

With a plastic or rawhide mallet, seat the drive center in one end of the workpiece and the cup center in the other. *Caution: Do not hit the centers with a metal hammer—you will ruin them.* Position the center point at the center mark; then hit the center sharply (Figure 12-22). When properly seated, the drive center will leave four slots where the spurs bit into the wood. The cup center will leave a small circle (Figure 12-23). ***Warning: The spurs of the drive center and the circle of the cup center must penetrate into the wood at least 1/16" in order to mount the stock securely on the lathe.***

If you're working with hardwood, drill 1/8" diameter holes, 1/2" deep in the center of both ends of the workpiece, and saw diagonal kerfs 1/8" deep. This will help seat the drive center.

If the workpiece you're turning is more than 3" square, cut off the square corners to form an octagon. This will make the workpiece safer and easier to turn. Use a bandsaw or table saw to cut off the corners.

Mount the drive center on the main spindle and the cup center in the tailstock. Position the power plant so that the centers are about 1" farther apart than the length of the workpiece, and lock the power plant in position. ***Warning: Be sure the speed dial is set on "Slow."***

Wax or soap the end of the stock that mounts to the cup center to help it turn smoothly. Hold the stock against the cup center; then extend the quill and mount the other end on the drive center. Press against the quill feed lever to be sure both the spurs and the cup are engaged. Do not release the tension. Then lock the quill in place (Figure 12-24).

Adjust the height of the tool rest for scraping or shearing, whichever you prefer. Then align the tool rest parallel to the stock within 1/8" to 1/4". Be sure the setscrews in the tool rest assembly are secured. Turn the stock by hand to be sure it clears the tool rest. Make a five-point check. All five locks—power plant, carriage, tool rest height, quill and tailstock—should be secure. The speed should be set at "Slow." Turn on the Mark V. The stock should rotate smoothly, without excessive vibration.

Rounding

Select a gouge and lay it across the left end of the tool rest. The cup should face up and slightly toward the right end of the tool rest. The shank and handle should be pointing down and angled slightly toward the left end of the tool rest. Gently feed the cutting edge toward the stock until the tip just touches the stock. Then draw it slowly and steadily along the tool rest to the right, removing a little bit of the stock (Figure 12-25).

To reverse the cutting action, turn the gouge so the cup still faces up but slightly toward the left end of the tool rest. Feed the gouge into the stock and draw it back along the tool rest to the right. Repeat this procedure until the stock is completely round, without any flat spots.

To tell if there are any flat spots without turning off the machine, carefully let the shank of the qouge rest on the revolving stock (Figure 12-26). If the gouge vibrates or jumps up and down, the stock is not quite round. ***Warning: Round all stock at "Slow" speed and never remove too much stock too quickly.***

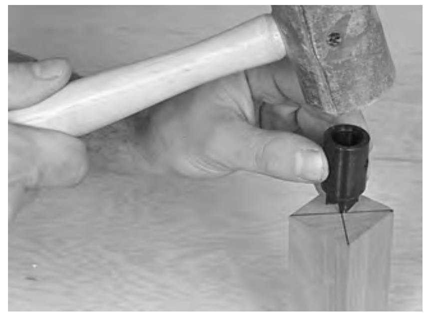


Figure 12-22. *With a mallet, seat the drive center in one end of the workpiece and the cup center in the other.*

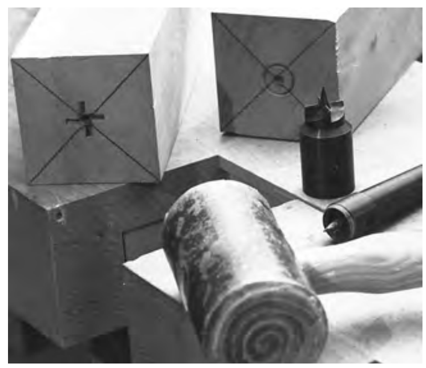


Figure 12-23. *When properly seated, the drive center will leave four slots in the stock as shown on the left, and the cup center will leave a small circle as shown on the right. The centers should penetrate into the stock at least 1/16".*

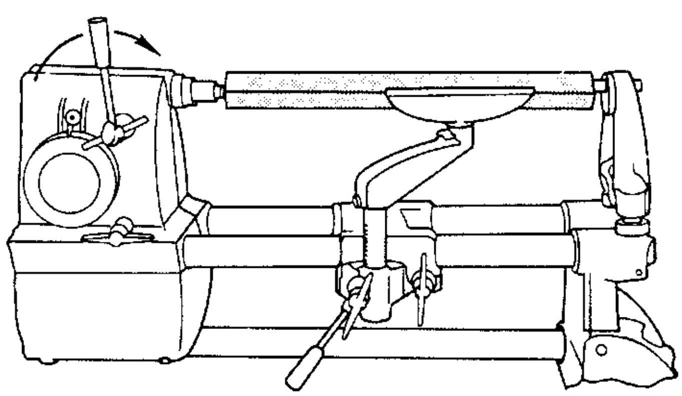


Figure 12-24. *Advance the quill to mount the stock between the centers. Press against the quill feed lever to be sure that both the drive center and the cup center are engaged.*

Figure 12-25. Round a workpiece with a gouge. As shown here, the gouge is being used to cut.

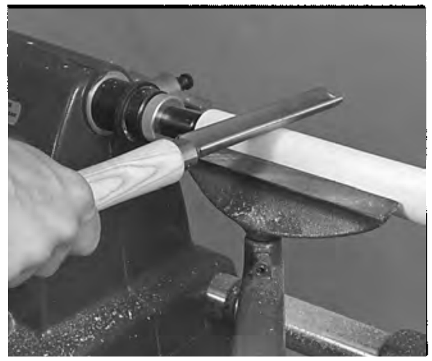


Figure 12-26. To tell if the stock is round without turning off the lathe, lay the shank of the gouge across the revolving stock. If the gouge vibrates or jumps up and down, the stock is not quite round.

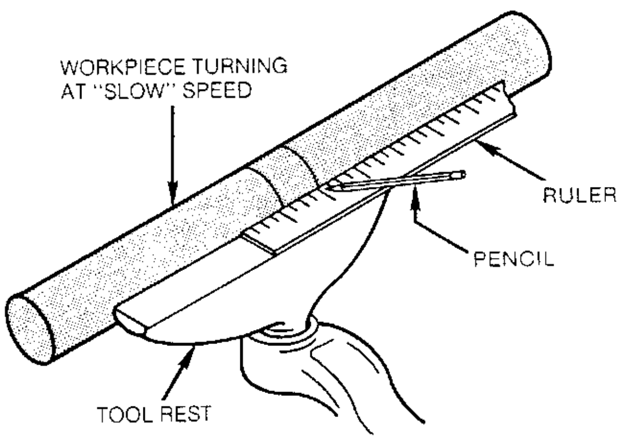


Figure 12-27. With a pencil, scribe lines on the revolving stock to indicate where you want the beads, coves, and other parts of your spindle design to begin and end.

Figure 12-28. With a parting tool, cut grooves in the workpiece to indicate the position and diameter of the different shapes in your design. Sizing cuts are usually made by scraping as shown.

Sizing

Once the stock has been rounded, "size" the stock, marking the various diameters of the beads and coves you want to cut.

Use a pencil and a parting tool for this operation. With the pencil, scribe lines on the revolving stock to indicate where you want the beads, coves, and other parts of your spindle design to begin and end (Figure 12-27).

With a parting tool, cut grooves in the workpiece to indicate the position and diameter of the different shapes in your design (Figure 12-28). To gauge when you've reached the proper diameter, set a pair of "outside" calipers at the desired measurement and test the diameter where you're cutting from time to time. When the calipers just slip over the stock at the bottom of the groove, you've arrived at the desired diameter (Figure 12-29).

Shaping

When you've marked the positions and diameters of the various parts of your design, begin to cut the shapes. Usually, it's easiest to start with the convex curves or beads.

Select a skew chisel to round the sides of the beads. Feed the edge of the chisel slowly into the stock; then move the handle of the skew from side to side as needed to shape the bead (Figure 12-30).

After you've made the beads, begin to cut the coves, the concave curves in your design. Select a gouge and slowly feed it into the workpiece, gradually removing stock. As you did when you were shaping the beads, move the handle of the tool from side to side

Figure 12-29. To gauge when you've reached the proper diameter, set a pair of "outside" calipers at the desired measurement. When the calipers just slip over the stock, you've arrived at the desired diameter.

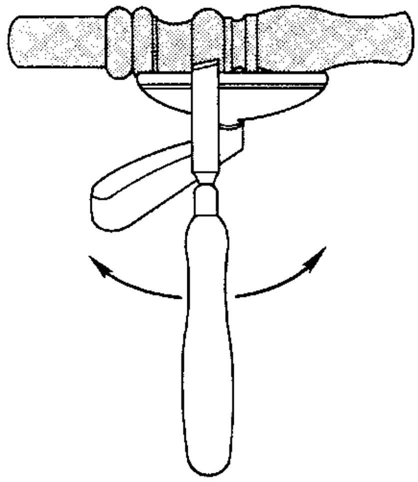


Figure 12-30. Begin shaping the stock by cutting the beads. As shown, a skew chisel is being used to scrape the round contour of a bead.

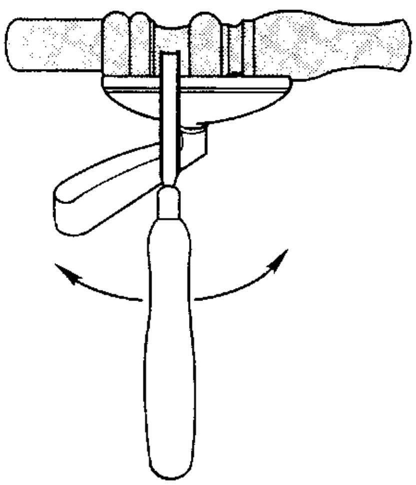


Figure 12-31. With a gouge, cut the coves in the stock. Move the handle from side to side to shape the cove. As shown, the tool is being used to scrape away stock.

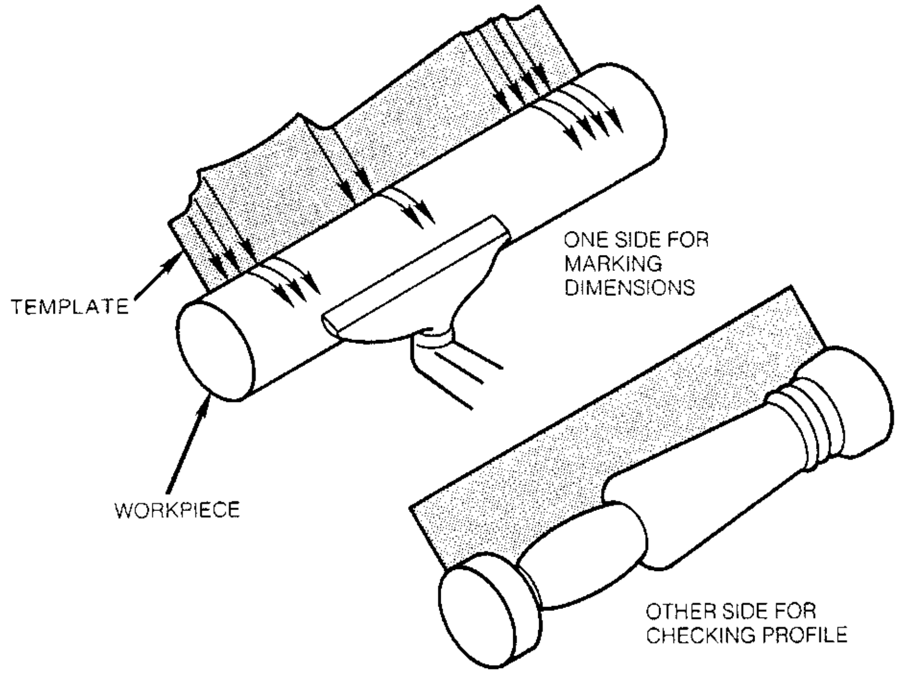


Figure 12-32. A hardboard template can be made for marking dimension lines and for checking profiles as you do the shaping. This is a good method to use when you need duplicate pieces.

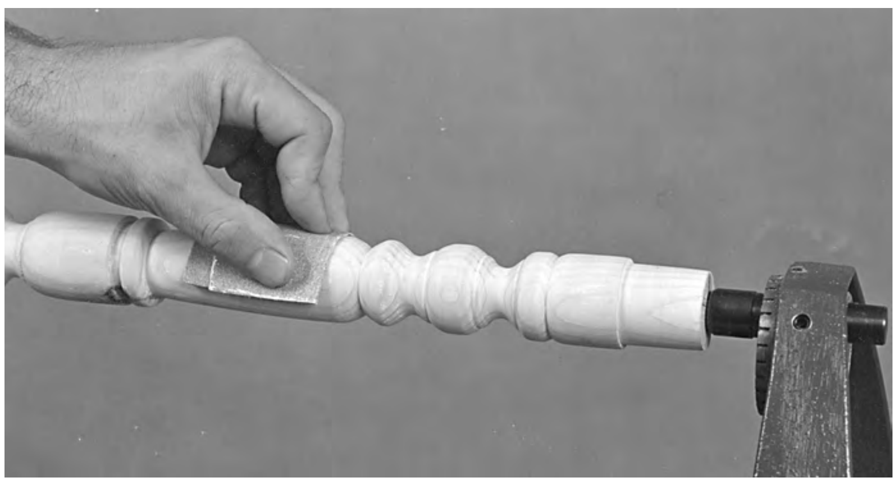


Figure 12-33. As you sand on the lathe, double the sandpaper over several times to protect your fingers.

to shape the cove the way you want it (Figure 12-31).

When forming duplicate pieces, for example, chair or table legs, it's better to work with a hardboard template (Figure 12-32). The template is a full-scale, half-profile of the part and can be used to check the turning as you go, as well as for marking initial dimension points.

Although woodworkers usually rely on skew chisels to cut beads and gouges to cut coves, you can use other tools if you wish. Select whatever seems best for you.

Sanding

It's much easier to sand a turning on the lathe than it is to remove it and hand sand it. However, since you have to get your fingers right next to the spinning stock, you must be extremely careful.

When the turning has been completely shaped, turn off the machine and let it come to a complete stop. ***Warning: Remove the tool rest before sanding a turning on the lathe.*** Turn on the machine and slightly increase the speed of rotation. Starting with medium (80#) sandpaper, begin to sand the spindle by holding the sandpaper lightly against it (Figure 12-33). Double the sandpaper over several times for two reasons: The paper heats up quickly and extra layers of paper protect you from being burned. Also, the extra layers of paper keep your hands from contacting the rotating spindle.

Work your way through progressively finer grits of sandpaper until you get the spindle as smooth as you want it. ***Warning: Never wrap the sandpaper entirely around the spindle or allow strands to wrap around the spindle. The spindle will grab the sandpaper or strand and draw your fingers into the rotating spindle.***

Because sanding a spindle on the lathe usually requires you to sand across the grain, tiny "feathers" will develop on the surface of the spindle. There are two ways to remove these. The easiest is to wet the spindle with a damp rag, wait a few minutes for the water to dry and raise the wood grain, then give the spindle a final sanding with a very fine grit sandpaper.

If you don't want to wet the wood, turn the Mark V off and dismount the spindle. Remove the centers and seat them in opposite ends of the spindle. Remount the spindle, putting enough pressure on the quill to engage both the drive center and the cup center. This reverses the rotation of the spindle so that you can remove any microscopic feathers with a light sanding.

Here are several other lathe sanding tips: The Mark V sanding disc is a super tool to use when smoothing uniform cylinders or tapers (Figure 12-34). Another trick used by professionals is shown in Figure 12-35. After the workpiece has been smoothed by sanding, hold a strip of wood against the workpiece as it is turning. The result will be a hard, burnished surface that is fine for a natural finish but will not take a stain.

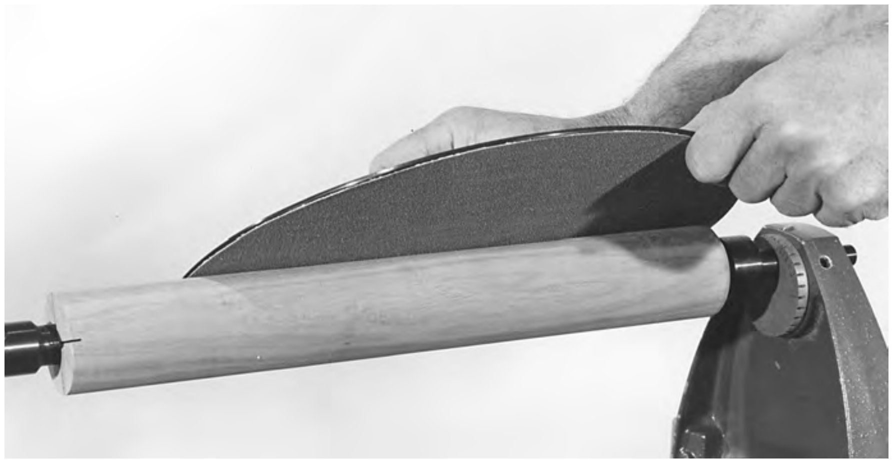


Figure 12-34. *The sanding disc provides plenty of flat, abrasive surface for smoothing uniform or tapered cylinders.*

Figure 12-35. *A lathe turner's trick. Smooth turnings with a strip of wood. You get a burnished surface.*

Parting

After the spindle is sanded, part the spindle from the waste stock. Using the parting tool turned on its edge, scrape away stock from either end of the spindle until the diameter is as small as it can safely go and still not break (Figure 12-36). ***Warning: Never part the stock completely or turn the spindle down to such a small diameter that it snaps on the lathe.*** Always remove the spindle from the lathe and finish cutting off the waste stock with a saw (Figure 12-37).

Figure 12-36. *After the spindle is sanded, use the parting tool to partially separate the spindle from the waste stock. Be careful not to part the stock completely.*

FACEPLATE TURNING

Faceplate turning is similar to spindle turning in some respects, but very different in others. We'll point out those differences as we go through this basic procedure. As with spindle turning, faceplate turning also involves six basic steps: Mounting, rounding, sizing, shaping, sanding and parting.

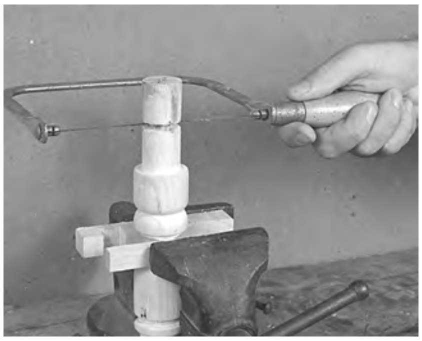


Figure 12-37. *When the stock has been partially parted, remove the spindle from the lathe and finish cutting away the waste with a saw or bandsaw.*

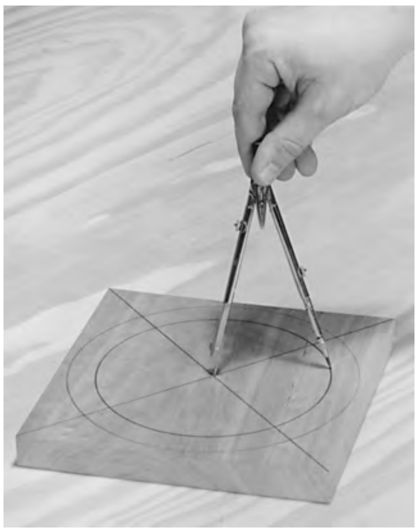


Figure 12-38. *Prepare stock for faceplate mounting by scribing the outside diameter of your project and a circle slightly larger than the faceplate on the surface.*

Figure 12-39. *Cut the workpiece into a circle to make turning it safer and easier.*

Mounting

To mount stock on a faceplate, first find the center of the stock by drawing diagonal lines from corner to corner. Then scribe the outside diameter of your project (the diameter desired after rounding) on the stock. Also, scribe a circle slightly larger than the diameter of the faceplate in the center of the circle you've already marked (Figure 12-38). Then cut the stock round using a bandsaw or scroll saw (Figure 12-39). This removes excess stock which makes turning safer and easier.

If you don't want screw holes in the bottom of your finished project, you can mount the turning stock to another block of wood; then mount this block to the faceplate. Select a scrap block at least 1" thick and about the same diameter as the faceplate you'll be using. Find the center of this scrap block; then glue the block to the turning stock, center-to-center. Put a piece of paper (brown craft paper or grocery sack) in between the block and the turning stock (Figure 12-40). ***Warning: Leave the pieces clamped for at least 24 hours prior to turning.*** Later on, this paper will make it easier for you to part the scrap block from the turning.

After the glue has set up completely (at least 24 hours), mount the scrap block to the faceplate with three #12 × 1-1/4" wood screws. ***Warning: Be sure the screws penetrate into the block at least*** **3/4"*.*** For large, bulky faceplate turnings use longer screws and a thicker scrap block.

Be sure the speed dial is set on "Slow." Then mount the faceplate on the main spindle of the Mark V (Figure 12-41). Position the tool rest to turn the outside of the workpiece first. When the tool rest is properly positioned and the setscrews secured, turn the workpiece by hand to make sure it doesn't scrape against the tool rest. Make a four-point check. All four locks — power plant, carriage, tool rest height, quill— should be secure. The speed should be set at "Slow." Turn on the Mark V and slowly turn the speed dial to the recommended speed for the operation. The stock should rotate smoothly, without excessive vibration.

Rounding

Round the outside diameter first. Use a gouge, just as you would for spindle turning, with this one exception: If the wood grains are perpendicular to the axis of rotation, do not attempt to shear. Scrape the workpiece round (Figure 12-42). Trying to shear will tear out large chunks of the stock.

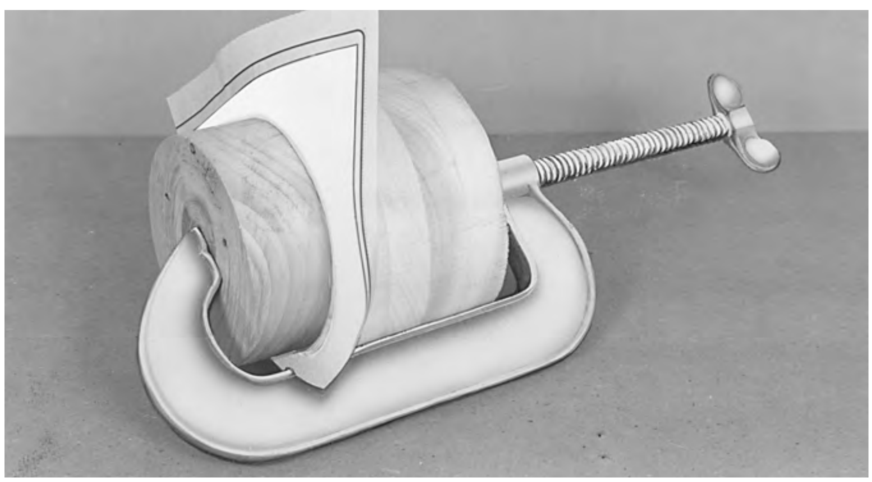


Figure 12-40. *Glue a scrap block and your turning stock together, center-to-center. Put a piece of paper (brown craft paper or grocery sack) between them as shown.*

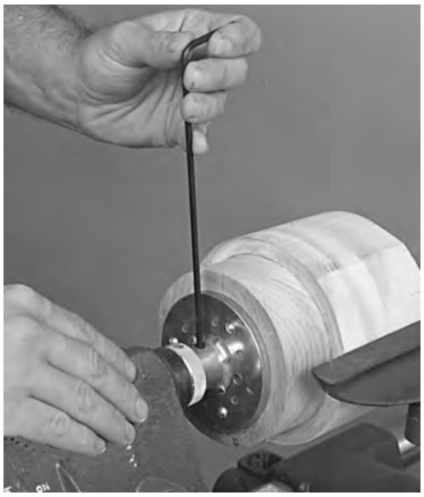


Figure 12-41. *Mount the faceplate (with the scrap block and turning stock attached) on the main spindle of the Mark V.*

Figure 12-42. *Before rounding a faceplate turning, check which way the wood grain runs. If the grain is perpendicular to the axis of rotation, do not attempt to shear. Scrape the workpiece round as shown.*

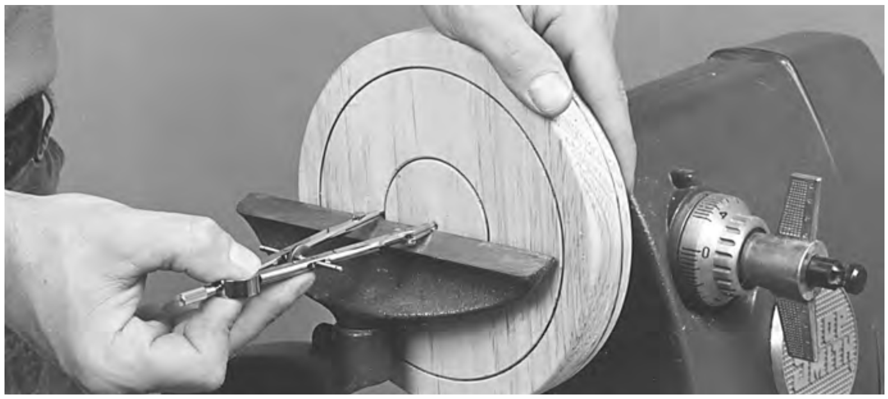


Figure 12-43. *Use dividers or a compass to mark concentric circles. A light touch is in order.*

Figure 12-44. *A marking gauge can be used to mark dimension lines on the perimeter of the workpiece.*

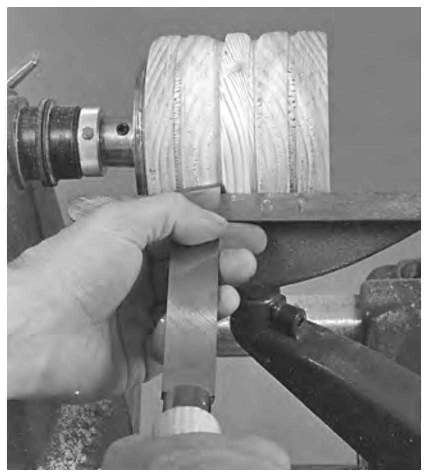


Figure 12-45. *Turn the outside of your workpiece first. Remember: If the wood grain is perpendicular to the axis of rotation, use a scraping action.*

Shearing only works well when the wood grain is parallel to the axis of rotation.

Sizing

After the workpiece has been rounded, it should be marked to show the limits and the depth of shapes you wish to produce. With the machine turned off, work with dividers or a pencil compass to mark concentric circles (Figure 12-43), but be sure to use the tool rest for support. Use a light touch. You can use a marking gauge to mark dimension lines on the perimeter of the workpiece as shown in Figure 12-44.

Shaping

Most woodworkers prefer to turn the outside first (Figure 12-45). Make your beads and coves in the same manner as you would for spindle turning. If the wood grain is perpendicular to the axis of rotation, scrape the desired shape in the outside of the workpiece.

When you get ready to turn the inside of the workpiece, turn the machine off. Let it come to a complete stop; then reposition the tool rest at 90° to the axis of rotation, about 1/4" in front of the workpiece. Adjust the height so that it's about 1/4" below the center of the workpiece.

No matter what the orientation of the wood grain, scraping is the only way to shape the inside of a faceplate turning. This is slow work, so have patience. Select a roundnose chisel, turn on the lathe, and slowly feed the chisel against the "down" side of the stock (Figure 12-46).

When doing deep hollowing jobs, keep adjusting the tool rest to provide good chisel support even if it means partially inserting the tool rest in the hollow being formed

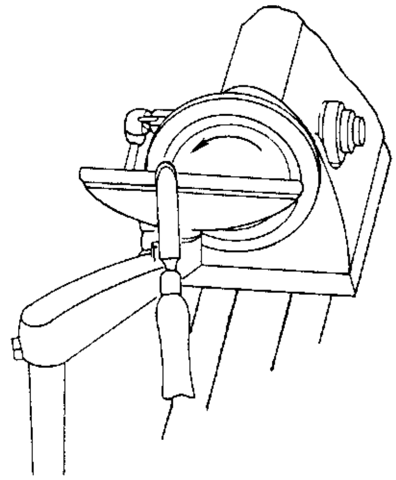


Figure 12-46. *To shape the inside of a faceplate turning, position the tool rest in front of the stock, just below the center. Feed your chisels against the "down" side of the workpiece. This will help hold the tool against the tool rest.*

Figure 12-47. *Always place the tool rest so the chisel will have maximum support even if on hollowing jobs it means inserting the tool rest into the cavity being formed.*

Figure 12-48. *Use "inside" calipers to periodically check the inside diameter of your turning so that you don't scrape away too much stock.*

(Figure 12-47). As you continue the hollowing operation, periodically check the inside diameter of the turning with "inside" calipers so that you don't scrape away too much stock (Figure 12-48). Stop scraping whenever you've removed as much stock as you want to cut away. Figure 12-49 shows a gauge you can make to check the depth of hollowing cuts. It's just a dowel that passes through a hole in a "beam" and which is locked in place with a setscrew. Cut depths can also be checked by placing a straightedge across the face of the workpiece and then measuring from it to the bottom of the cavity.

Templates, like those described for spindle turnings, can also be made for faceplate work (Figure 12-50). One side of the template is used to mark dimension points, the other side has the checking profile that you use to gauge the cuts you make. Templates are always a good idea when you must turn duplicate pieces.

Figure 12-49. *You can make a simple gauge to check the depth of cut on hollowing jobs.*

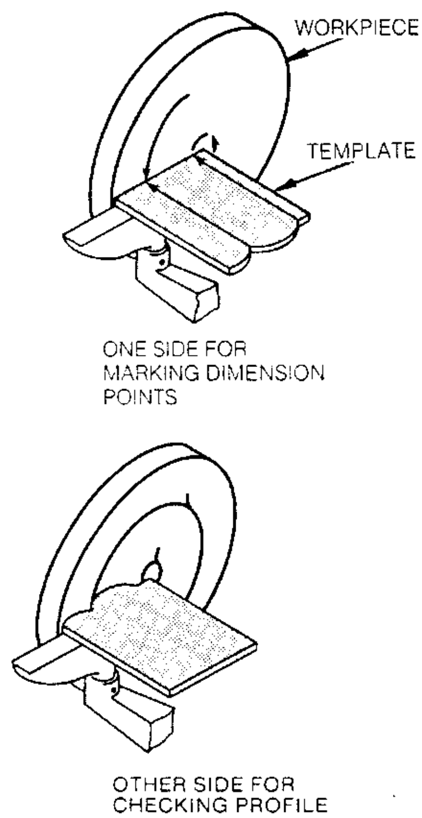


Figure 12-50. *A full-sized template can be used to mark dimension points and to check the profile.*

Figure 12-51. *Remounting the faceplate on the upper auxiliary spindle reverses the direction of rotation so that you can sand the "feathers" off the turning.*

Sanding

When you've finished shaping the turning, turn off the machine and let it come to a complete stop. ***Warning: Remove the tool rest before sanding a turning on the lathe.*** You can remove the feathers either by wetting the wood or by removing the faceplate from the main spindle and remounting it on the upper auxiliary spindle (Figure 12-51). This reverses the direction of rotation.

Parting

To part a faceplate turning, first dismount the faceplate from the Mark V spindle and unscrew the faceplate from the scrap block. Clamp the scrap block in a vise and place a bench chisel against the joint between the block and the turning (where you've put the paper). Sharply rap the chisel with a mallet, driving it in between the block and the turning (Figure 12-52). The turning will part from the scrap block. Sand any paper or excess glue off the turning.

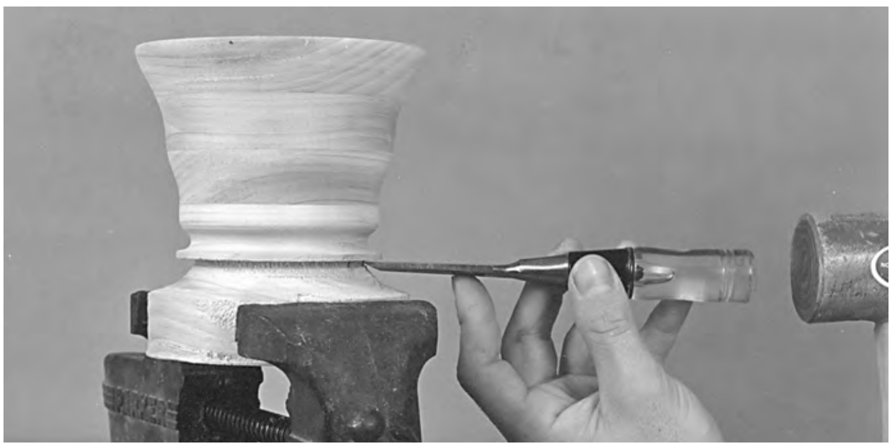


Figure 12-52. *Part the turning from the scrap block by driving a bench chisel in between the block and the turning.*

OTHER SPECIAL TECHNIQUES

There are many special techniques that can be performed on the lathe. Let's take a look at some of the simplest:

Screw Center Work

Workpieces that are too small to be mounted on a faceplate or not long enough to be fitted between centers can be set up for turning by using a screw center (a device that is mounted on the Mark V main spindle). Find the center of the workpiece and start a hole for the screw by using an awl or by drilling. Mount the workpiece by threading it on the screw center (Figure 12-53). The technique makes it possible to shape small items like drawer or door pulls, finials or small posts (Figure 12-54).

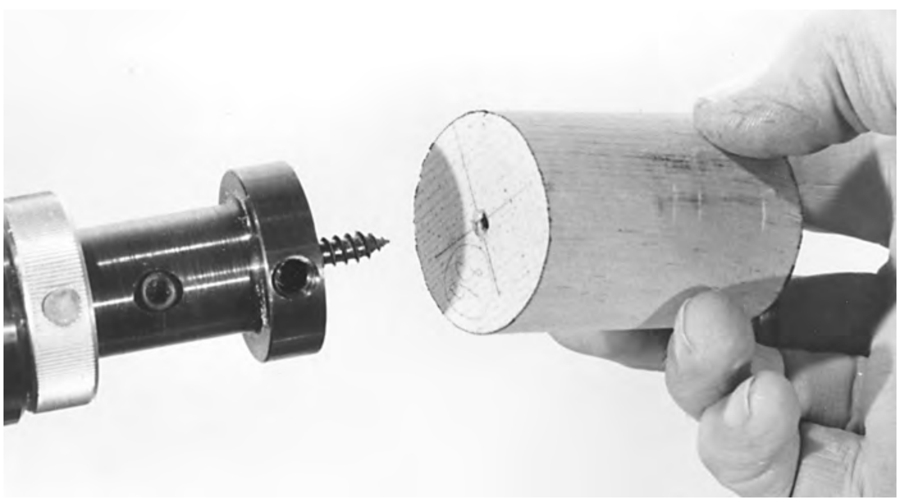


Figure 12-53. *Small workpieces can be turned by mounting them on a screw center. Be sure there are no chips between the workpiece and the screw center's front face.*

Extra-Long Work

When a project is longer than the spindle capacity of the lathe, it can

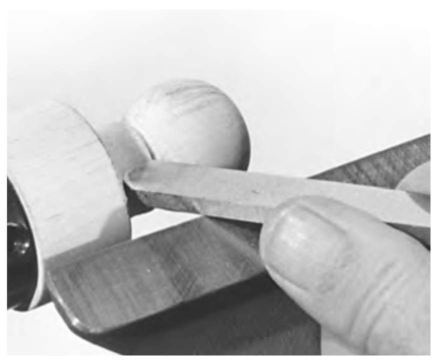


Figure 12-54. *Turning is accomplished in normal fashion. On jobs like this it's best to use carbide-tipped tools since they have smaller cutting profiles than conventional tools.*

be turned as separate pieces that are then joined in the manner shown in Figure 12-55. The tenon on the one piece can be formed while the part is on the lathe. Drill a matching hole in the mating piece; then put the parts together with glue. Use a lockwedge, if you wish, to reinforce the joint.

The same idea applies when you join a faceplate turning to a spindle turning (Figure 12-56).

Glued-Up Stock

When a large diameter is required in one area of the turning, two methods are used to prepare the stock (Figure 12-57). In one, start with oversized stock and use a jointer or bandsaw to reduce the stock before it is mounted on the lathe. ***Warning: Glue the stock and leave it clamped for at least 24 hours prior to turning.***

In the other, glued blocks are used to build up the larger diameter. The mating surfaces must be perfectly flat and true for a perfect joint if the final turning is to resemble a solid piece of wood.

When solid stock large enough for a deep bowl or similar project is not available, stock may be glued together (Figure 12-58). Or rough-cut rings may be glued onto a solid base. This method saves a lot of material since the cutout discs may be used in other ways. Figure 12-59 shows rings cut for a project that will have straight sides. If the sides are to slope or taper, the rings should vary in size. The important thing is a good glue job so the stock will hold together with just a faint line showing on the finished item.

You can produce intriguing lathe projects with an inlaid ap-

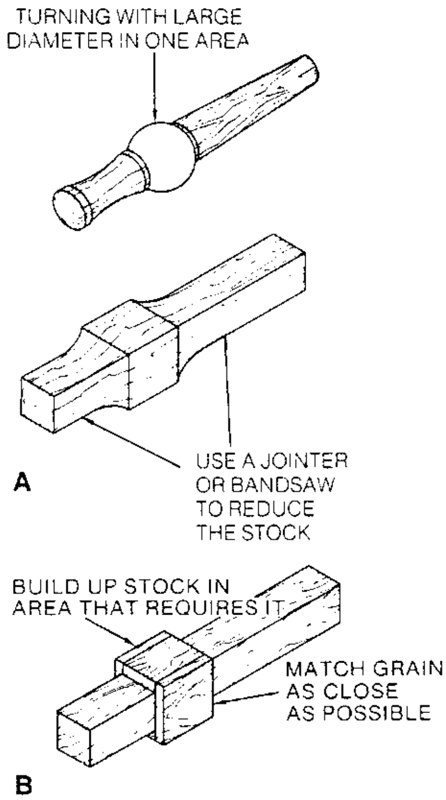


Figure 12-57. *When a large diameter is required in one area of the turning, either (A) reduce the stock or (B) build up the stock.*

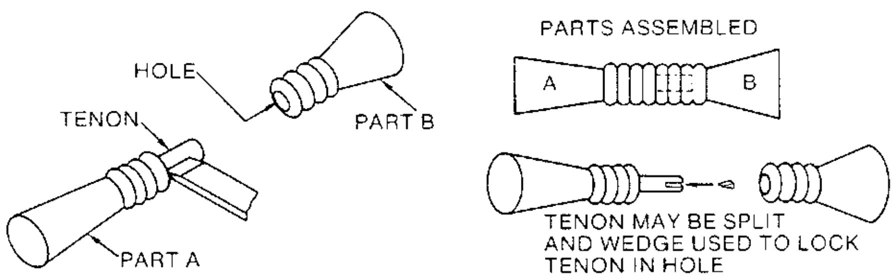


Figure 12-55. *Extra-long lathe projects can be produced if you turn separate pieces and then connect them as shown here.*

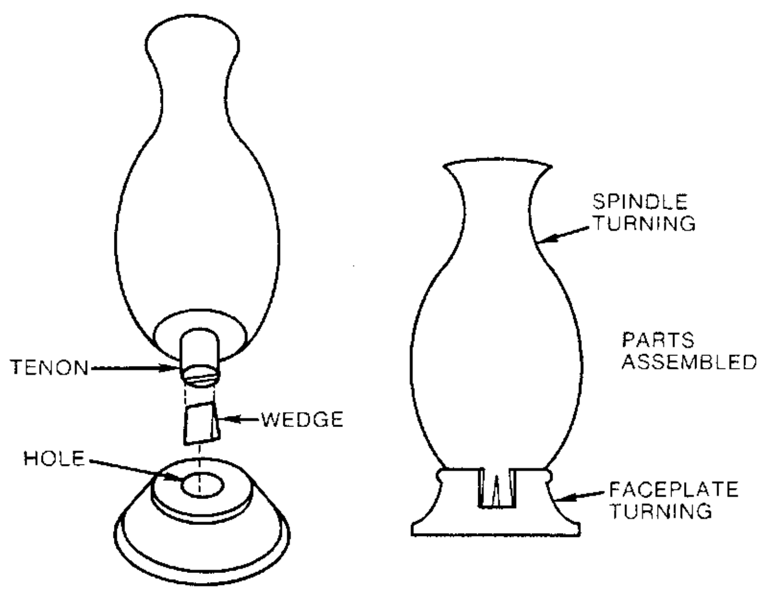


Figure 12-56. *The same idea will work when you need to connect a spindle turning to a faceplate turning.*

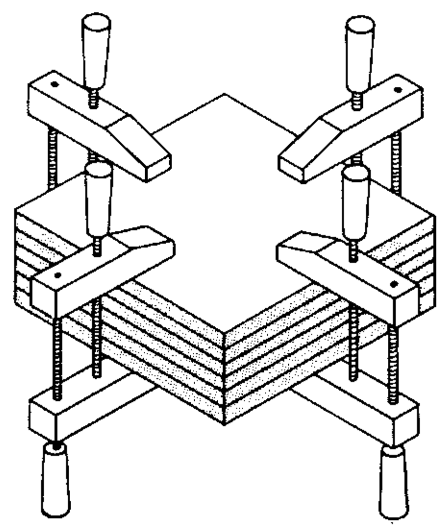


Figure 12-58. *Make a large turning block by laminating pieces of stock. The laminations can be of contrasting wood.*

pearance when you prepare the base stock by gluing together pieces of contrasting wood. The initial blocks can be prepared for either spindle turning (Figure 12-60) or faceplate turning (Figure 12-61). The blocks won't look like much to start; the appealing effects occur when the turning is complete. It's not easy, but try to visualize the results as you plan the initial block assemblies.

Select wood not only on the basis of color contrast, but also for similarity in density. Good combinations to try are maple with rosewood, and holly or birch with cherry, walnut, or mahogany.

Split Turnings

Split turnings are lathe projects that end up as half-round, shaped columns. Using the paper-glue-joint method shown in Figure 12-62, two pieces of wood will produce identical half-round moldings. Four pieces of wood, paper-glued to a central core piece, will separate as elliptical moldings. Four pieces of wood, assembled as a solid block, will become four pieces of quarter-round molding.

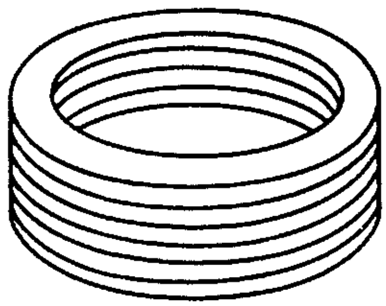


Figure 12-59. Speed up shaping a deep bowl by gluing precut rings to a solid base.

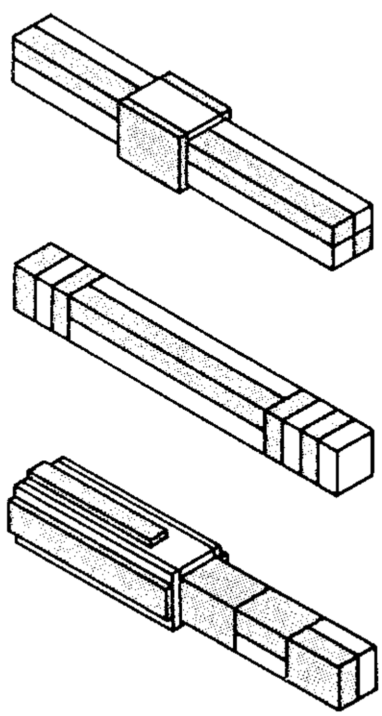


Figure 12-60. You can get interesting inlaid effects if you prepare a turning blank by gluing together pieces of contrasting wood. It's not easy to do, but try to visualize the end result.

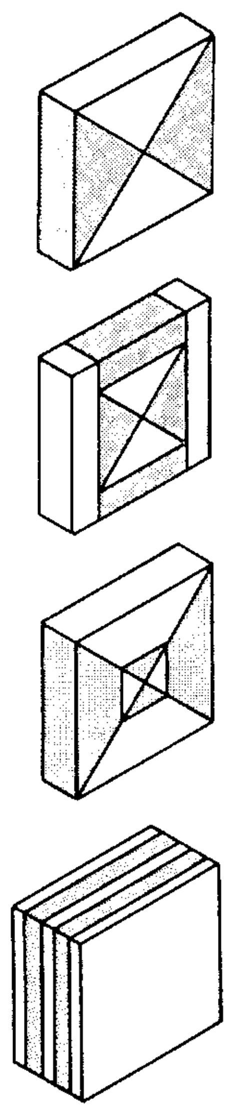


Figure 12-61. The same idea applies to faceplate work. A good glue job is critical.

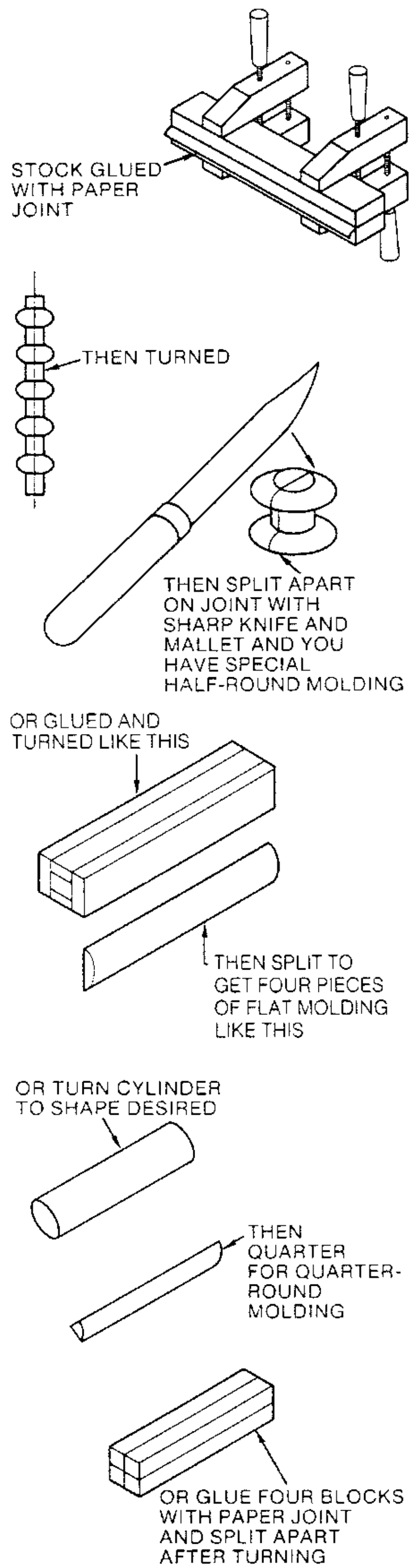


Figure 12-62. Here are other ways you can prepare stock for split turning. Oval moldings and even quarter-rounds are possible.

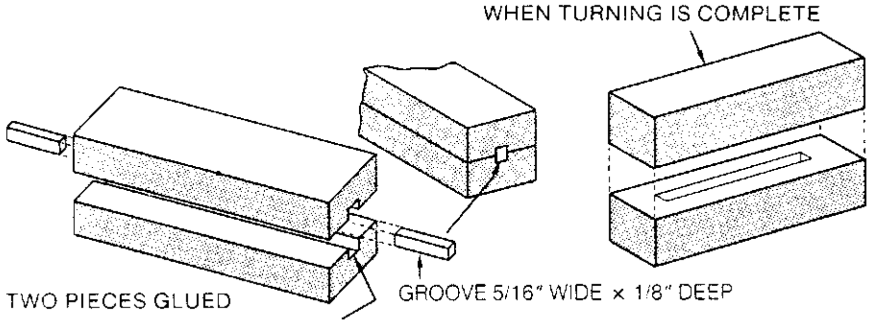


Figure 12-63. *You can prepare stock this way when you need a lathe turning with a center hole such as a lamp base.*

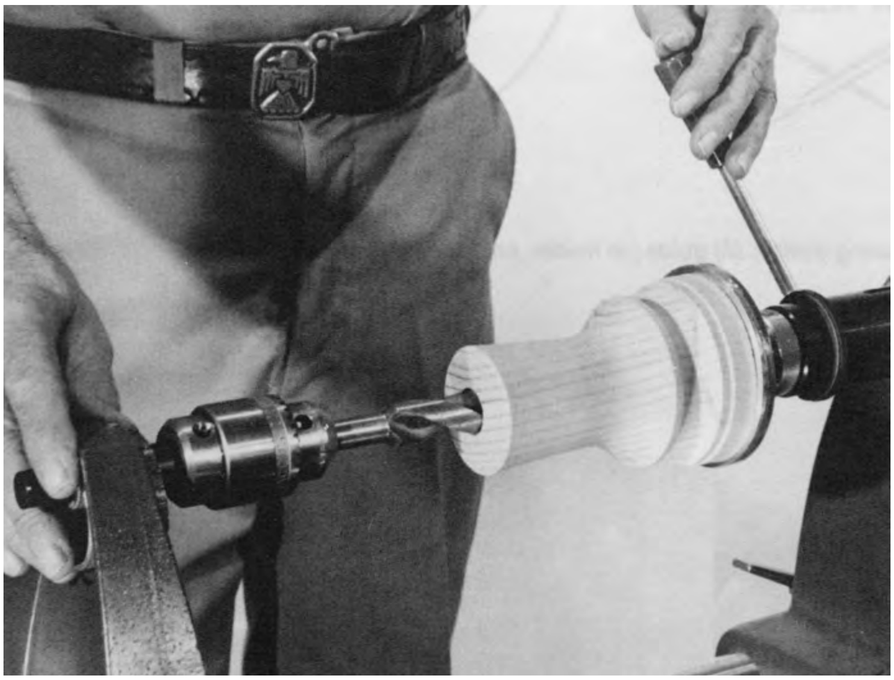


Figure 12-64. *The drill chuck grips the bit. The workpiece, while turning, is quill fed against the bit to form the hole.*

Warning: Glue the stock and leave it clamped for at least 24 hours prior to turning.

Procedures like this are useful when a special molding is needed or when you need a particular hardwood molding that isn't available.

Through Holes

The two methods shown in Figure 12-63 can be used to prepare stock for projects like lamp bases before the material is mounted for lathe turning. Cut grooves in the center of the stock. A groove about 7/16" wide by 7/32" deep in each piece will do for lamp cords.

Glue the pieces together and use keys to plug the opening at each end. When the turning is complete, open the grooves by boring holes at each end of the turning.

Accurate center holes, of limited length when using conventional bits or much deeper when working with extra-long bits or extension bits, can be formed by mounting the drill chuck on the tailstock. Figure 12-64 shows the technique being used to form a socket hole in a small candle stand. The procedure is the opposite of normal boring. Here, the drill bit is stationary; the workpiece turns.

Other methods of forming through holes in round or square work are described in Chapter 11.

Indexing

Some lathe projects, like wheel hubs, require radial holes that are equally spaced about their circumference. A good way to do such work accurately is to use an indexing device. The plans for one that you can make and which is mounted on the Mark V's upper auxiliary spindle is shown in Figure 12-65. Make the guide pin holder first. Then drill holes in the power plant cover and mount the holder as shown in Figure 12-66. Drilling holes in the power plant cover will not damage the machine. You must situate the holder so the guide pin and the spindle have a common vertical centerline.

The indexing disk, which is the control that positions a project for drilling, is made next. After the disk is cut out and rounded, mount it on a small faceplate. Then secure the faceplate on the auxiliary spindle (Figure 12-67). Push the guide pin forward so it will mark the disk. This will establish the radius of the circle on whose circumference the guide holes must be drilled. Make a layout and drill the holes. The plans suggests a spacing of 22-1/2°, but you can increase or decrease it.

A typical use for the indexing device and a drill guide are shown in Figure 12-68, where the hub for a wheel is being drilled for spokes. For example, if the hub is to have eight spokes, lock the indexing device at any point and drill the first hole. Turn the indexing device

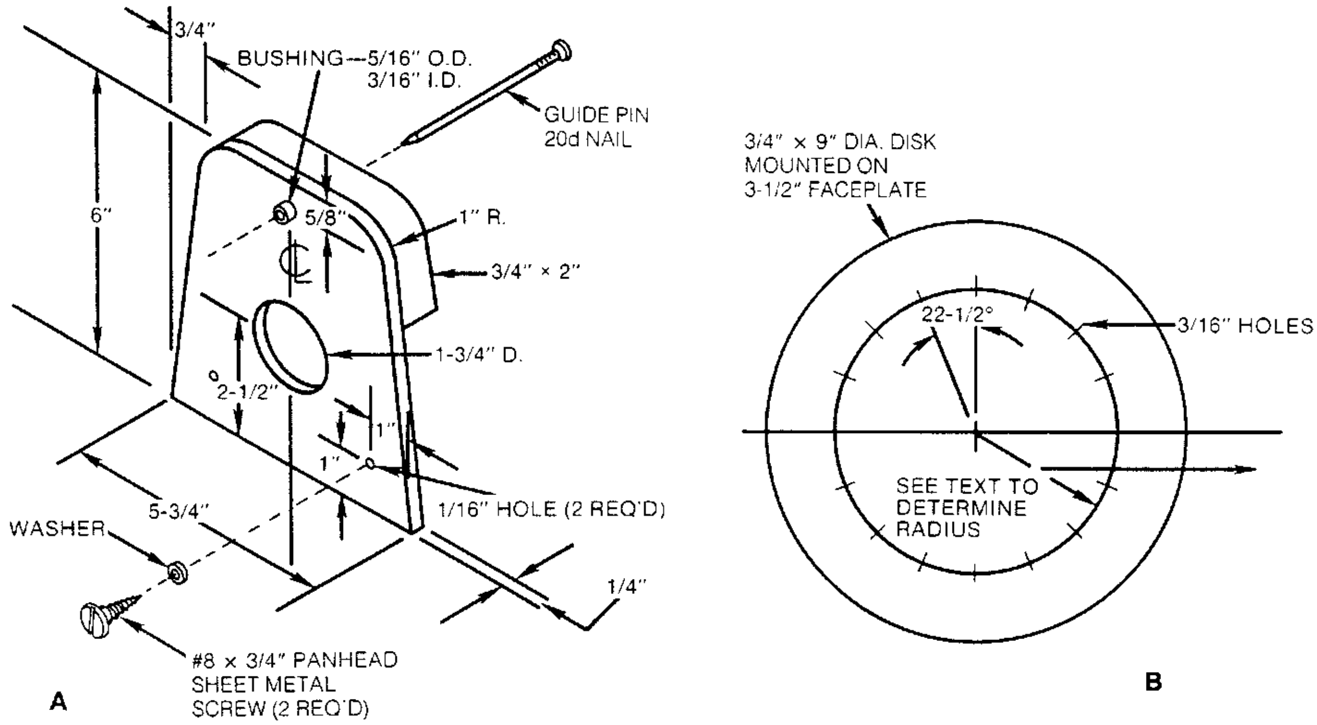


Figure 12-65. *Construction details of an indexing device, (A) guide pin holder, and (B) indexing disk.*

Figure 12-66. *The guide pin holder is mounted this way. Drilling mounting holes in power plant cover will not damage the machine. Be sure the guide pin and the auxiliary spindle have a common vertical centerline.*

Figure 12-67. *The indexing disk is mounted on a faceplate which locks on the upper auxiliary spindle. When the disk is engaged by the guide pin, lathe-mounted work will be held in a fixed position.*

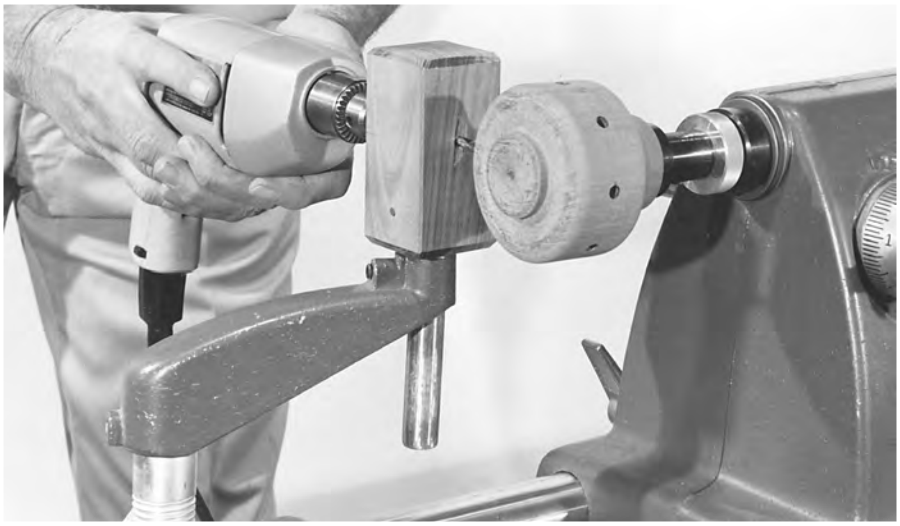


Figure 12-68. A typical application for the indexing device. It positions work so radial holes can be equally and automatically spaced. The drill guide keeps the bit square to the workpiece.

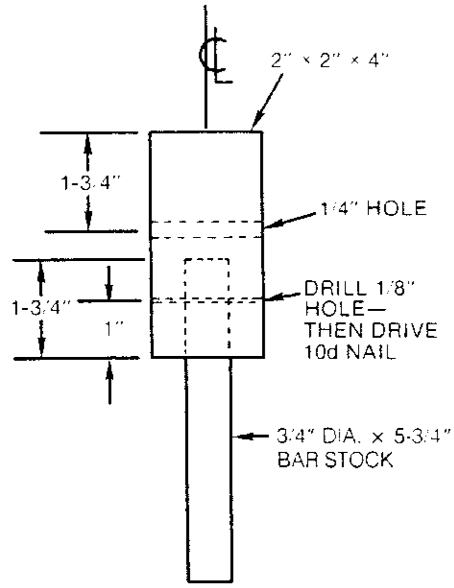


Figure 12-69. Construction details of the drill guide.

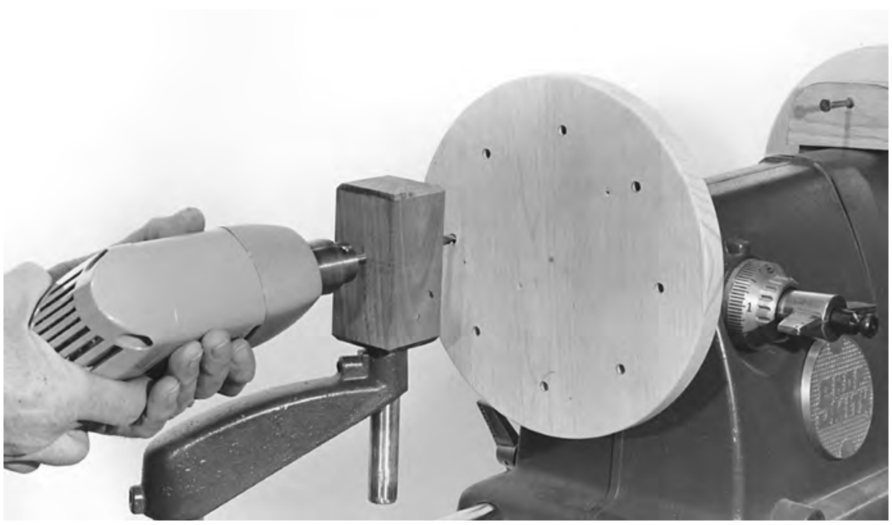


Figure 12-70. The indexing device and the drill guide can also be used to automatically space surface holes. The drill guide can also serve as a stop to gauge hole depth.

45°, lock it with the pin, and drill the second hole. Turn the indexing device 45° for each hole until all are drilled. If the wheel needed four spokes, the device would be turned 90° to establish each hole position.

The drill guide, made as shown in Figure 12-69, is mounted in the tool rest arm and positioned so the bit will be square to the work and so its point will be on the work's horizontal centerline.

Indexing, as shown in Figure 12-70, can also be used to gauge the spacing of surface-drilled holes. The drill guide can do double-duty. When you position it correctly, it will act as a stop to gauge hole depth.

Turning Small Components

Model makers will find a dowel turning fixture almost indispensable for small turnings like headlights, wheel hubs, rims, capstans, deadeyes for boat and automobile models, and for making components for miniature furniture.

A good feature of the dowel turning fixture, shown in Figure 12-71, is that it allows mounting of a long piece of dowel that is gripped for turning with the drill chuck that substitutes for the usual drive center. The bolt acts as a tool rest. The table to which the fixture is clamped, or the power plant is moved to position the dowel for each new turning. The dowel doesn't have to be cut until several individual parts have been formed.

To make the dowel turning fixture follow the plans in Figure 12-72. The plans show three sizes of holes, but you can accommodate other sizes of dowels merely by drilling additional holes.

Figure 12-73 shows the relationship between the dowel turning fixture and a turned dowel. It's a good idea to coat the dowel with paste wax to minimize friction where the dowel turns in the block.

The dowel turning fixture can also position tiny work for concentric drilling. If the work is very tiny, it can be gripped in a router chuck locked on the main spindle.

Turning Ovals

The most important part of turning a cylinder into an oval shape is the

Figure 12-71. A dowel turning fixture makes it easy to turn small parts from dowel stock.

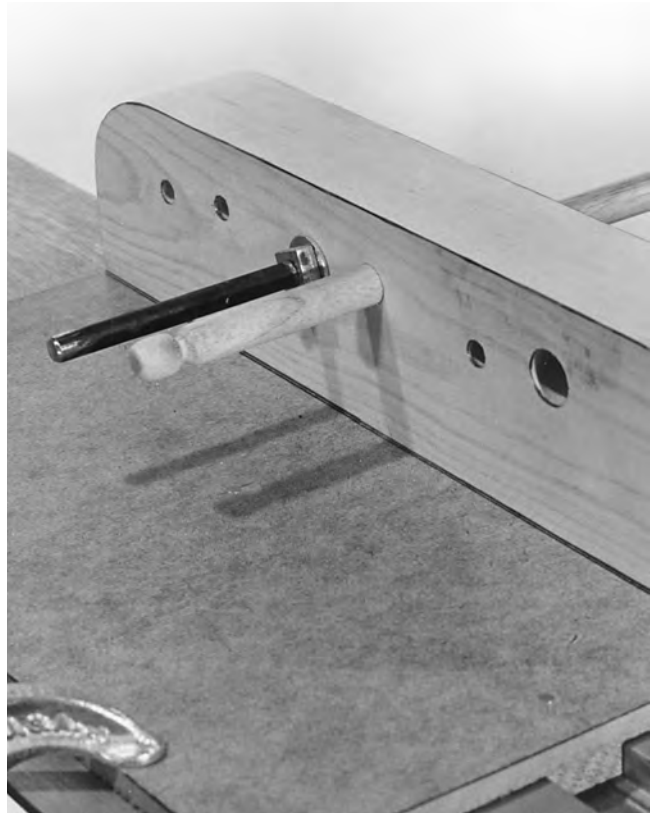


Figure 12-73. The bolt, which is part of the dowel turning fixture, serves as a tool rest. Apply paste wax to the dowel so it can turn with minimum friction.

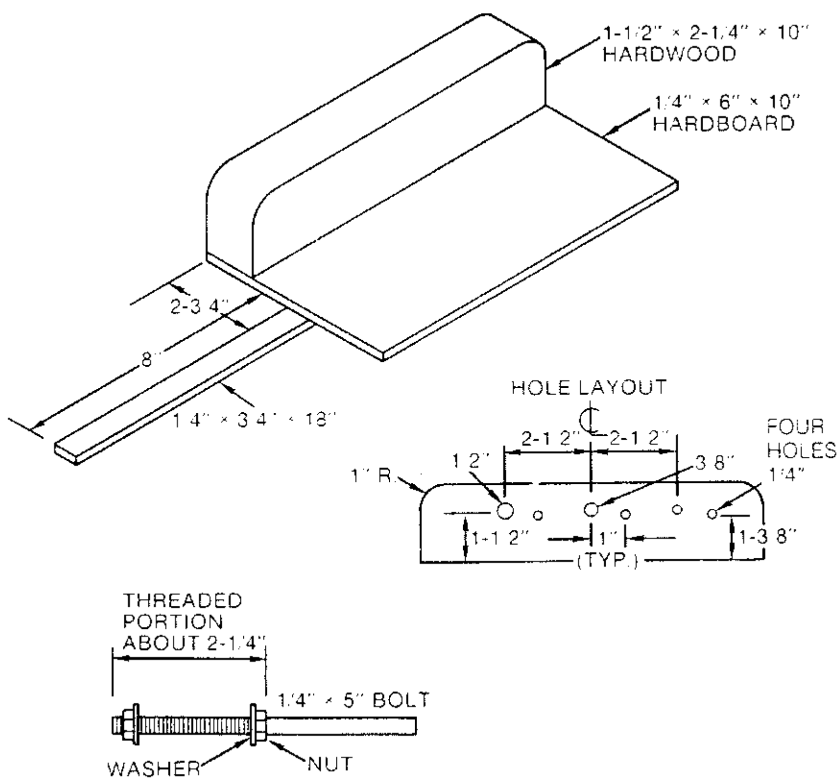


Figure 12-72. Construction details of the dowel turning fixture for 1/4", 3/8", and 1/2" dowels. Additional holes for other sizes of dowels can be drilled.

initial layout on the ends of the stock.

First make an accurate template for locating the true center and the two off centers (Figure 12-74). If the ridge line is located first, it is easy to position the template at the ends of the stock and mark the centers with an awl.

Turn the work on true center until it is round. Re-mark the ridge line.

Mount the work on one of the off centers. Turn it until the cut nears the ridge line. Now it's round on one side, oval on the other.

Mount the work on the remaining off center; turn it down to the ridge line. Now the work is oval. Sand it as illustrated in Figure 12-75.

Turning Spirals

Spiral forming is classified as a lathe job even though most of the

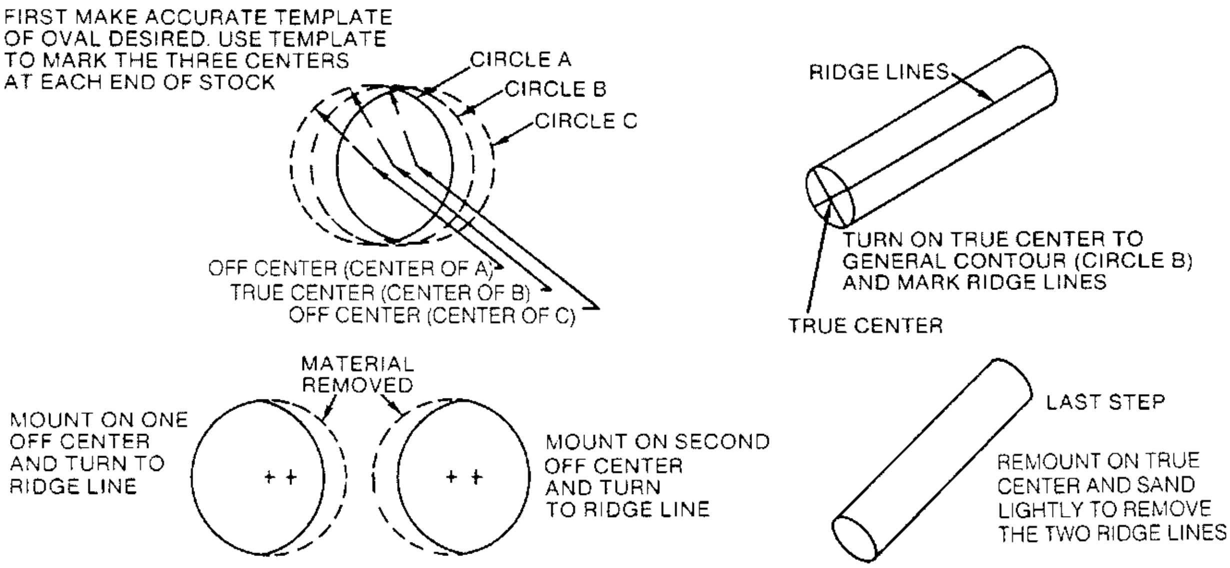


Figure 12-74. *You can turn cylinders with an oval cross section if the work is shaped while it is mounted on off centers. These drawings show the procedure to follow.*

work is done by hand. It is started by mounting stock between lathe centers and turning it to a cylinder.

Layout of the spiral divisions is shown in Figure 12-76. First mark off the length of the spiral. Divide this into equal spaces, each approximately the diameter of the cylinder. Draw four lines along the length of the stock, connecting common perpendicular diameters at each end. Now divide each space into four equal parts and, with a heavy piece of paper as a guide, pencil-mark diagonal lines across each one as shown.

Now follow the sequence detailed in Figure 12-77. Use a saw to cut along the spiral line to the depth needed (Figure 12-77A). This depth is easily controlled if a keyhole saw is used. If a backsaw is used, clamp a block of wood to it to act as a depth guide.

Next use a round file to form a groove to the depth of the saw cut (Figure 12-77B). Open up the groove with a square file (Figure 12-77C). Shape it with a half-round file (Figure 12-77D). Use sandpaper to do the final shaping and smoothing.

Figure 12-75. *When the oval is complete, use sandpaper to smooth the project and to remove the ridge line. The shape of the oval will depend on how far apart you space the off centers.*

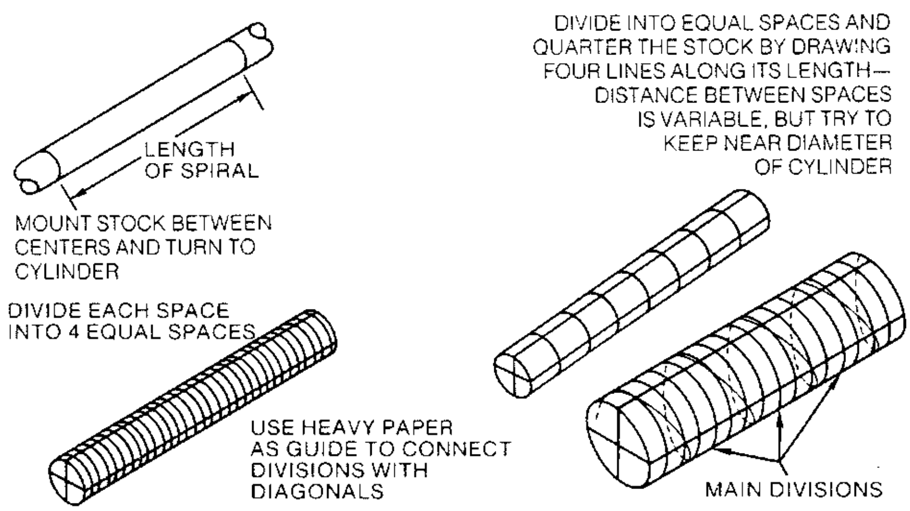
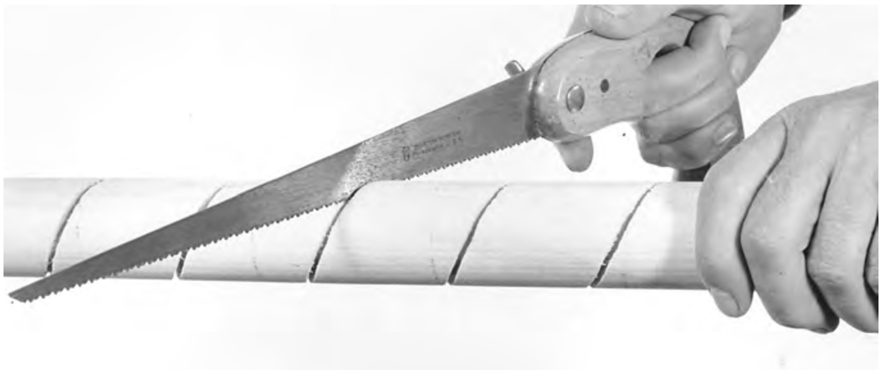
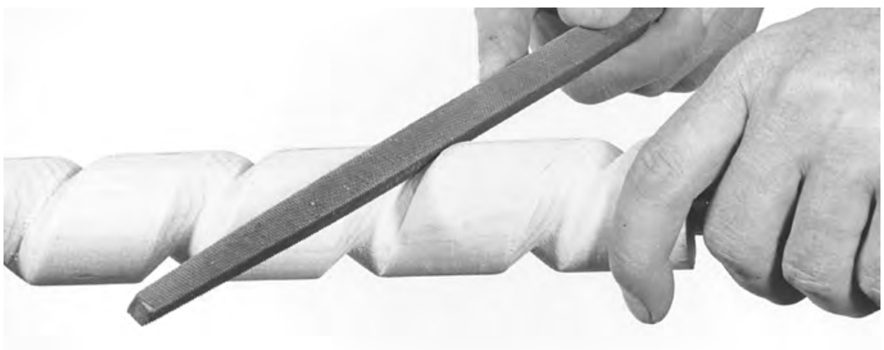


Figure 12-76. *This is the kind of layout you must use to prepare stock for spiral forming.*



A

B



C

D

Figure 12-77. *To form spirals: (A) Use a keyhole saw or backsaw to cut on the spiral line. (B) Start the shaping with a round file. (C) Continue the shaping by using a square file. (D) Finish the shaping with a half-round file. Then work with strips of sandpaper to achieve final smoothness.*

Chapter 13
Lathe Duplicator

Although lathe turning is often considered one of the most creative and rewarding types of woodworking, it can also be one of the most frustrating—especially for the new or inexperienced woodworker. That's because many projects require several matching pieces—such as two lamps, four table legs or a set of salad bowls—and it usually takes quite a bit of practice to develop the necessary skills to turn these matching pieces by conventional methods.

The lathe duplicator eliminates this problem and makes it possible for anyone to turn as many duplicate pieces as they need after only one or two short practice sessions. In addition, the duplicator allows you to enjoy the lathe and create freehand turnings without having to learn how to hold, use or sharpen ordinary lathe chisels.

These capabilities are possible because of the lathe duplicator's unique design. Instead of using ordinary chisels, the duplicator has cutters which are mounted securely to a separate tool rest assembly. A follower with the same profile is installed directly above the cutter. By guiding the follower along a template or pattern mounted above the stock, the cutter will duplicate the profile in the workpiece below.

LATHE DUPLICATOR—SETUP AND FEATURES

The lathe duplicator mounts on the Mark V Models 500 and 510 (Figure 13-1). To set up the lathe duplicator follow the instructions in the Owners Manual that came with the duplicator.

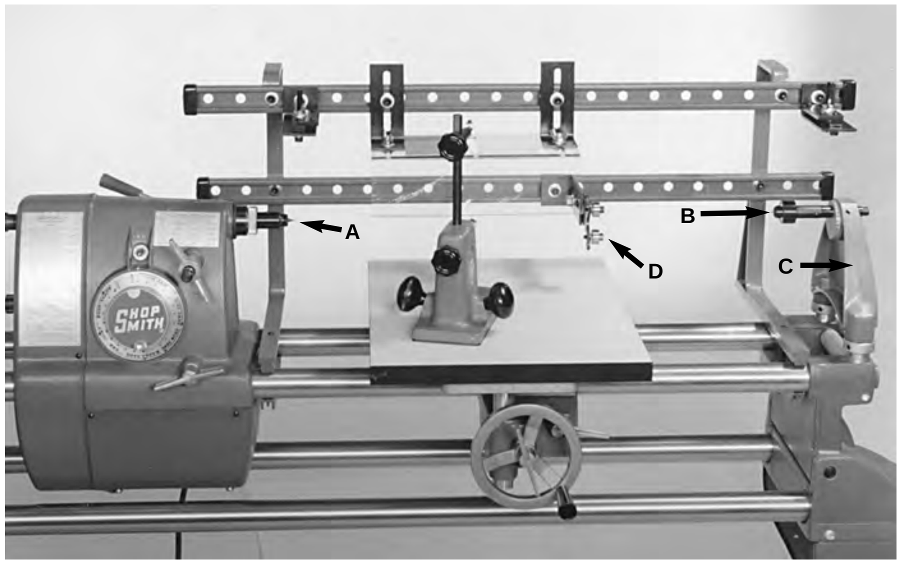


***Figure 13-1.** The Lathe Duplicator mounts on the Mark V. The Mark V accessories that are used for spindle duplicating are: (A) drive center, (B) cup center, (C) tailstock and (D) optional steady rest. For faceplate duplicating a faceplate is mounted on the main spindle.*

Some of the important features and capacities of your lathe duplicator are:

- Maximum spindle length
  - — 34″ with cup center
  - — 33-1/2″ with live center and no spacer
  - — 32″ with live center and 1-1/2″ spacer
- Minimum spindle length
  - — 6-1/4″ with cup center
  - — 5-3/4″ with live center and no spacer
  - — 4-1/4″ with live center and one spacer
  - — 2-3/4″ with live center and two spacers
- Maximum spindle diameter
  - — 8″ for freehand turning or with flat template
  - — 4″ with an original turning as a template
- Maximum bowl diameter
  - — 8″ for freehand turning or with flat template
- Maximum depth of cut
  - — 2-1/4″ for duplication (up to 3-1/4″ for light freehand cuts inside bowls)
- Template specifications
  - — 36″ maximum length
  - — 3/8″ maximum thickness
  - — 1/4″ minimum thickness (smaller templates only)

CRITICAL LATHE DUPLICATOR ALIGNMENTS

Proper alignment is important for all power tools, but accuracy is especially important with the lathe duplicator. Even a small error in alignment will cause a variation in the duplicated pieces.

Complete alignment instructions are provided in the Owners Manual that came with your duplicator. The four most critical alignment procedures are summarized below. These alignments should be checked whenever the lathe duplicator is set up or if problems occur when making duplicates.

Cutter Support Alignment

In order to cut properly, the cutter support must be aligned so that the top of the cutter tip is held parallel to the surface of the worktable.

Begin by removing the follower support. Then loosen the nylon cutter guide and slide it back to expose the flat side of the cutter support rod.

Loosen the front and rear cutter support setscrews and adjust the center setscrew so it is lightly seated in the positioning groove of the cutter support rod. This assures proper protrusion of the cutter tip relative to the follower tip during duplication.

Place an accurate square on the tool rest base and adjust the cutter support, so that the side flat is against the square as shown in Figure 13-2. Then tighten the setscrews, reposition the cutter guide and replace the follower support.

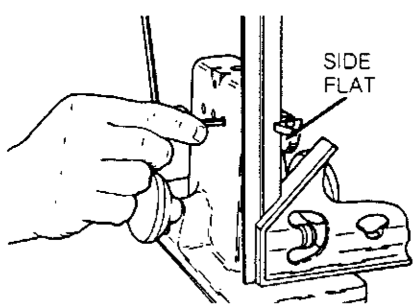


Figure 13-2. *Align the cutter support.*

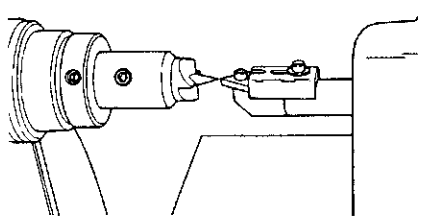


Figure 13-3. *Align the top edge of the cutter with the tip of the lathe drive center.*

Cutter Alignment

In order to cut properly, the top edge of the cutter tip must be aligned with the drive and cup centers.

Begin by placing the tool rest assembly on the table with the cutter tip facing the drive center. Adjust the table height until the top edge of the cutter is aligned with the tip of the drive center as shown in Figure 13-3. Lock the table height.

Then move to the opposite end of the lathe and check the alignment of the top edge of the cutter with the cup center (Figure 13-4). Raise or lower the tailstock as needed and lock it in place.

Note: Although raising or lowering the tailstock will alter the normal center-to-center alignment of the lathe, overall performance of the duplicator will not be affected. Correct cutter height is extremely important when using the lathe duplicator. If you plan to switch back and forth to conventional lathe turning, you may want to put a pencil mark on the tailstock mounting tubes, so you can easily return to the normal alignment position.

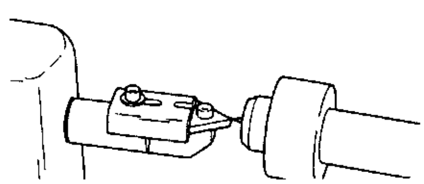


Figure 13-4. *Align the top edge of the cutter with the tip of the lathe cup center.*

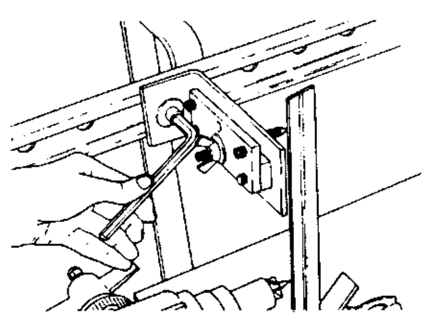


Figure 13-5. *Align the template center, Step 1.*

Template Center Alignment

For accurate duplication, the template centers must be aligned with the drive and cup centers.

First, loosen the left hand template bracket mounting screw and slide the template bracket in the channel until the tip of the template center is even with the tip of the drive center, then tighten the template bracket mounting screw (Figure 13-5).

Next loosen the two cap screws, so that the template center can be positioned directly over the drive center. Check this alignment with a square placed both in front of and behind the centers. When the alignment is correct, tighten the two cap screws (Figure 13-6).

Repeat this procedure to align the cup center with the other template center.

Follower to Cutter Alignment

For accurate duplication, the follower tip must be directly above the cutter tip.

Begin by adjusting the height of the follower tip until it is even with the template center. Wiggle the follower support rod as you tighten the knob to be sure the screw is seated on the flat of the upright support rod.

Then loosen the setscrew for the follower upright. Align the cut-

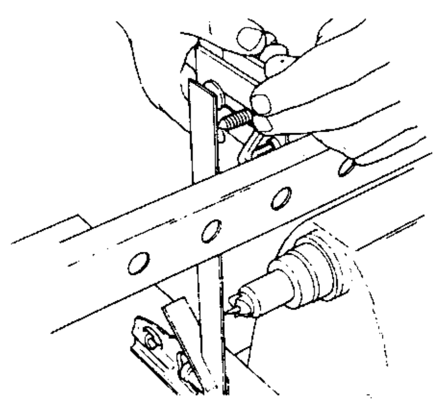


Figure 13-6. *Align the template center, Step 2.*

ter tip with the cup center and the follower tip with the template center. Tighten the setscrew on the upright (Figure 13-7).

CUTTERS

A total of five different cutters are available for the lathe duplicator and each cutter is supplied with a matching nylon follower tip which traces the profile of the template or pattern during duplication.

All of the cutters except the cone cutter are made of carbide and will stay sharp for many hours of turning. Refer to Chapter 24 for suggestions on touch-up honing and care. ***Warning: Never attempt to grind these carbide cutters because the dust can produce eye and skin irritation as well as respiratory system and internal organ damage.***

The cutters are shown in Figure 13-8 and are described below:

1/2″ Round Cutter—This is the best cutter for initial shaping. It is also very good for forming graceful curves, cove cuts and dishing.

3/8″ Square Cutter—The square cutter may be used for rough shaping, but it is best for turning square corners, grooves, short dowels, plugs and straight profiles. It is a good choice for forming tenons when making multi-section turnings.

35° Diamond Cutter—Best for turning fine beads, deep grooves, sharp corners and intricate detail because the narrow tip allows greater penetration.

60° Triangle Cutter—This is often considered the universal cutter because of its versatility. It produces good results in work ranging from rough shaping down to medium detail.

Normally the triangle cutter is mounted with the point facing the workpiece, however, it may also be used with a flat side facing the work if a square cutter is not available (Figure 13-9).

1/2″ Cone Cutter—The cone cutter is recommended for spindle turning only. It cuts quickly for rough shaping and is ideal for finishing cuts when the shape of the turning permits.

The four carbide cutters cut with a scraping action and produce a somewhat rough surface. The cone cutter, however, is made of steel and has a sharpened edge which shaves the wood instead of scraping it away. This allows the cone cutter to cut faster and more smoothly, but the cutting edge will not last as long as the carbide cutters. ***Warning: The cone cutter is not recommended for faceplate work because its sharp cutting edge tends to bite too deeply into the end grain of the workpiece.***

To get the longest life from the cone cutter, divide the tip into quarters and use one section of the cutting edge until it is dull. Then mark that section with a colored marker and rotate the tip 90° to the next section. Sharpen or replace the cone cutter when the entire edge becomes dull.

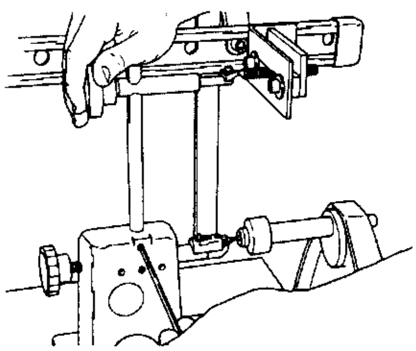


Figure 13-7. Align the follower to the cutter.

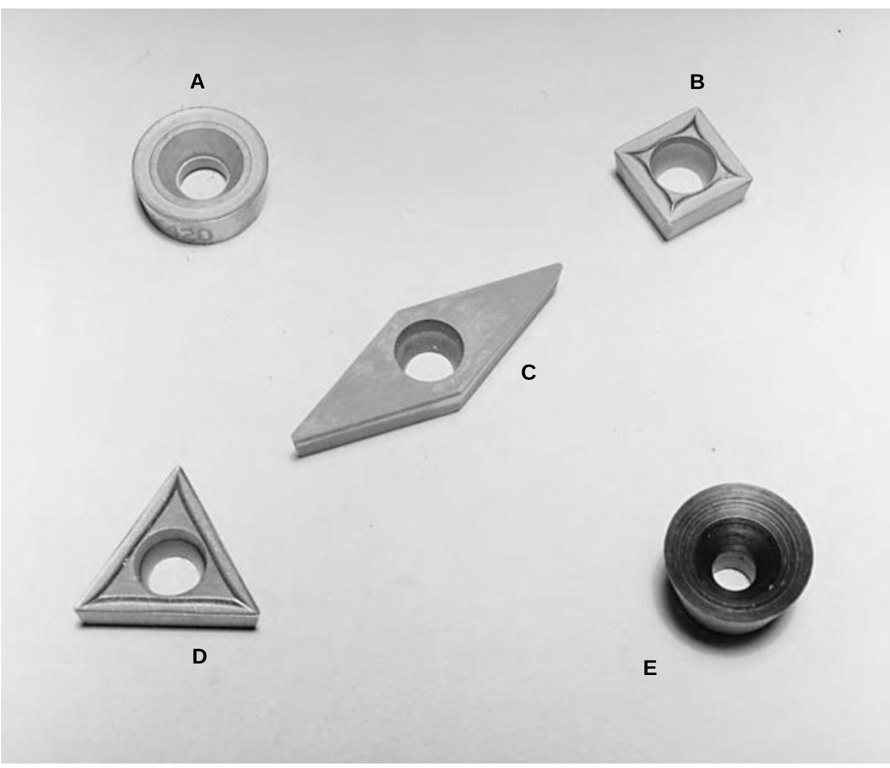


Figure 13-8. Five cutters handle a variety of profiles. (A) 1/2″ Round, (B) 3/8″ Square, (C) 35° Diamond, (D) 60° Triangle, and (E) 1/2″ Cone.

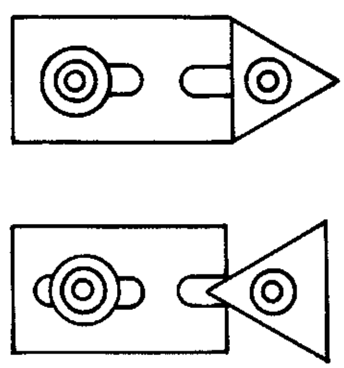


Figure 13-9. The triangle cutter can be mounted with the point or a flat side facing the workpiece.

TURNING CHARACTERISTICS OF COMMON WOODS

Because most lathe duplicator cutters cut with a scraping action, the density and grain structure of the wood will affect the quality of the turned surface and the amount of sanding required. Generally speaking, the best results will be achieved with very hard woods which have straight, even, closed grains. Softer woods or those with pronounced annual rings often chip, tear and feather and will require considerably more sanding.

Refer to Table 13-1 to find the turning characteristics of various common woods.

LATHE DUPLICATOR SAFETY

Warning: Before using the lathe duplicator, read and understand these important safety instructions:

- **Wear proper eye and ear protection.**
- **Keep your hands, fingers and other parts of your body at least 2″ away from the rotating workpiece until it is rounded. After it is rounded, use caution when you get close to the rotating workpiece. Do not touch the workpiece as it turns.**
- **Keep the guard in place whenever you are performing turning operations. Position it not more than 1/2″ from the workpiece.**
- **When turning glued-up stock, make sure the glue joints are strong. Glue the stock and leave it clamped for at least 24 hours prior to turning.**
- **Wear proper apparel. Never wear jewelry, gloves, ties, loose clothing or clothing with long sleeves. Keep long hair tucked under a hat. Jewelry, gloves, ties, clothing and hair could become entangled in the workpiece.**
- **When mounting stock between the centers, the spurs of the drive center and the cup of the tailstock center must penetrate at least 1/16″ into the stock. Do not use a drive center or tailstock center if the point is damaged. The stock could be thrown from the lathe.**
- **Wax or soap the end of the stock that mounts to the cup center. This lubrication helps keep the center from wearing into the stock and causing the stock to loosen on the lathe. The ball bearing live center is highly recommended for use with the lathe duplicator.**
- **When mounting stock to a faceplate, use #12 × 1-1/4″ long screws. The screws must penetrate at least 1″ into the stock. The surface of the stock that's against the faceplate must be smooth and true.**
- **Cut faceplate stock round and spindle stock that's more than 3″ square into an octagon. This removes excess stock, minimizes imbalance, reduces vibration and makes turning large diameter stock safer and easier.**
- **Check the balance of the workpiece. Prior to mounting workpieces more than 3″ in diameter, check and adjust the center of balance (dynamic center). Unbalanced workpieces could be thrown from the lathe.**
- **Do not turn on the power with the cutter or any part of the tool rest assembly against the workpiece. Turn on the machine and let it come up to speed before starting the cut.**
- **Do not stand in the line of rotation of the workpiece when you first turn on the machine. If the machine is set on the wrong speed or the workpiece is unbalanced or improperly mounted, the workpiece could be thrown from the lathe.**
- **Feed the cutter slowly into the workpiece. Use both hands to hold onto and control the tool rest assembly.**
- **Periodically, turn off the machine and check that the workpiece is held securely between the centers or on the faceplate.**
- **Do not lean across or reach underneath the lathe while it is running.**
- **Do not try to stop the lathe by grabbing the stock or any**

Table 13-1: Turning Characteristics of Common Woods

Wood	Characteristics	Suitability
Beech, birch, cherry, hard maple, rosewood, ebony, Honduran mahogany	Very hard, consistent woods with tight, closed grain pattern.	Excellent
Walnut, soft maple, Philippine mahogany, teak, and many fruitwoods	Slightly softer woods or those with more open grain structure.	Good
Red oak, hickory, ash, sassafras, red cedar, white pine, sugar pine	Softer woods or those with open or stringy grain structure.	Fair
Basswood, balsa, cypress, redwood, yellow pine, western cedar	Very soft woods with open, stringy or irregular grain.	Poor

part of the machine. Do not part the stock completely or turn the spindle down to such a small diameter that it snaps on the lathe. This can be extremely dangerous.

• Do not turn stock with splits, loose knots, or other defects that could cause the stock to break, splinter or come loose while turning. Never turn second-hand lumber. If you hit a nail or screw, you could be hit by pieces of metal.

• Remove the lathe duplicator components from the Mark V before sanding or finishing a workpiece on the lathe.

• Do not grind the carbide cutters. The dust created by grinding the carbide can cause eye and skin irritation as well as respiratory system and internal organ damage.

• Do not allow the cutter to come in contact with the parts of the lathe duplicator or Mark V. The cutter will cause damage to the parts and you could be hit by pieces of metal.

Table 13-2: Lathe Duplicator Speed Chart

Size of Stock	Rounding	Shaping	Sanding
Up to 2″ dia.	C (950 RPM)	F (1300 RPM)	K (2050 RPM)
2″ to 4″ dia.	B (850 RPM)	E (1150 RPM)	J (1900 RPM)
4″ to 6″ dia.	A (750 RPM)	D (1050 RPM)	H (1600 RPM)
Over 6″ dia.	Slow (700 RPM)	A (750 RPM)	B (850 RPM)

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

Figure 13-10. *Spindles are duplicated from flat templates.*

LATHE DUPLICATOR SPEEDS

Warning: As with all Mark V accessories, selecting the proper speed dial setting is important to help prevent damage to the equipment or injury to the operator. Generally, when using the lathe duplicator, slower speeds are used for large stock or during initial rounding operations and then the speed is increased for final shaping and sanding.

Refer to Table 13-2 to determine the correct speed for each operation.

PATTERNS AND TEMPLATES

The template support assemblies of the lathe duplicator are designed to hold either flat templates or three dimensional patterns. Flat templates are used for duplicating either spindles (Figure 13-10) or faceplate turnings. Three dimensional patterns are generally used only for duplicating spindles (Figure 13-11). Although it is sometimes possible to use an existing turning as a pattern for faceplate work, the original must usually be destroyed in order to mount a cross-section of it above the workpiece.

A three dimensional pattern can be an original turning—such as a table leg which you have just created by freehand turning—or it could be a spindle from an antique chair you are trying to repair or reproduce. It could even be a broken piece which has been glued back together to serve as a pattern. Appearance isn't important, but shape is, because every defect in the profile of the pattern will be duplicated in the workpiece.

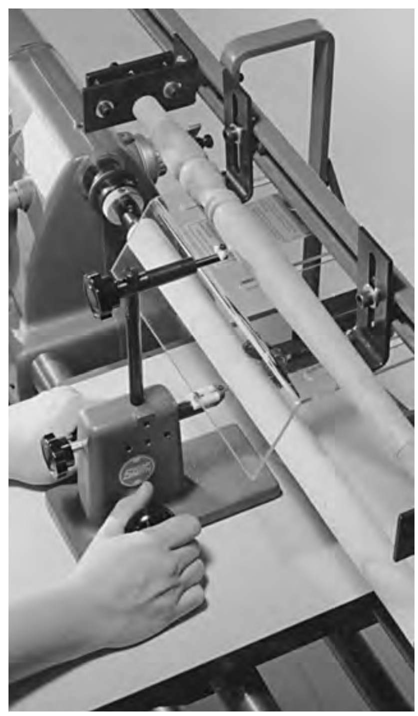


Figure 13-11. *Spindles are also duplicated from an existing turning.*

Template Basics

There are four lines on all templates which are absolutely essential. They are:

- **Centerline** which is used to locate the template in the template clamps directly over the center of the workpiece. This is the most important line on the template.
- **End lines** show the end of the final piece and allow you to make certain enough stock is available at each end to complete the turning.
- **Profile line** which guides the follower tip while the cutter tip duplicates the shape in the workpiece.

To prevent interference, spindle templates should have 2″ of extra stock at each end (Figure 13-12). They may, however, be secured with only one setscrew in each clamp. Faceplate templates must be at least 3-1/2″ wide, so that both setscrews will engage the template (Figure 13-13).

For some faceplate turnings—such as a thin-walled bowl—one template may not be practical because it would be too fragile. In these cases, you will need separate templates for the inside and outside profiles—or you can make one template with two centerlines (Figure 13-14) and reposition it after turning the outer profile. In either case, accurate construction is extremely important.

After a template has been mounted and you are sure its position is correct, you can drill a 1/4″ locating hole through the template clamp (Figure 13-15). The template can then be removed and replaced very accurately by inserting a 1/4″ dowel through the centering hole in the template clamp and template.

Template Materials

Templates may be made from a variety of materials. Probably the

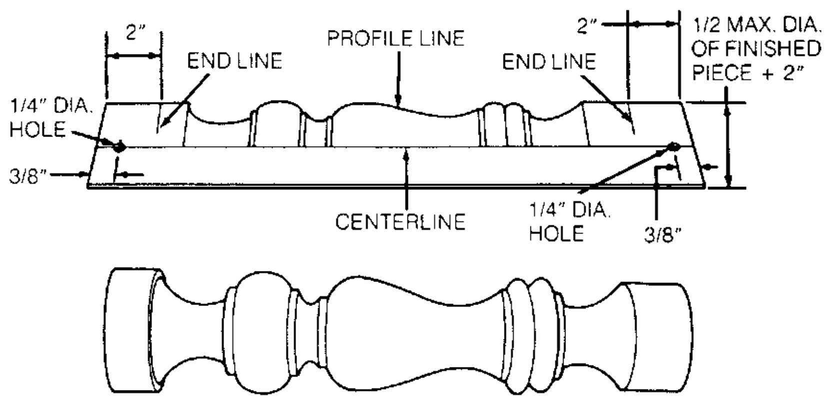


Figure 13-12. A typical spindle template showing important dimensions and its finished product.

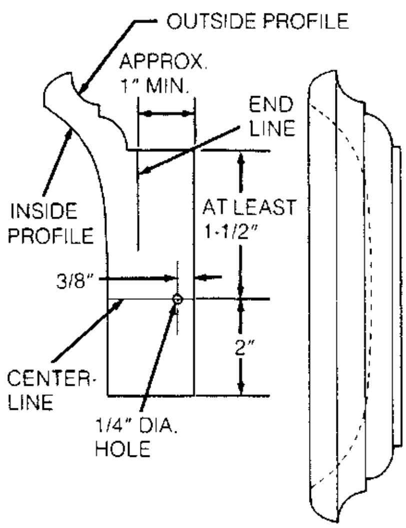


Figure 13-13. A typical faceplate template showing important dimensions and its finished product.

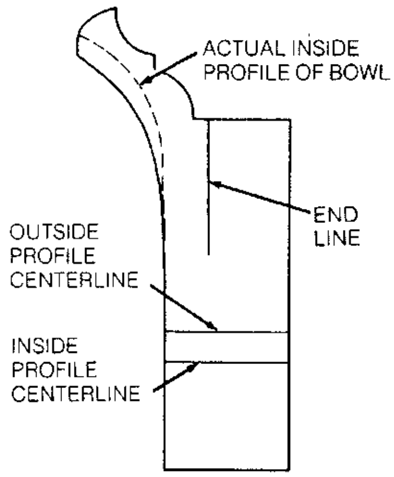


Figure 13-14. A template with two centerlines for making a thin-walled bowl.

Figure 13-15. Drill a locating hole when template will be removed and used again.

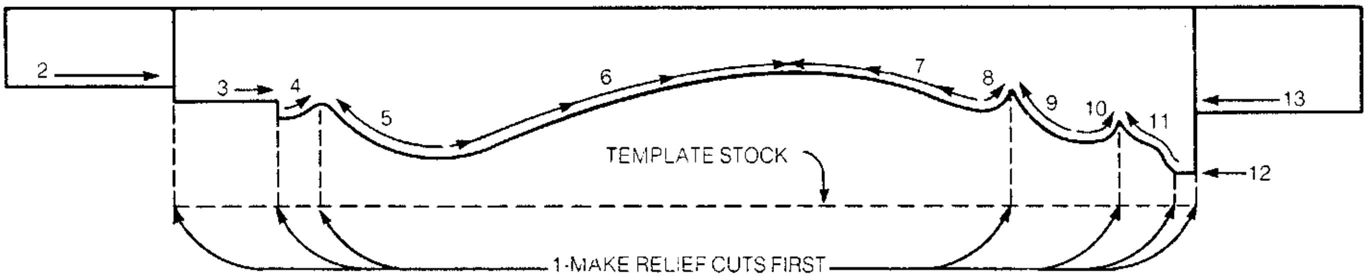


Figure 13-16. When cutting out the template, plan your cuts to avoid tight turns.

most popular and economical choice is 1/4" thick tempered hardboard. It is hard and durable and yet it is easy to cut and sand.

For greater accuracy and durability, use sheet acrylic materials. Although somewhat more difficult to cut and sand, acrylic templates will last almost indefinitely.

After an acrylic template has been cut and shaped, scribe the critical lines into its surface. Then remove the paper covering. The clear template allows light to shine through the template and eliminates shadows on the workpiece. For better visibility, you can also accent the profile edge of the template with a colored marker.

Templates may also be made of wood if thin stock or a thickness planer is available. Hard, closed grain woods are best. Softer, more open grained woods are not recommended because the template is easily dented or chipped and becomes useless.

Template Construction

Templates are made by creating a full size drawing of the turning, attaching the drawing to suitable stock with rubber cement and then cutting out the profile with a bandsaw, jigsaw or scroll saw.

If your project plans are not full size, they must be enlarged. This may be done by using a grid system to scale up the drawing or by using a pantograph to trace and enlarge the image. Even more accurate enlargements can be made with a copier machine. When you have your full size drawing, check to be sure the available cutters will fit into any narrow grooves or profiles.

Once the full size drawing has been attached to the template stock, cut out the template (Figure 13-16). Note that the first cuts to be made are relief cuts that let waste stock fall away as you cut the profile. This helps keep the blade from binding in tight spots and lets you make each cut more precisely.

Next cut each section of the profile staying slightly outside the line to leave a little stock for final sanding. Use multiple cuts whenever necessary to avoid difficult turns with the blade. The profiles will be smoother with less sanding required.

Finally, sand to the profile lines until the template is perfectly smooth. This can be done with sandpaper, triangle and half round files, or even an emery board. Remember that any bump or chip in the profile edge will be duplicated in your final turning.

SPINDLE TURNING

Spindle turning includes any turning where the workpiece is held between the drive center and tailstock center. Follow the instructions in Chapter 12 when mounting spindles on the lathe. ***Warning: When mounting spindles, it is important for the drive center and tailstock center to be driven at least 1/16" into the ends of the stock.*** Although the tailstock live center is recommended for use with the lathe duplicator, the standard cup center should be used for scoring the end of the stock. *Caution: Driving the live center into the stock with a mallet will damage the ball bearings in the live center.*

Setup

Mount the template or pattern above the workpiece as shown in your Lathe Duplicator Owners Manual. If you are using a flat template, the centerline should be visible through the centering holes (Figure 13-17) and the end of the template should fit securely inside the template clamps.

If you are using a three dimensional pattern, rotate the template brackets and seat the tips of the template centers securely into the ends of the pattern (Figure 13-18), so it cannot turn during duplication. If your pattern includes a square section such as the top of a table leg, the **square corner must face the follower tip,** not the flat side (Figure 13-19).

Make sure the end lines of the template or pattern are inside the

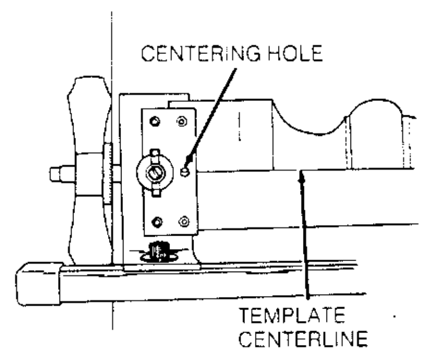


Figure 13-17. *Use centering hole to align template.*

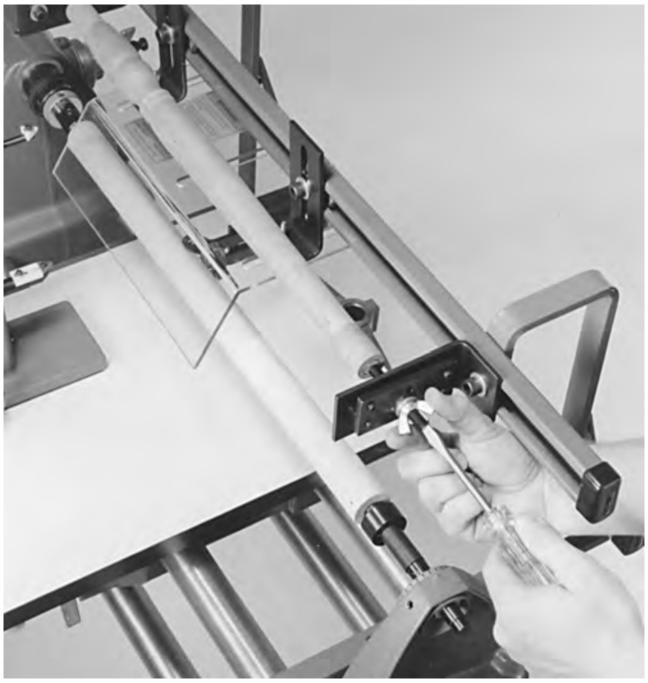


Figure 13-18. *Seat template centers securely in the pattern.*

Figure 13-19. *Corners of square sections must face the follower tip.*

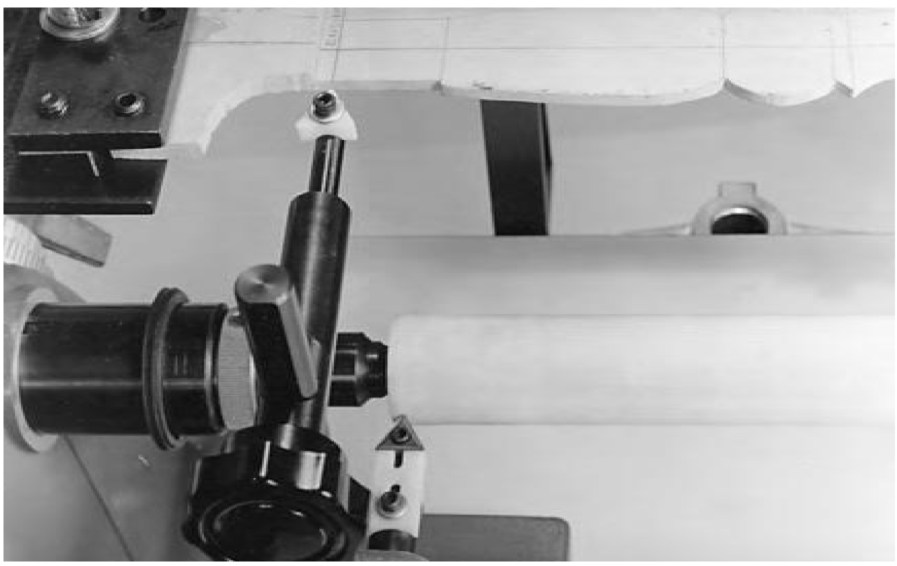


Figure 13-20. *Make certain both end lines are inside the ends of the workpiece.*

ends of the workpiece (Figure 13-20). Adjust the location of the template brackets if necessary.

Finally adjust the guard. It should be within 1/2" of the stock and just high enough for the cutter to reach the workpiece.

Rounding

Turn on the Mark V and set the speed dial to the proper speed. Grasp the handles of the tool rest assembly and advance the cutter into the stock until it begins to cut. You can be aggressive, but do not force the cutter in so hard that it stops the workpiece.

Round off the corners, working in small sections from one end of the stock toward the other until it is completely rounded. If you are working on a long workpiece, round one area then turn off the Mark V and reposition the table and guard. ***Warning: Check to be sure the stock is still securely mounted.*** Then continue rounding.

Rough Shaping

During rough shaping you should leave about 1/32" of stock for removal during final detailing. This may be done by keeping the follower tip away from the template, but if you are new to the duplicator you may want to retract the cutter to avoid mistakes (Figure 13-21).

To retract the cutter, loosen the three setscrews that hold the cutter support and turn the cutter adjusting knob one-half turn counterclockwise. Press the cutter support back against the adjusting stud and **tighten the front and rear setscrews only.** The center setscrew cannot seat in the positioning groove when the cutter support is retracted.

To begin shaping, move the table and guard to either end of the workpiece. Turn on the Mark V and set the speed dial to the proper speed.

Start by shaping the larger diameters and then progress to the

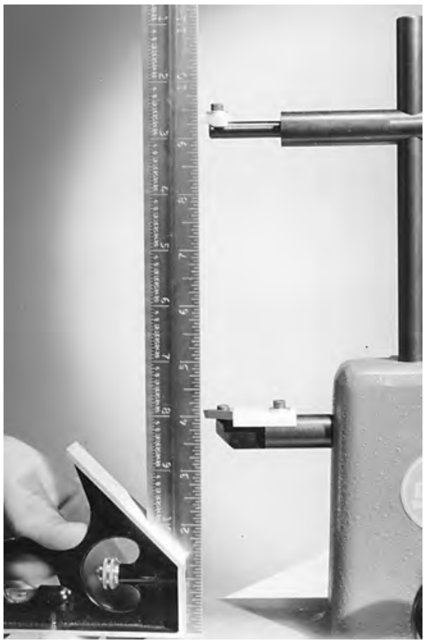


Figure 13-21. The cutter tip may be retracted for rough shaping to leave stock for detailing.

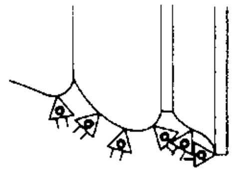


Figure 13-22. Keep the follower perpendicular to profile of the template during rough shaping.

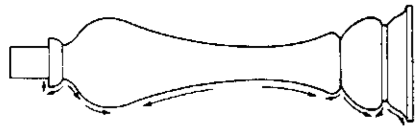


Figure 13-23. Cut in an "uphill" direction when detailing beads and coves.

Figure 13-24. Checking for exact diameter. Follower tip to template centerline should be exactly half the diameter of the turning.

smaller ones. Don't force the cutter into the stock or press so hard that you deflect the turning. Use a steady rest (Figure 13-1) to support long or thin turnings.

Use a back and forth motion, working down into each contour. Also keep the follower perpendicular to the profile of the template (Figure 13-22), so extra stock will be left on all surfaces.

When you are cutting properly, you will produce large chips, not fine dust or a burnished surface. If cutting is slow, check the table height adjustment to be sure the cutting edge is even with or slightly below the centerline of the turning or lathe centers.

Final Detailing

If you have retracted the cutter for rough shaping, it should be readjusted before making your final passes. Be sure that the center setscrew is seated in the positioning groove of the cutter support, so that the cutter is exactly even with the follower. Align the cutter support as described earlier and tighten all three setscrews.

Final detailing requires a certain "art", but the duplicator makes it easy to learn. Use a light touch and move the cutter in an "uphill" direction when shaping beads and coves (Figure 13-23). The smoothest surface is usually produced by dragging the cutter sideways—not by approaching the workpiece with the point of the cutter.

Also be careful not to press so hard that you deflect the template or rock the base of the tool rest assembly. If you do happen to make a mistake, don't panic. It is often possible to save the turning by removing the follower and smoothing out the mistake by turning freehand. Although the piece will not be an exact duplicate, slight variations may not be noticeable in the final project.

Turning to Exact Diameters

You can turn duplicate pieces even if a template or pattern is mounted slightly out of alignment, but some projects require turning to an exact diameter. Creating a tenon for joining a spindle and faceplate or sections of a long bedpost are two examples.

To verify the alignment, turn a flat area at the desired location, but leave enough stock so that the follower tip does not contact the template. (The cutter must be in its normal position—not retracted.)

Use a good set of calipers to accurately measure the turned diameter. Then measure from the follower tip to the centerline of the template (Figure 13-24). If the alignment is correct, this distance will be exactly one half the diameter of the turning. If not, make any necessary adjustments before proceeding. For very critical work it is a good idea to make a practice turning from scrap stock to verify the setup before turning the actual project pieces. *Note:* The tailstock chuck arbor is useful for drilling mating holes for joining two or more turnings. Refer to Chapter 12.

Parting Cuts

After all turning and sanding on the lathe has been completed, remove the turning from the lathe and use a bandsaw or coping saw to trim off the scrap at the end of the workpiece. ***Warning: Do not part the stock completely on the lathe.***

If you wish to cut a square shoulder where the stock will be parted, use the square cutter or reverse the mounting of the triangle cutter and use its side.

FACEPLATE TURNING

Faceplate turnings are made with the stock mounted to a faceplate which is attached to the Mark V main spindle. Follow the instructions in Chapter 12 when mounting faceplate turnings.

Warning: Make sure the workpiece does not have loose knots, splits or defects. Use #12 × 1-1/4" or larger screws to attach the stock to the faceplate. Allow glue joints to dry for at least 24 hours and cut the stock round on the bandsaw before turning.

Setup

All faceplate turning should be done at the far right end of the Mark V. Remove the right-hand template support. Move the table as far to the right as it will go and reposition the power plant and left-hand template assembly.

Mount the template in the template assembly with the edge of the template firmly seated against the spacer in the clamp. Then tighten the two setscrews to hold the template securely. Accurate alignment of the template is extremely important to assure accurate diameters and eliminate unplanned tapers in the final turning.

Loosen the template bracket screw and position the template over the workpiece. Use the tool rest assembly as an alignment gauge to be sure the end line on the template is inside the left edge of the workpiece (Figure 13-25). Tighten the template bracket screw.

Finally, mount and adjust the guard (Figure 13-26). ***Warning: The brackets should be attached to the left and center slots of the guard and the guard should extend from the power plant over the workpiece.*** Adjust the guard so it is as close to the workpiece as possible and just high enough for the cutter to pass freely underneath it.

Rounding

Turn on the Mark V and set the speed dial to the proper speed. Grasp the handles of the tool rest assembly. ***Warning: Do not extend your fingers beyond the front edge of the base.***

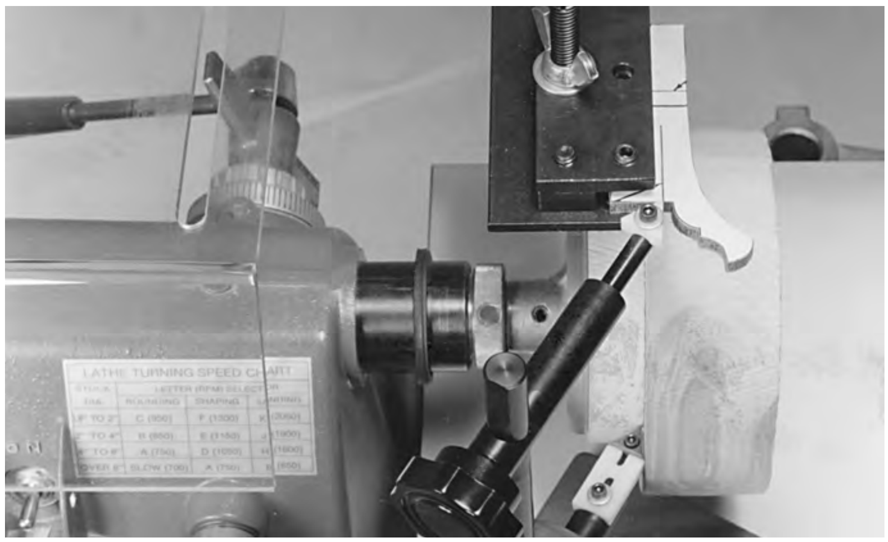


Figure 13-25. *The template end line should be inside the end of the workpiece.*

Figure 13-26. *Setup for faceplate turning with the guard extending over the workpiece.*

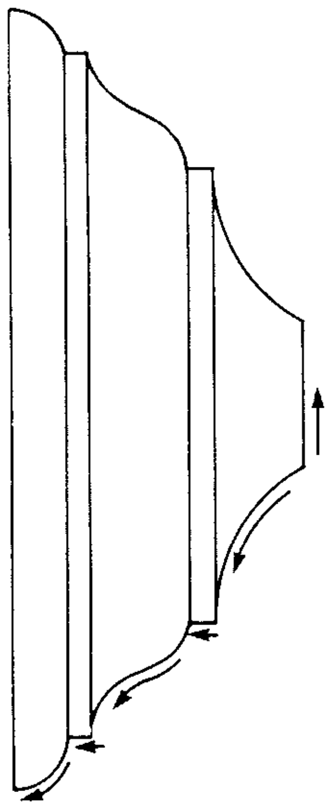


Figure 13-27. Work "uphill" on beads and coves; "downhill" from sharp shoulders.

Begin rounding the outside edges, working in small areas at a time, until the workpiece is completely rounded. Then, if the right-hand face is rough or not parallel with the faceplate, move around to the end of the machine and straighten this face.

Rough Shaping

The techniques for rough shaping faceplate workpieces are very much like those for spindles. Work in small areas, beginning with the larger diameters. The cutter may be retracted to leave some stock for final detailing.

If you are cutting properly, you will see large chips. As the profile takes shape, these chips will become curled shavings often several inches long.

Generally you should rough shape the outside profile and then begin roughing the inside contour. The exception is when you are working on a project—such as a thin walled bowl—where two templates or two centerlines are required for the outside and inside profiles.

In these cases, it is usually easier to continue with final detailing of the outside profile before beginning on the inside. This will eliminate having to reposition the templates for final shaping. If repositioning will be necessary, drill the 1/4" alignment hole (Figure 13-15) before removing the template and be sure the setscrews return to exactly the same indentions in the template.

Final Detailing

Reposition the cutter if it has been retracted and begin cutting with a light touch. Work "uphill" on beads and coves, but "downhill" when shaping from the top of a sharp shoulder into a round profile (Figure 13-27).

Undercutting

Undercutting involves cutting an inside diameter that is larger than the opening. This is quite common in salad bowls and similar projects where the middle is wider than the top or bottom.

The free-floating tool rest lets you make undercuts with only minor limitations (Figure 13-28). First is the limit of the cutting angle you can achieve before the tool rest base runs into the turning. Second is the depth of the undercut before the lip of the turning begins to rub on the underside of the cutter support. These limitations are reduced as the size of the turning increases. In some cases, you can increase the undercut by extending the cutter support up to one inch and making light passes freehand.

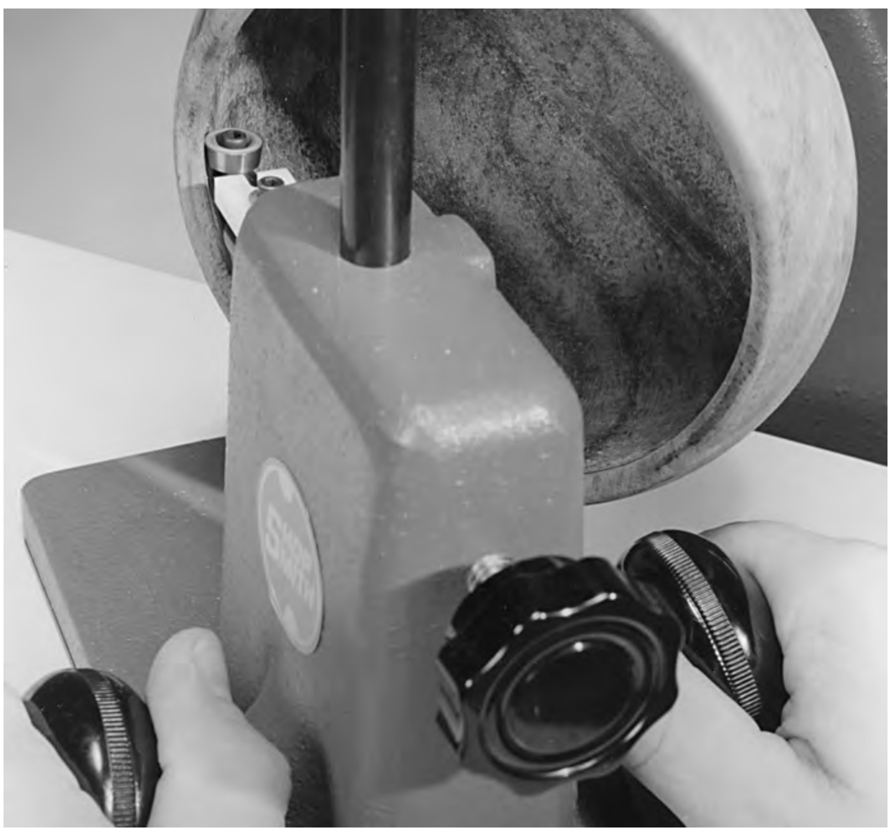


Figure 13-28. Undercutting the inside of a bowl.

PRODUCTION TIPS

If you are making a number of spindle and faceplate turnings, these tips will help speed up the job and eliminate needless work.

• Complete each operation on all pieces before moving to the next. For example, prepare all the stock, make all the turnings, plus sand and finish all the parts.

• Mounting three or four turnings on extra faceplates will be faster than removing and remounting each piece.

• When using different cutters for rough turning and final detailing, rough shape all turnings before changing tips or getting an extra tool rest assembly.

• Drill centering holes in templates to speed up remounting and realignment.

FREEHAND TURNING

Freehand turning is very much like duplicating except no template or pattern is required. You can shape the piece any way you imagine it (Figure 13-29). The setup is the same except that the template brackets, the follower and the follower upright support are removed. Leave the channel assembly and guard in place.

SANDING AND FINISHING

Sanding and finishing a turning are much easier done on the lathe than removing it and finishing it by hand. ***Warning: Before you start, remove all lathe duplicator components.*** *Caution: Lay a cloth over the way tubes to catch grit and finish.*

For sanding, use quarter sheets of sandpaper folded into thirds. This gives you a rigid piece, yet it will bend to fit the shape of the turning and the thickness helps protect your fingers from heat build-up (Figure 13-30). ***Warning: Never wrap sandpaper, steel wool or a rag around the turning and never use a rag with frayed edges. They could easily pull your fingers into the workpiece.***

Turn the Mark V on and set the speed dial to the correct speed. Begin working with new 100-grit paper and light pressure. Then switch to used 100-grit paper. Finish sanding with new and used 150-grit paper. For open grain woods, wet the surface to raise the grain between sandpaper changes. Allow the water to dry before sanding.

For a smoother surface and reduced sanding time, dismount the spindle, turn it end-for-end and sand in the opposite direction. ***Warning: When remounting the stock, be sure to put enough pressure on the quill to engage both the drive and cup centers.*** You can reverse the rotation of a faceplate turning by mounting the faceplate on the upper auxiliary spindle.

For finishing, use a very low speed and prepare a natural oil finish with the stain mixed in. Polyurethane is not recommended because it will dry too quickly. Mask any areas to be glued later.

Soak a rag and a piece of fine, slightly used wet/dry sandpaper in the finish. Use the rag to apply the finish to the turning. Then sand. Repeat, adding more finish until a mixture of finish and sanding dust covers the entire turning. Rub this paste with your hands and let it set for a minute or two or until it becomes sticky. Then buff the turning and let it dry. Apply additional coats of finish, but do not sand.

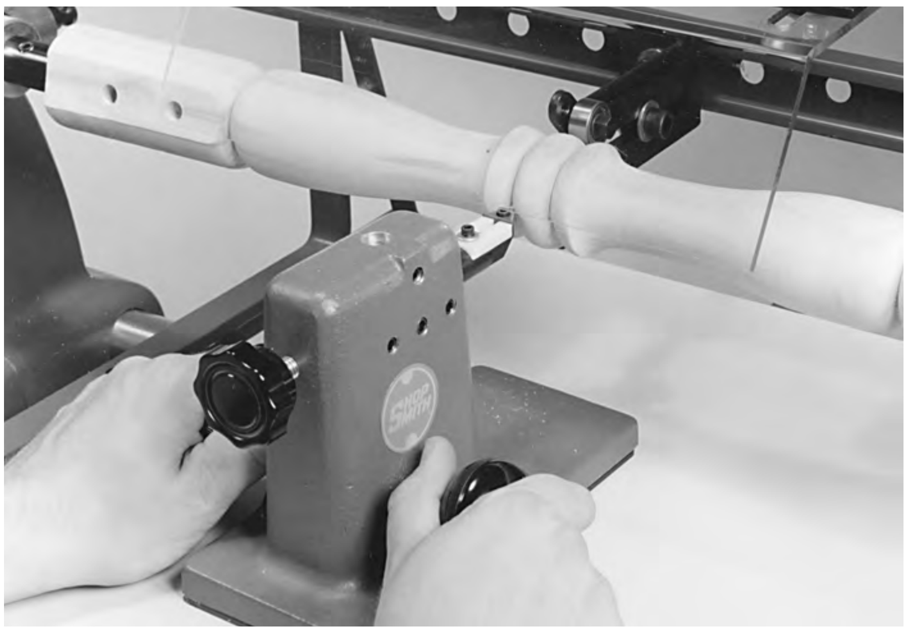


Figure 13-29. *You can do freehand turning with the lathe duplicator.*

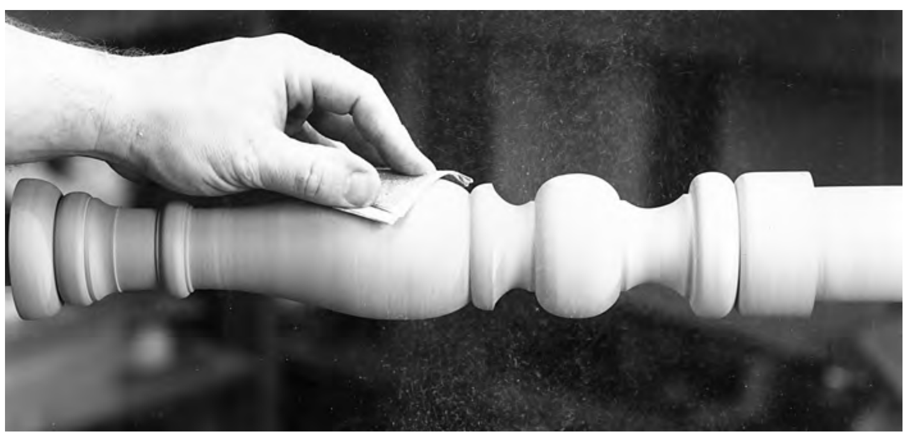


Figure 13-30. *When you sand on the lathe, fold quarter sheets of sandpaper into thirds to protect your fingers from the heat build-up.*

Chapter 14
Bandsaw

The bandsaw gets its name from the continuous loop or "band" formed by the flexible steel blade. This blade cuts with a downward motion, toward the table. Because it cuts continuously, you'll find the bandsaw is one of the fastest cutting tools in your shop.

The bandsaw will perform a wide variety of workshop operations. The two most common uses are cutting curves or irregular shapes in wood and resawing (slicing thin boards from thick ones). But you can also make crosscuts, rips, bevels, miters, compound curves, duplicate parts, and many other special cuts.

You can also cut materials other than wood. With the proper blade installed, the bandsaw will cut plastic, plastic laminates, particle board, and even soft, nonferrous metals such as copper, brass, and aluminum.

BANDSAW—SETUP AND FEATURES

To set up your bandsaw, follow the instructions in the Owners Manual that came with your bandsaw.

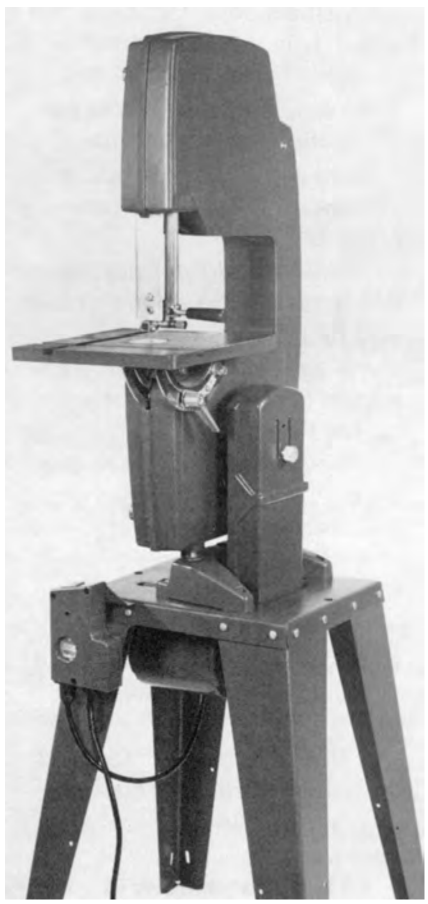
As you work with the bandsaw, you'll find that it has several special features:

- The bandsaw can be mounted on the Mark V or a Shopsmith Power Stand (Figure 14-1).
- The cutoff capacity is 10-1/2″—the distance across the machine's throat. However, with the blade offset 30° right, you can cut off (freehand) any length of stock up to 3-7/8″ wide. The bandsaw will cut stock up to 6″ thick.
- The bandsaw accepts continuous-loop blades 72″ long and 1/16″ to 5/8″ wide.

Bandsaw blades are mounted on two wheels, 11″ in diameter. Both wheels are covered with rubber tires to protect the teeth of the blades and provide traction. The idler (upper) wheel revolves on needle bearings, while the drive (lower) wheel revolves on sealed ball bearings. The blades are tensioned by adjusting the position of the idler wheel.

- The table surface is 11-3/4″ (front to back) by 12″ (right to left). The table can be tilted from "0" to 45° right (away from the frame). It has an adjustable positive stop at "0." If this stop is removed, it can be tilted an additional 5° left.
- The bandsaw mounts on the power mount end of the Mark V. ***Warning: You can run the bandsaw together with a disc or drum sander (Figure 14-2) as long as***

A



B

Figure 14-1. The Bandsaw can be mounted on (A) the Mark V or (B) on a Shopsmith Power Stand.

Figure 14-2. The bandsaw/disc sander is a logical dual-purpose setup, but the speeds used must be that of the bandsaw, not the disc sander.

you remember that the dual setup must run at bandsaw speeds.

• You can supply extra support for long stock by setting up the Mark V worktable and the rip fence as shown in Figure 14-3. Since the carriage can be positioned anywhere between the power plant and the end of the machine, you can adjust to supply support where it is most needed.

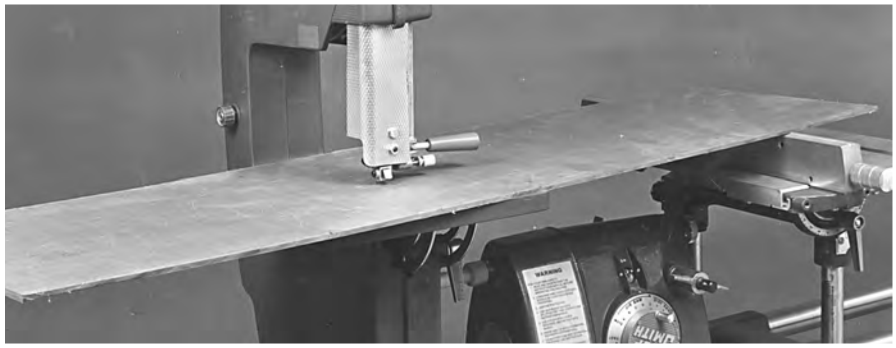


Figure 14-3. *You can get extra support for long workpieces by using the Mark V worktable and rip fence this way.*

BANDSAW BLADES

Your bandsaw will accept any blade 1/16″ to 5/8″ wide and 72″ long (within 1/2″). Choosing the right blade for the job will depend on:

• the kind of material you're about to cut

• the thickness of the stock

• the bandsaw operation you're about to perform

• the intricacy of the design

Wider blades are stiffer, so the cut is straighter. Larger teeth and deeper gullets help clear the sawdust in a deep cut. Wider blades are the best choice for heavy resawing or sawing thick stock. Narrower blades are better suited for intricate work. The narrower the blade is, the tighter the radius it will cut. Choose narrow blades when you need to cut complex designs. To help select the blade that will work best for any given operation, refer to Table 14-1.

BANDSAW SAFETY

Warning: Before using the bandsaw, read and understand these important safety instructions:

Danger Zone—The bandsaw danger zone is 3″ out from the blade in all directions.

Use a push stick whenever you need to maneuver a workpiece inside the danger zone. This safety device helps protect your hands and fingers. A push stick also gives you better control when you're working near the blade.

Always replace the cover on your bandsaw before you turn it on—never operate the machine without the protective cover. And remember there is a blade guard attached to the upper blade guide. This guard automatically covers the unused portion of the blade when the guides are adjusted properly. Always adjust the upper blade guides to a maximum of 1/4″ above the stock. Not only is this safer; it gives the blade better support.

• Wear proper eye and ear protection and a dust mask.

• Do not remove stock or scraps until the blade has stopped.

• Maintain proper adjustment of blade tension, blade guides and bearings.

• Keep the upper guide adjusted to a maximum of 1/4″ above the stock.

• Never reach close to the blade or under the table while the machine is running.

• Hold stock firmly against the table.

• Never attempt a turn tighter than the blade will allow. Otherwise, the blade might break or jam.

• Use a push stick to finish a resawing or ripping cut.

• Support long stock with a roller stand.

• Hold round stock in a V-block.

• Never cut extremely small stock. Cut small components from larger stock.

• If the blade breaks, turn off the machine and stand away until it stops.

• Whenever you mount and operate the bandsaw on the Mark V, secure the accessory mount lock, power plant lock and the bandsaw mounting tubes.

• Never turn on the machine with stock pressed against the blade.

• If you hear a ticking sound or unusual noise, stop the bandsaw immediately. A ticking sound often means a damaged blade.

• If you're using a Shopsmith Power Stand, be sure you're using the proper pulley and belt combination and that the pulley and belt are properly guarded.

BANDSAW SPEEDS

Before you begin any bandsaw operation, turn on the Mark V, set the speed according to Table 14-1, and let the bandsaw come up to speed. The speed of a bandsaw is measured by how fast the blade travels, or "Feet Per Minute (FPM)."

The speed is determined by the blade and the material. Generally, slow speeds are used with wide blades to cut hard, thick woods and dense materials. High speeds are used with narrow blades in soft materials.

BASIC BANDSAWING

Adjust the height of the upper blade guide so that it's no more than 1/4″ above the work (Figure

14-4). Then think through the cut before you turn on the machine. Know where you'll put your hands as you feed the stock into the blade; make sure the stock won't be blocked by the bandsaw frame (Figure 14-5). When you're satisfied that you can make the cut safely and without interference, turn on the power, set the speed dial to the proper speed and wait until the machine comes up to speed.

Take a comfortable stance in front and slightly to the left of the blade, and start your cut. As you work, you may shift more toward the center. ***Warning: Stand on the left side of the blade. If the blade breaks it may fly to the right.***

Slowly feed the stock into the blade. Use both hands to guide the stock and keep it pressed firmly down against the table.

As you work, watch out for several problems that may cause the bandsaw to bog down or produce an inaccurate cut:

- feeding the stock too fast
- side pressure (against the flat of the blade)
- trying to turn a radius too small for the blade
- excessive blade "lead"
- worn or dull blades.

Don't force the work, but you can feed fairly rapidly since the machine cuts quickly. It's alright to pause in the cut for a moment, but try not to remain stationary for too long. The blade will heat up in the kerf, burning both the stock and the blade. Feed the stock directly against the teeth, even when cutting curves. To determine if the

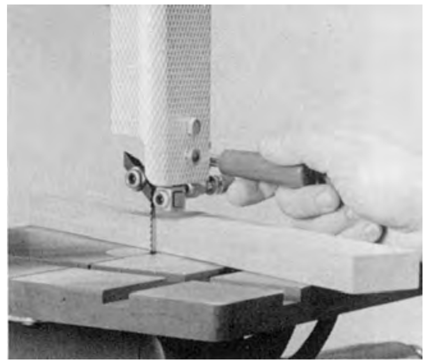


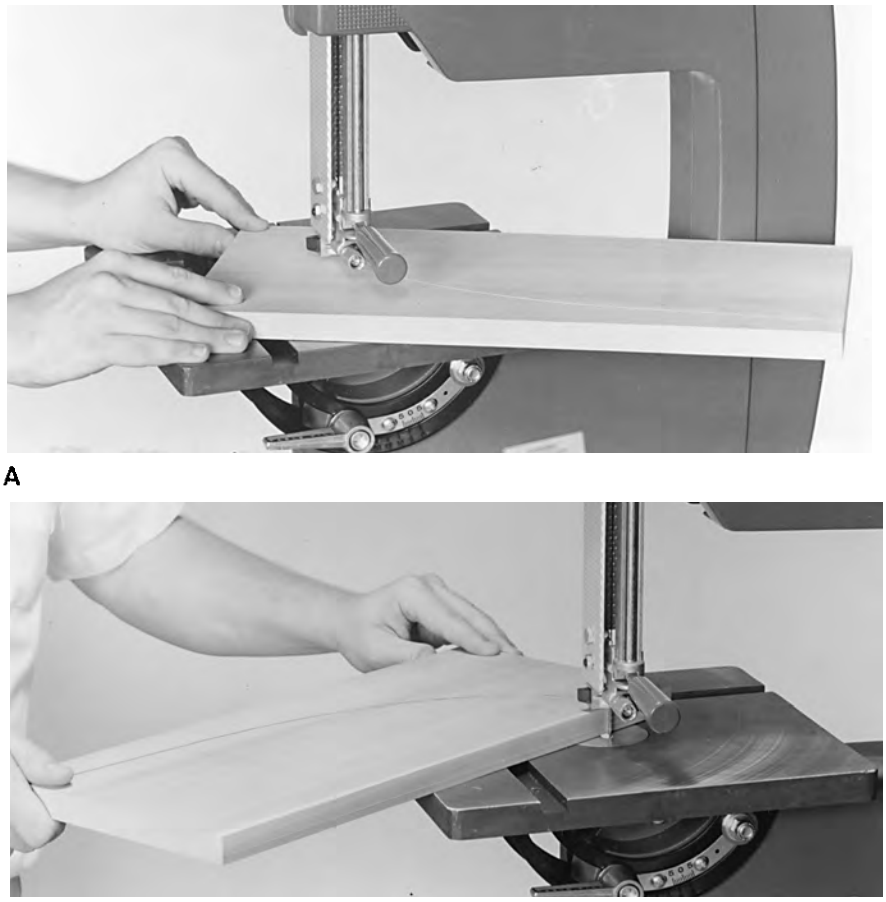
Figure 14-4. *Adjust the upper blade guide so that it's a maximum of 1/4" above the workpiece.*

Table 14-1: Bandsaw Blades and Speeds

	Characteristics	Recommended Use	Recommended Speed**
	1/16" Woodcutting Blade* — 24 teeth per inch, 1/32" minimum turning radius.	For extremely fine detail work only. Use for wood and plywood up to 3" thick. Not for heavy-duty cuts or resawing. **Note: Set the tension scale at 1/8" setting.**	A (750 RPM, 2160 FPM) for hardwood. B (850 RPM, 2450 FPM) for softwood.
	**1/8" Woodcutting Blade** — 7.5 teeth per inch, 1/4" minimum turning radius.	For very fine detail work only. Use for wood and plywood up to 3" thick. Not for heavy-duty cuts or resawing.	C (950 RPM, 2750 FPM) for hardwood. D (1050 RPM, 3000 FPM) for softwood.
	**1/4" Combination Blade** — 6 teeth per inch, 3/4" minimum turning radius.	A good general purpose blade for wood, plywood, plastics, particle board, and soft, non-ferrous metals. Limit resawing to stock 4" thick, metalwork to stock 1/4" thick. **This is the blade that comes with your bandsaw.**	B (850 RPM, 2450 FPM) for hardwood. C (950 RPM, 2750 FPM) for softwood. Slow (700 RPM, 2000 FPM) for other materials.
	**1/2" Combination Blade** — 4 teeth per inch, 2" minimum turning radius.	For heavy-duty cutting of wood, plywood, plastics, particle board, and soft, non-ferrous metals. Suitable for resawing stock up to 6" thick, and metalwork in stock up to 1/2" thick.	Slow (700 RPM, 2000 FPM) for hardwood, softwood, and other materials.
	**5/8" Woodcutting Blade** — 3 teeth per inch.	For heavy-duty resawing. Efficiently handles wood up to 6" thick. Straight cuts only. **Note: Set the tension scale at the 1/2" setting.**	Slow (700 RPM, 2000 FPM) for hardwood and softwood.

Several blade manufacturers make bandsaw blade stock for a variety of special purposes — intricate scrollwork, cutting iron pipe, etc. If you need a special blade, you can have it made at a well-equipped commercial saw shop. **Use only high-quality blade stock 1/16"-1/2" wide.** Be sure that the finished blade is 72" long, plus or minus 1/2", and that the weld is ground perfectly smooth.

* *Caution: Do not use 1/16" blade without special guide blocks. Failure to use special guide blocks will ruin the blade and damage the standard guide blocks.* ****NOTE:** These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.



A

B

Figure 14-5. (A) Visualize the cut before you begin and you can avoid the kind of throat interference that is occurring here. (B) Started this way, the cut can be made in one continuous pass.

blade is the right size for the curve, refer to Table 14-1.

If the blade continually wanders off the pattern, there are several possible causes: The blade guides may be improperly adjusted. Or you could be pressing against the side of the blade. You may also be trying to cut a curve that's too tight for the blade. If the blade wanders or "leads" just to one side or the other, the teeth are improperly set. To correct the set of the teeth, refer to the Bandsaw Owners Manual.

If the machine bogs down, stop a moment to let the bandsaw catch up. Check to see if the blade is twisting in the guides. If it is, you may be pressing against the side of the blade or trying to turn a corner too tight for the blade. If the blade is properly positioned in the guides, you're probably feeding the stock too fast. Once the bandsaw is back up to running speed, feed the stock a little slower. If the problem persists, check the blade to see if it's worn. Replace dull or worn blades immediately.

If the blade jams on a scrap, turn off the machine and unplug the power before you attempt to clear the scrap. If the blade breaks, move around to the left side of the machine and turn off the power. Wait until the wheels come to a complete stop before removing the cover and the broken blade.

Basic Techniques

Getting a smooth, accurate cut begins by guiding the stock carefully with both hands, feeding the stock forward against the teeth at the proper rate, and not turning corners too tight for the blade. Here are a few additional suggestions to help you get the best results:

Cutting Outside the Pattern Line—For precision work, cut slightly outside the line—in the waste stock—then sand to the final dimension with a disc sander, belt sander, strip sander or drum sander. Not only does this technique make it easier to be accurate, the finished edge is smoother. The mill marks left by the bandsaw are removed when you sand up to the line.

Breaking Up a Cut—Break complicated cuts up into simple curves and lines. Study your pattern to see how you might cut it in several easy passes. Don't be afraid to cut into the waste stock and loop around in order to reposition the blade at a better angle to the pattern line (Figure 14-6).

Backtracking—In order to break up intricate patterns into simple cuts, you may have to cut in to a point, then back the blade out and cut from another angle (Figure 14-7). This is a safe technique if done carefully, but there is always a danger that you may bind the blade, pull it out of the guides and off the wheels. Sawdust can also build up behind the blade, preventing you from backing it out. To backtrack out of a cut longer than 1", turn off the machine and let it come to a complete stop before backtracking. If you can, avoid backtracking in long cuts altogether.

Drilling Relief Openings—A few well-placed relief openings will give you sufficient turning room to make tight cuts. Square-cornered relief openings can be formed with mortising bits and chisels; round holes, made with drill bits, can be used when the blade can't turn the radius required. Sometimes, corner holes are used just to make bandsaw cutting easier; the radius of the corner is exactly right be-

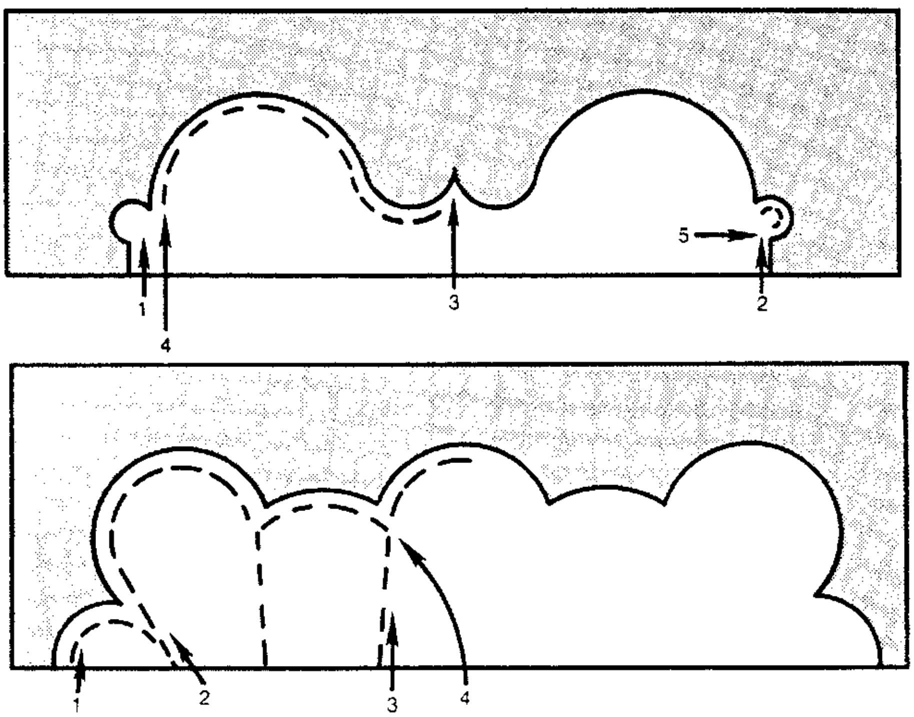


Figure 14-6. Break complicated cuts up into simple curves and lines.

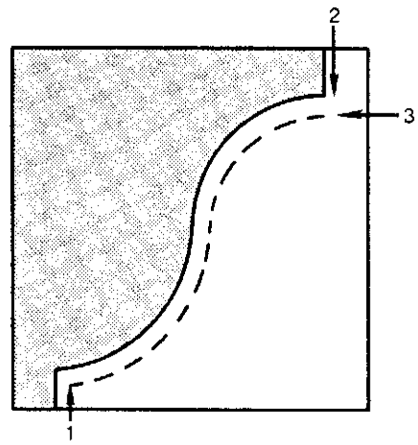


Figure 14-7. You may have to backtrack with the blade in order to cut some patterns. Plan ahead and avoid backing out of cuts.

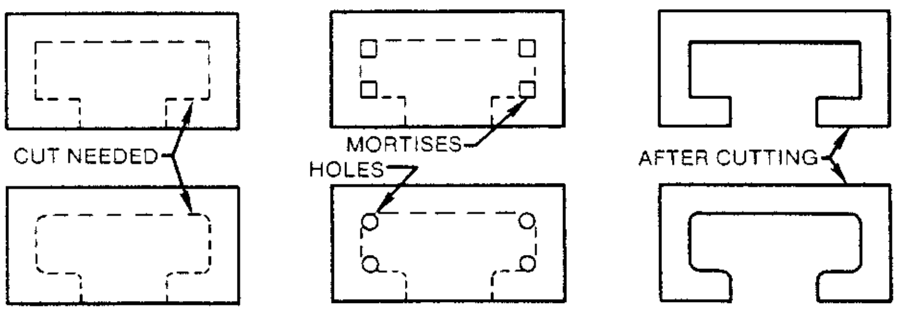


Figure 14-8. Round or square relief openings can facilitate making internal cuts. When possible, plan the openings as part of the design.

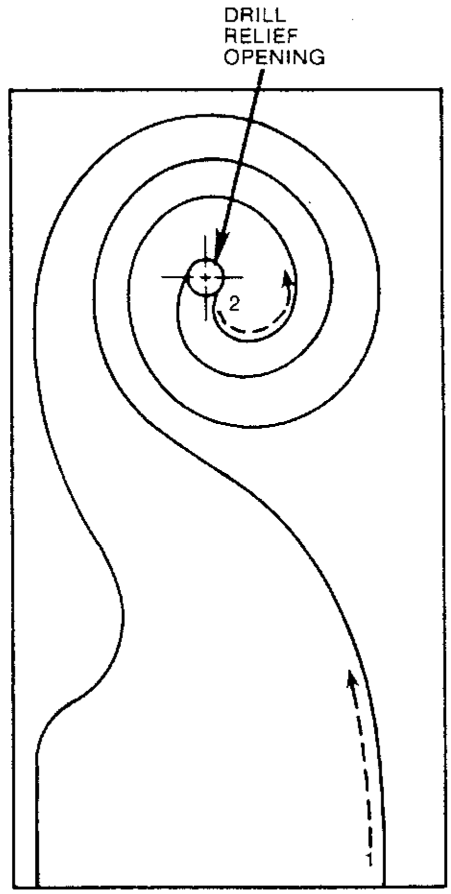


Figure 14-9. Relief openings give you turning room to cut tight internal corners.

cause of the bit size that is used. In all cases, be sure the layout for the corners, square or round, is accurately done to conform to the design (Figure 14-8).

Keep in mind that making relief holes is one of the handiest techniques for cutting intricate scrollwork (Figure 14-9). Drill these holes slightly inside the pattern line in the waste stock.

Making Relief Cuts—Radial or tangential relief cuts make it possible for you to cut a curve smaller than the blade can normally turn.

Make radial cuts toward the pattern line and backtrack out (Figure 14-10). Then cut the desired curve. As the blade meets up with each radial cut, a little piece of waste stock will fall away. This, in turn, provides more room for the blade to turn.

Make tangential cuts by cutting on the pattern line until the blade starts to bind slightly, then run off at a tangent to the curve. Cut completely through the waste stock to the edge of the workpiece, removing a small amount of stock. Start cutting the pattern line again where you ran off at a tangent (Figure 14-11). Repeat this process until you've cut the desired curve.

Remember that radial cuts are useful when cutting both internal and external curves. Tangential cuts can only be used on external curves.

"Nibbling"—There are times when you'll need to cut a detail in a pattern that's too small to use any of the techniques described pre-

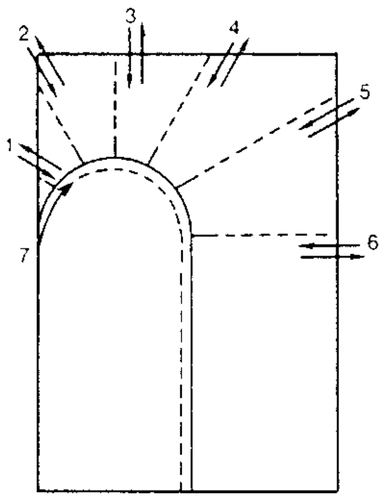


Figure 14-10. To cut tight external curves, make several radial cuts before you cut the pattern line.

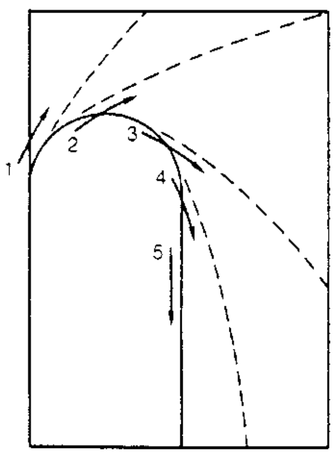


Figure 14-11. You can also cut tight external curves by making a series of tangential cuts as shown.

viously. For these extra-fine jobs, feed the stock very lightly against the blade and let the teeth "nibble" it away (Figure 14-12). This is handy when you need to cut tiny corners and curves.

Layout—Many of the methods described in connection with scroll sawing and jigsawing (see Chapters 15 and 16) can be used to minimize layout and waste when bandsawing. A specific application, which is typical, is the forming of a curved rail (Figure 14-13). Two pieces that result from a single cut are joined to form the arch shape.

CROSSCUTTING

As mentioned earlier, the table slots allow you to use the miter gauge with safety grip for many bandsaw operations. By mounting the miter gauge in the slot that's parallel to the flat of the blade, you can make crosscuts and miter cuts similar to the cuts made on a table saw (Figure 14-14). Your cut-off capacity, however, is limited to 10-1/2". Any longer than that and the stock will strike the bandsaw frame.

To increase the cutoff capacity when crosscutting, you can offset the blade. When the blade is offset, you can cut off any length of stock that you can safely handle, as long as the stock is not more than 3-7/8" wide. However, when the blade is offset, you must crosscut without the miter gauge.

RIPPING

By locking the miter gauge in the table slot that runs perpendicular to the flat of the blade, you can use the miter gauge as a rip fence (Figure 14-15). Secure the miter gauge in the slot by turning the Allen screw in the center of the miter gauge bar clockwise. This presses the sides of the bar out against the sides of the slot. We also suggest you put a single thickness of paper in the table slot near the miter bar locking screw, as an extra precaution to keep the miter gauge from shifting during ripping operations.

If you need more support for the workpiece, attach a miter gauge extension to the miter gauge. The standard extension, mounted on the miter gauge (Figure 14-16A), is suitable for normal ripping operations. A longer extension (Figure 14-16B) provides needed support when handling long stock, while a higher extension (Figure 14-16C) will help you work more accurately when doing resawing. The sizes of

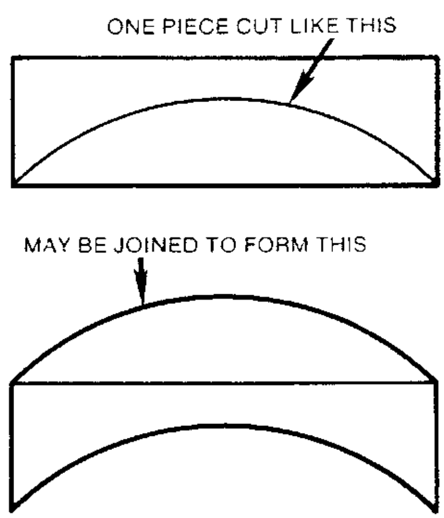


Figure 14-13. Wise planning of the layout can often make it possible to join pieces to form a particular shape. It is also a way to economize with material.

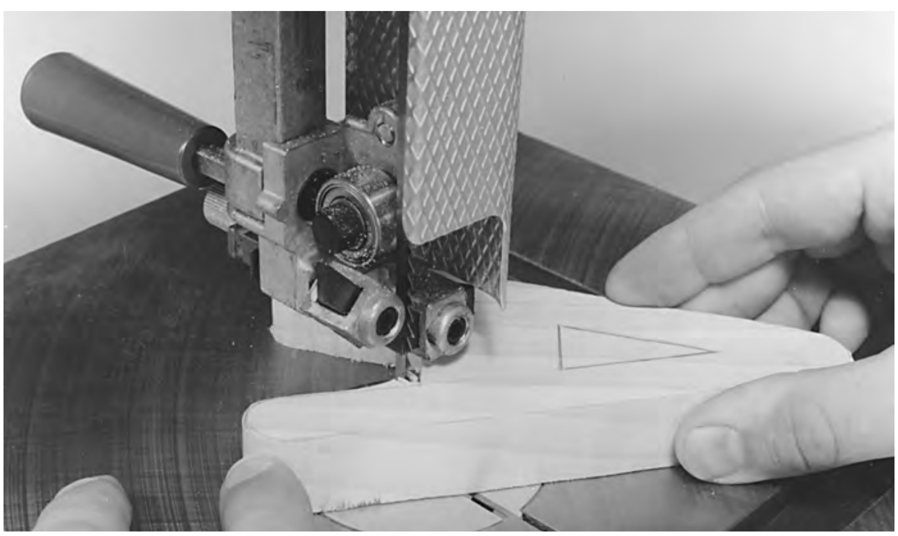


Figure 14-12. To cut corners and curves in tight spots, feed the workpiece very lightly against the blade and let the teeth nibble away.

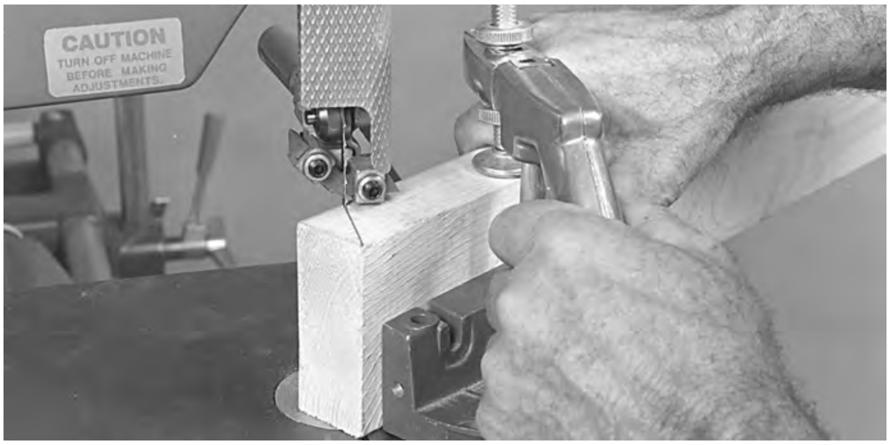


Figure 14-14. *By mounting the miter gauge in the table slot that runs parallel to the flat of the blade, you can crosscut and miter.*

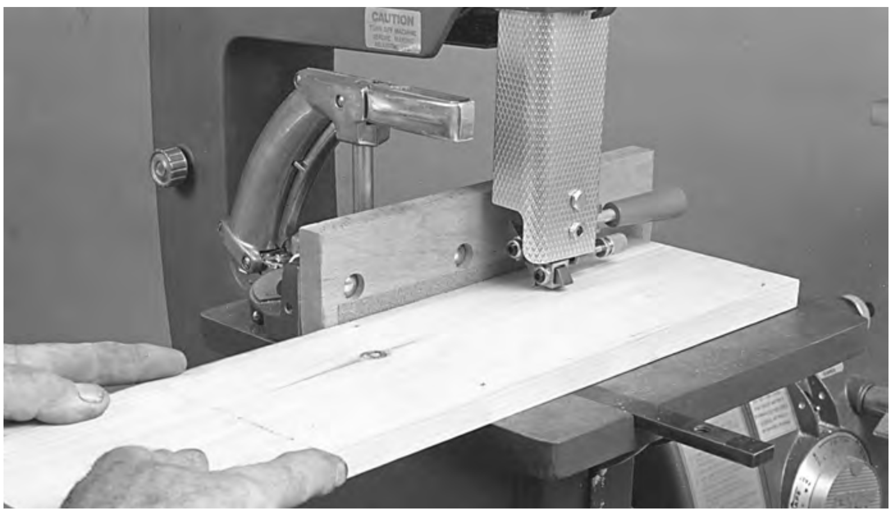
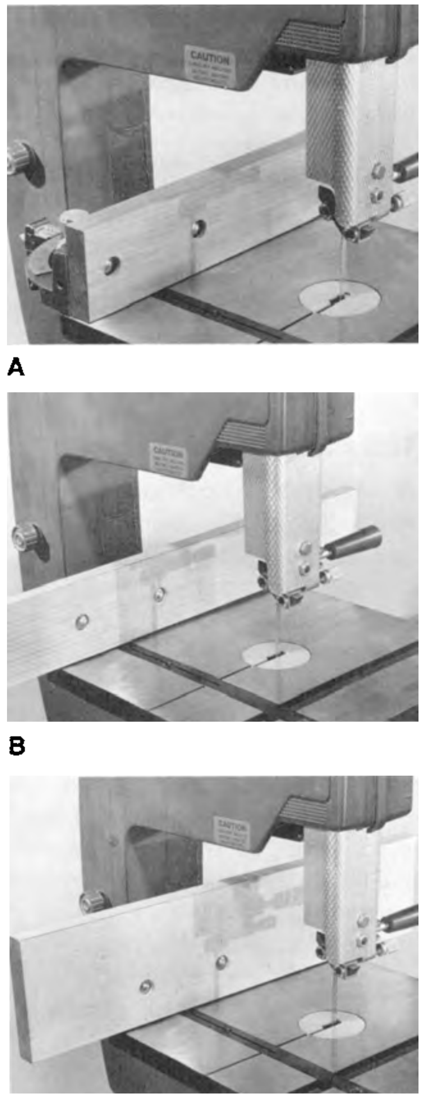


Figure 14-15. *Lock the miter gauge with an extension attached in the table slot that runs perpendicular to the flat of the blade, and use it as a rip fence for ripping operations.*



A

B

C

Figure 14-16. *(A) A standard miter gauge extension makes a useful fence for average ripping operations. The locking miter gauge is what makes this and similar setups possible. (B) A longer extension provides more support when ripping extra-long workpieces. (C) A higher extension provides needed support for resawing operations.*

all three extensions and the mounting holes they need are detailed in Figure 14-17. You may also want to use a roller stand or the Mark V table and rip fence to help support the workpiece on either the infeed or outfeed side of the bandsaw.

When you're using the miter gauge as a rip fence, pay particular attention to blade lead—the tendency of the blade to drift off the cutting line in one direction. To correct blade lead, first try readjusting the blade guides or angling the miter gauge slightly. If this doesn't work, refer to the Bandsaw Owners Manual to correct blade lead. If after trying both of these remedies blade lead remains a problem, slow down the feed and give the blade more time to make the cut and stay straight.

When ripping, feed the stock very slowly and be sure to maintain the extension-to-work contact throughout the pass. You can use your hands as shown in Figure 14-18; or, if there is enough room between the extension and the blade, use your left hand on the extension much as if you were doing a rip cut on the table saw. But, in any case, be sure to keep a push stick handy during ripping operations and use it to feed the stock during the last few inches. Also, if you force the cut, it is likely that the stock will move away from the fence or the blade will wander off the cutline. Extension-guided ripping won't work if the blade has lead. You must eliminate the lead, change to another blade, or make the cut freehand.

On a few operations, such as sawing or ripping thick stock with a thin blade, it may be necessary to increase the blade tension slightly beyond the normal setting. However, this increased tension will shorten the life of your blade. Always remember to reset the tension screw when you no longer need the extra tension.

If accuracy is not critical or the blade is showing excessive lead, you can also make rip cuts freehand. Just remember not to work with pieces so small that they bring your fingers inside the danger zone. Use a push stick instead.

RESAWING

Resawing thick stock into thin boards is one of the bandsaw's most useful functions. This operation cannot be performed efficiently on any other home workshop power tool.

To get a good resaw, first joint the bottom edge of the stock. Also make sure the surface that will rest against the extension is as smooth and flat as possible. If the board is cupped, the cup should face the extension. Check the squareness of the table to the blade and adjust it, if necessary—just 1° to 2° out of square will make the resawn board noticeably uneven.

Since resawing usually involves stock several inches thick and many feet long, it's a good idea to use a long, high miter gauge extension. Clamp a feather board to the table to help hold the stock up on edge and flat against the extension. Use a push block to move the stock (Figure 14-19).

Place the miter gauge in the table slot that runs perpendicular to the flat of the blade, and lock it in place so that the fence is 1/32" to 1/16" farther away from the blade than the desired thickness of the resawn board. (This extra distance will give you room to surface the wood after it's been resawn.) Also clamp the feather board to the bandsaw table so that it will press against the stock just in front of the blade. Always use a push stick to finish a resawing cut.

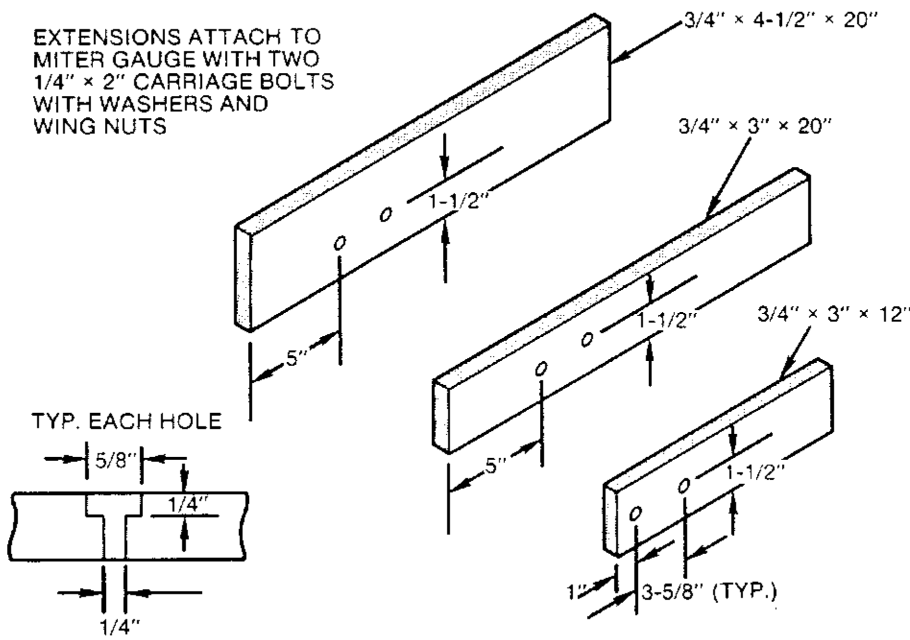


Figure 14-17. Construction details of three miter gauge extensions.

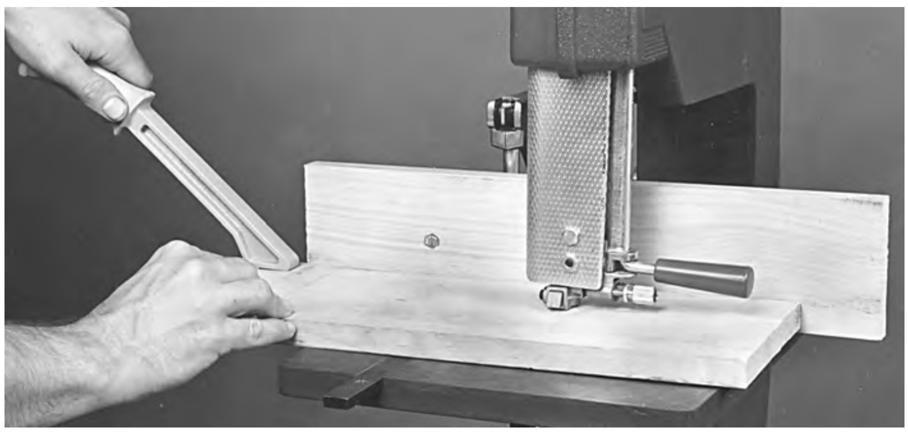


Figure 14-18. Ripping will be accurate if you feed at a reasonable speed and keep the workpiece against the miter gauge extension. Ripping against an extension will be a problem if the blade has lead.

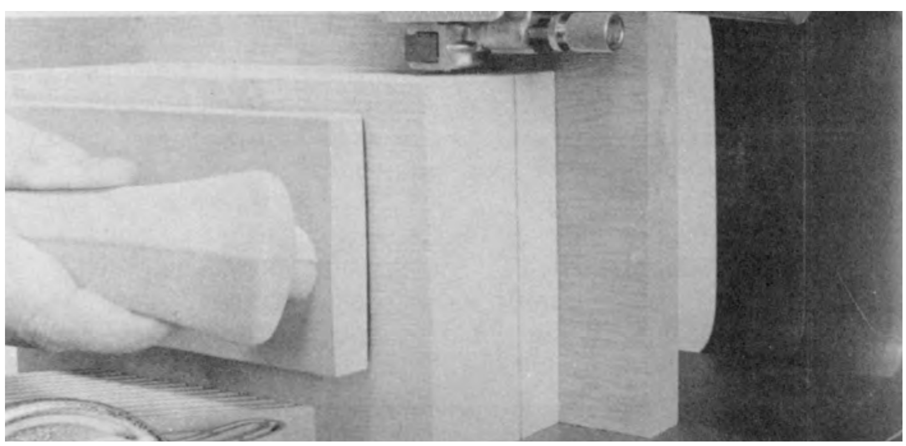


Figure 14-19. Use a high miter gauge extension when resawing. Feed the workpiece very slowly, especially if you are using a blade that is less than 1/2" wide. Narrower blades can be used, but they are more likely to "bow" in the cut.

If you're using a 1/4" blade for this operation, increase the tension to the 3/8" mark on the blade tension scale.

As you make the cut, hold the workpiece firmly against the extension. Take your time and don't rush the cut. If you rush, the blade may follow the annual rings in the wood, giving you an uneven cut. As with ripping, blade lead can also ruin your cut. If the blade tends to wander, even when you feed the stock slowly, readjust the blade guides or the angles of the miter gauge. If this doesn't work, refer to the Bandsaw Owners Manual to correct blade lead. If none of these remedies correct the problem, use another blade for resawing.

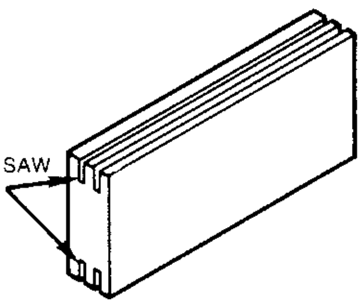


Figure 14-20. You can prepare a workpiece for resawing by making table saw cuts. The kerfs help to guide the blade and they reduce the amount of material on which the blade must work.

Many woodworkers prepare stock for resawing by first kerfing the material on the table saw as shown in Figure 14-20. The kerfs do double-duty; they act as a guide for the bandsaw blade and they reduce the amount of material through which the blade must cut.

It isn't resawing, in the strict sense, but the bandsaw's ability to cut through thick stock can be utilized to cut square stock round or prepare material for lathe turning (Figure 14-21). Cutting stock this way considerably reduces the amount of waste that must be cut away with lathe chisels.

Thinning Out—Thinning out is a type of resawing procedure that is used to reduce the thickness of stock in particular areas so the material will be easy to bend. Mark the section to be thinned on one edge of the stock. The section should be 1" or so longer than the bend you plan. Make the two end cuts first. Then, starting from any point between them, make an oblique approach to the straight line and continue the pass until it meets the first cut. Turn the stock end-for-end and complete the cut (Figure 14-22). Figure 14-23 shows an example of the kind of bending that can be done by using the thinning-out method. The thickness of the material that will be left after the cutting will depend on how sharp the bend must be. Bends made this way should be reinforced with glue blocks.

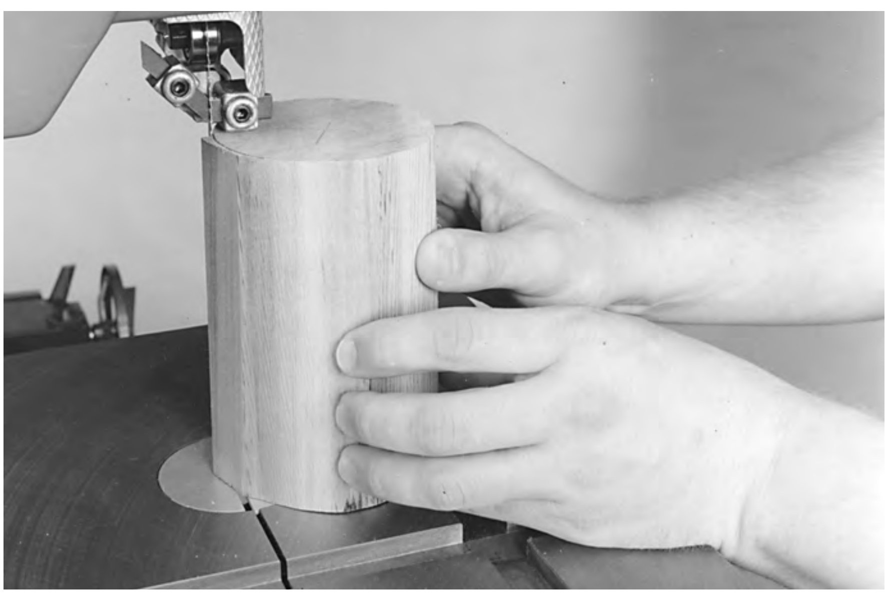


Figure 14-21. The bandsaw's impressive depth of cut can be utilized to cut square stock round or prepare stock for lathe turning. Small circles require a narrow blade, so feed very carefully to keep the blade from bowing.

BEVEL CUTS

To make bevel cuts, simply tilt the table to the desired angle and secure the tilt lock. If the accuracy of the cutting angle is critical, check the tilt with a protractor or drafting triangle.

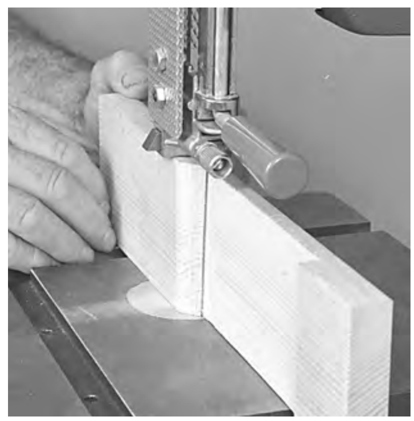


Figure 14-22. Thinning out stock so it can be bent is a type of resawing. How much of the stock's thickness you leave depends on how sharp a bend you must make.

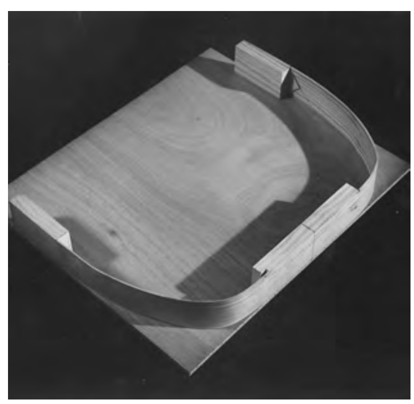


Figure 14-23. An example of how stock can be bent after it is thinned out. The thinned sections will be weak and should be reinforced with glue blocks.

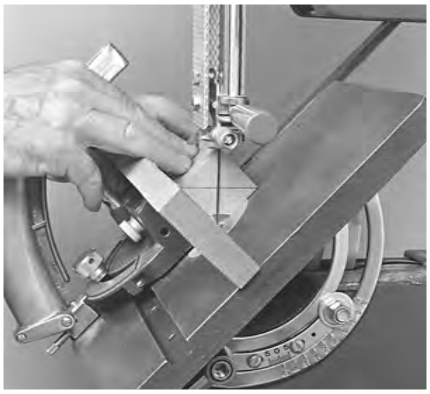


Figure 14-24. *The miter gauge can be used to guide and support the stock when making bevel cuts.*

Figure 14-25. *This is how to use the V-block arrangement to cut chamfers. The table tilt will determine the angle of the chamfer. The miter gauge with an extension supports the stock.*

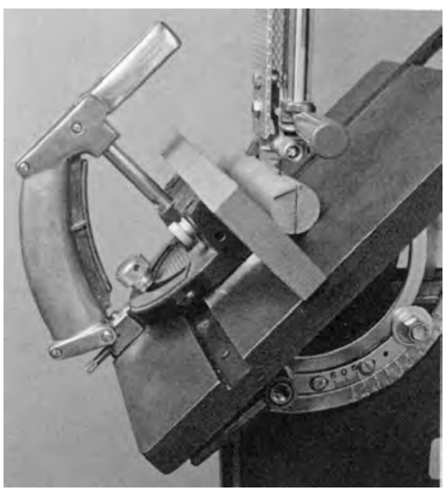


Figure 14-26. *A tilted table and a miter gauge with an extension create a perfect V-block. Always place the miter gauge so it is on the down side of the table.*

You can make bevel cuts freehand, or you can use the miter gauge to guide and support the stock. After the table is adjusted to the proper tilt, lock the miter gauge in the table slot that runs perpendicular to the flat of the blade, so that the miter gauge is on the right or downhill side of the blade facing up. This will keep the stock from sliding down the table while making the cut (Figure 14-24).

Adjust the upper blade guide so that it's as close to the stock as possible. The left or uphill side of the stock should barely clear the left guide block.

As you cut, hold the stock firmly on the table and against the miter gauge. If you're making this cut freehand, be careful not to let the stock slip downhill. This will put side pressure on the blade, making it hard for you to follow the pattern line and possibly bogging down the bandsaw.

Use the same setup for cutting triangular glue blocks or for forming chamfers (Figure 14-25). The angle of the chamfer is determined by how much you tilt the table.

ROUND STOCK

Cutting round stock requires extra caution because its shape makes the workpiece difficult to hold. ***Warning: The teeth of the blade can catch the stock, spinning it out of your hands, or worse, dragging your hands into the blade. For this reason, round stock should always be supported and guided with the miter gauge or a V-block.***

If you're ripping a round piece, such as a lathe turning, use the miter gauge with an extension locked in a tilted table to form a "V" (Figure 14-26). When crosscutting round stock, use the miter gauge to push the stock into the blade. Hold the stock firmly while you're working. By clamping a stop block to the left side of the table, you can cut duplicate lengths of dowel. Make sure the back edge of the stop block does not extend beyond the front edge of the blade (Figure 14-27). ***Warning: Be careful when making the cut because the blade guide must be raised to accommodate the miter gauge face. This exposes the blade.***

Figure 14-28 demonstrates a setup that can be used to form spiral grooves in dowels or larger rounds. The spiraling can be done on dowels before they are cut into lengths for use in glue joints, or it may be done just for decorative purposes. Tilt the table from 10° to

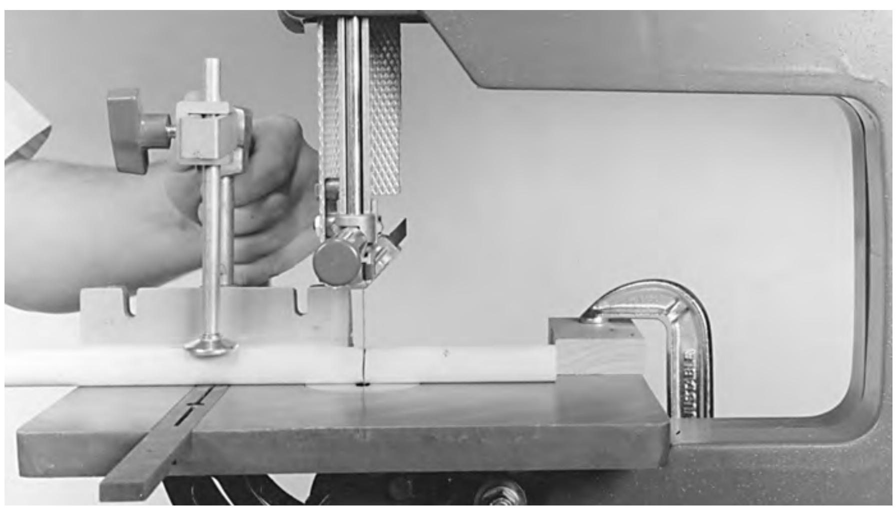


Figure 14-27. *Use the miter gauge to crosscut round stock. By attaching a stop block to the left side of the table, you can accurately cut duplicate lengths.*

20°, depending on the "pitch" you want, and lock the miter gauge in position to control the depth of cut. Slowly rotate the dowel to make the cut. This is a good way to mark stock for spirals that you hand-shape on the lathe.

Special V-Block—If you make a special V-block, you can use the bandsaw to accurately form half-round or quarter-round moldings from dowel, rounds, or from pieces that you have shaped on the lathe. Figure 14-29 shows how to make the V-block. The V-block guide that rides in the kerf keeps the stock aligned throughout the pass (Figure 14-30). Be sure to saw the kerf exactly on the centerline of the V. Position the V-block by moving it past the blade and then installing the guide. If the guide isn't a tight fit, use a C-clamp at the base of the block to close the kerf about the guide. Make certain to clamp the V-block so it is parallel to the edge of the table (Figure 14-31).

RESAWING DUPLICATE PARTS

Because the bandsaw cuts easily through thick stock, it's possible to preshape a block of wood and then resaw it into separate pieces that will be duplicates of the original design.

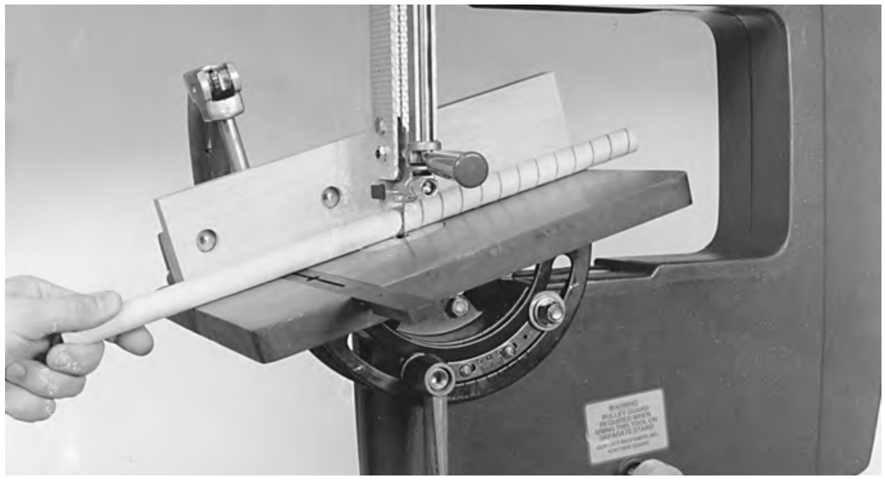


Figure 14-28. *When cutting spiral grooves in dowels and rounds, the table tilt determines the "pitch" of the spiral and the miter gauge determines the depth of cut.*

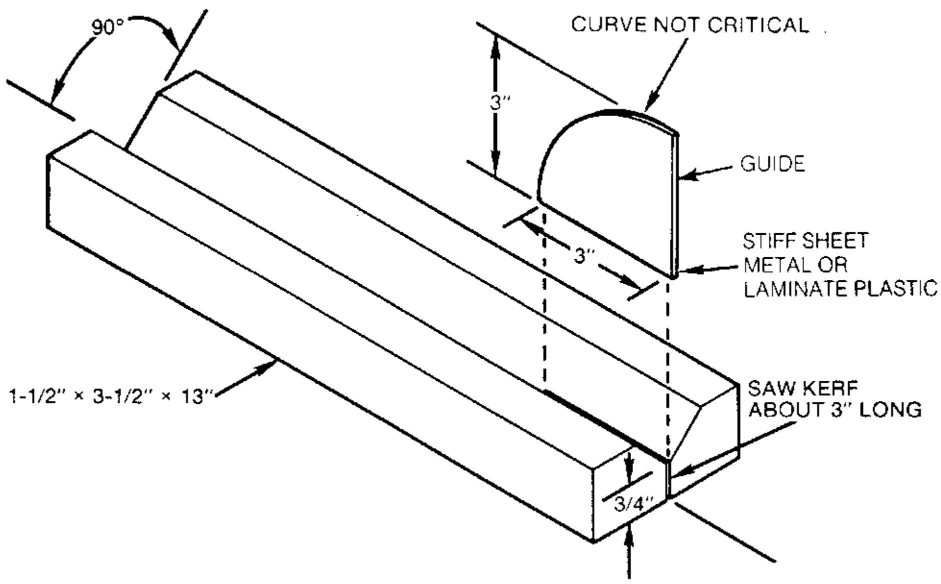


Figure 14-29. *Construction details of a special V-block.*

Figure 14-30. *The guide rides in the kerf and keeps the stock perfectly aligned throughout the pass.*

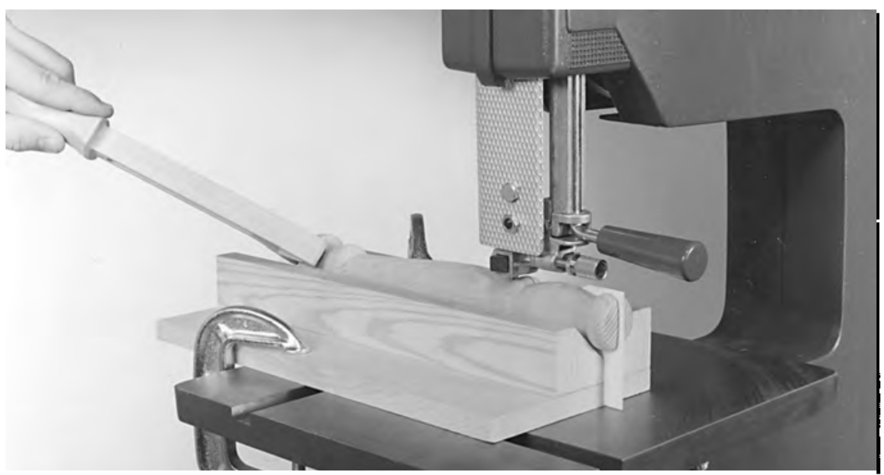


Figure 14-31. *Be sure the V-block is clamped in a position that is parallel to the table's edge. Lathe-turned pieces, as well as simple rounds, can be halved, even quartered.*

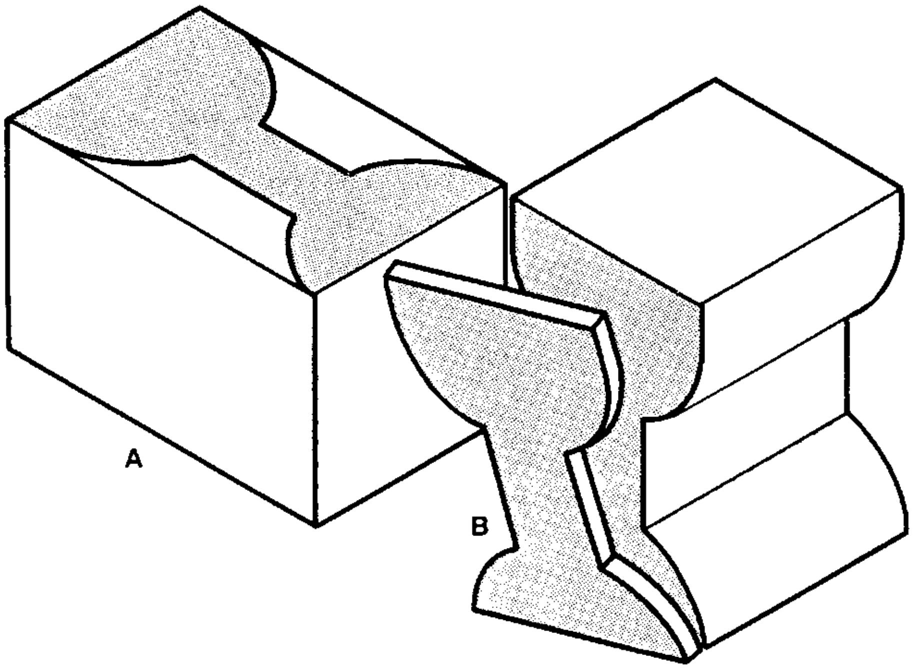


Figure 14-32. *To resaw duplicates: (A) Draw the pattern on a thick piece of stock. (B) Cut out the shape and then resaw it to make the duplicates.*

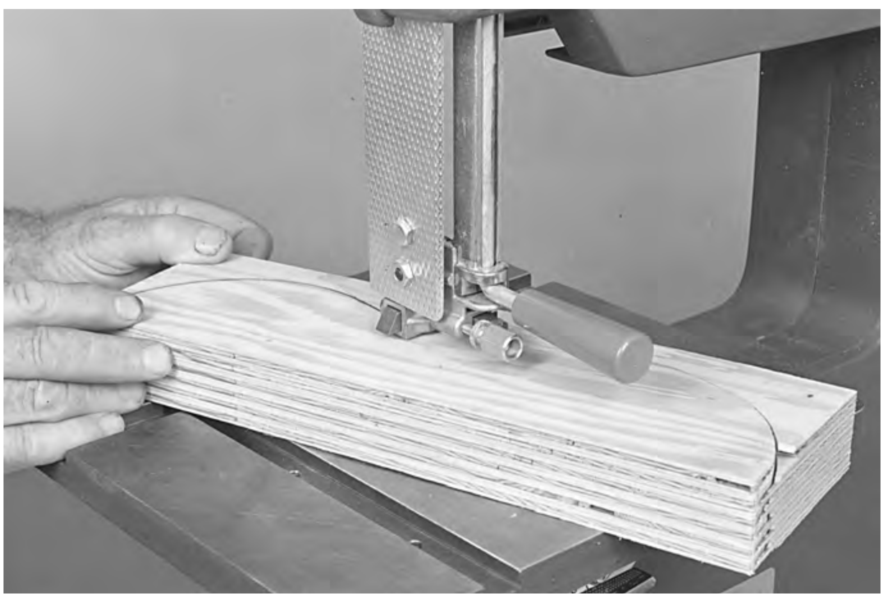


Figure 14-34. *The pad is cut as if it were a solid block of wood.*

The shape of the piece that is needed is drawn on one surface of the thick stock. The shape is then cut out on the bandsaw. The shaped piece is then resawn (Figure 14-32). Follow the procedures for "Resawing" earlier in this chapter. It's generally a good idea to leave enough extra stock so that you can sand the resawn pieces smooth.

PAD SAWING

Pad sawing is another way to quickly and accurately produce multiple pieces that have the same shape. The technique consists of holding together a pad of separate pieces, either by driving nails in waste areas or by using enough double-sided tape to do the job. The pattern of the part you need is

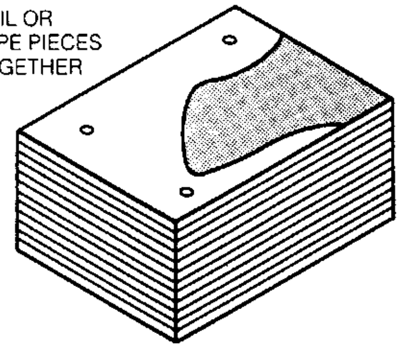


Figure 14-33. *Pad sawing is another way to produce many similar pieces. The pad of individual pieces is held together with nails or with tape.*

drawn on the top piece of stock (Figure 14-33). The pad is then cut as if it were a solid block of wood (Figure 14-34). After cutting, the parts separate into individual pieces, all of them exactly alike.

PATTERN SAWING

Pattern sawing is a method of working so that a pattern, shaped like the part that is needed, can be used as a guide to cut duplicate pieces. This eliminates the need to do layout on individual pieces and assures exact duplication.

The technique is detailed in Figure 14-35. The guide block, clamped to the table, is undercut at one end to permit passage of the material being cut and is notched to accommodate the blade's width and thickness. The workpiece, cut to rough size and shape, is held to the underside of the pattern with short brads that protrude from the pattern just enough to catch the workpiece.

Sawing is done by guiding the pattern along the edge of the guide block. Since the blade is positioned by the notch in the guide block, the work is automatically cut to the shape of the pattern.

SAWING PARALLEL CONVEX CURVES

Some duplicate curve cutting can be accomplished by using the

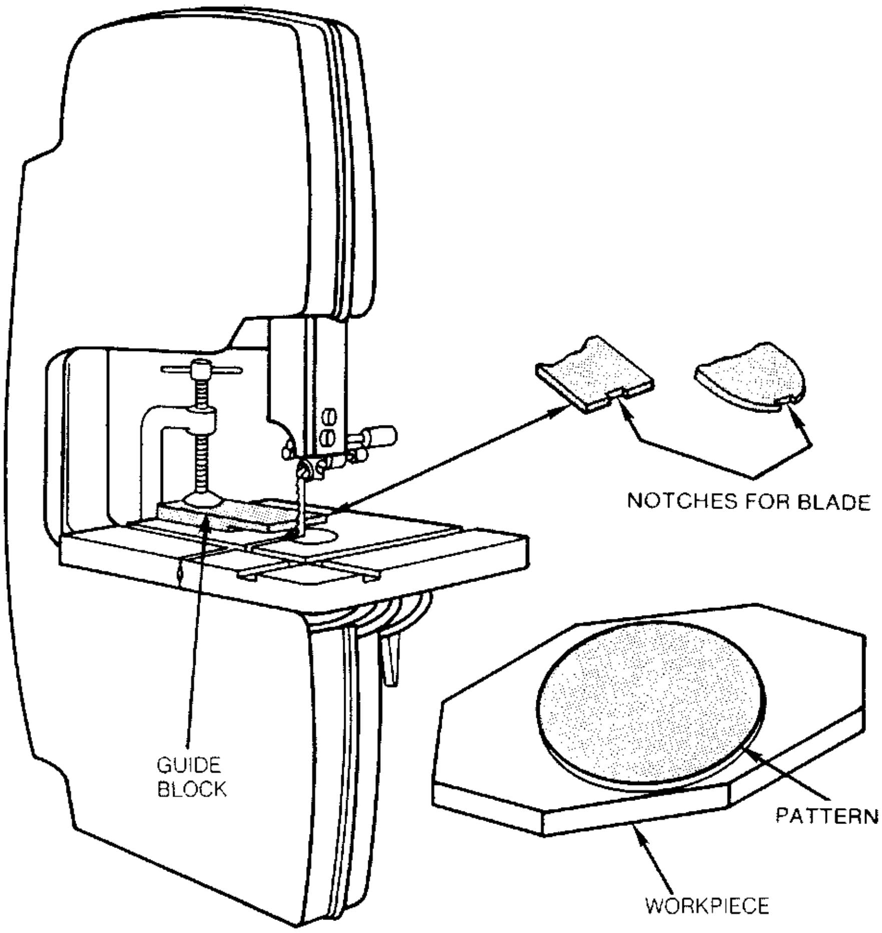


Figure 14-35. This is the setup to use for doing pattern sawing. The front edge of the guide block can be straight or round depending on the shape of the workpiece you will be cutting.

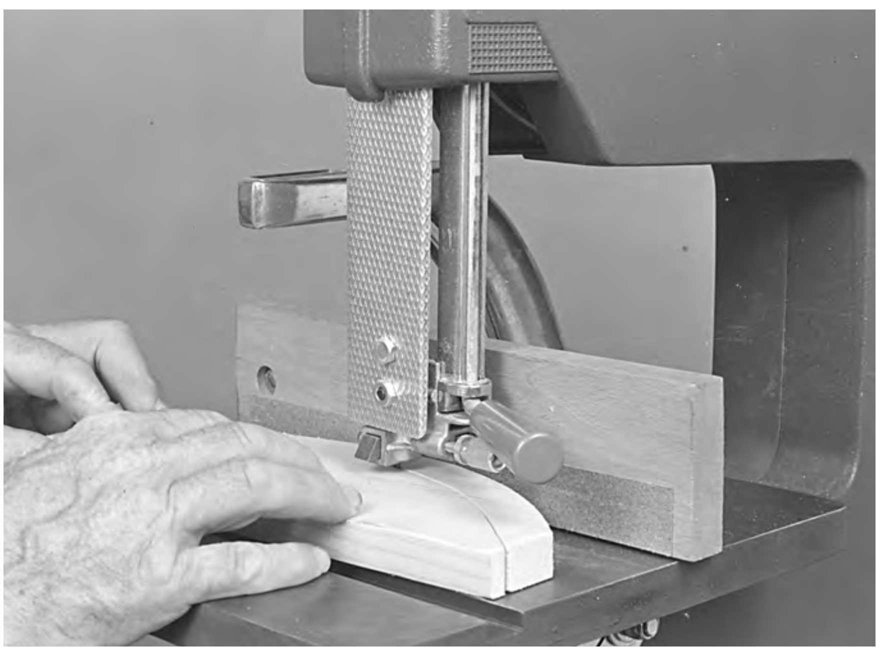


Figure 14-36. A miter gauge extension arrangement can be the guide when cutting parallel, uniform curves. The critical factor is keeping the arc of the workpiece tangent to the guide throughout the pass.

miter gauge extension setup as a guide. The workpiece is cut out on the bandsaw. Then, after the edge has been sanded, the workpiece is fed past the blade (Figure 14-36). The most important rules are: Feed the workpiece slowly and keep the arc of the workpiece tangent to the extension all through the pass. If you don't maintain the correct contact between workpiece and extension, the blade will surely move off the line of cut. Be sure the blade is sharp and has no lead.

You can't work with an extension if the workpiece has an irregular or reverse curve. For such work you need the arrangement that is shown in Figure 14-37. The guide block, with one end smoothly sanded to a point, is clamped to the table so the point is directly opposite the blade's teeth. The distance between the block and the blade will control the width of the cut. It is essential to keep turning the workpiece so contact between the workpiece and the guide's edge will be constant throughout the pass.

It is almost impossible to make the cut oversize, but it can be narrower than you want if you allow the workpiece to move away from the guide. You can use these techniques successfully if you handle the work carefully and don't try to hurry the cutting.

PIVOT SAWING

You can cut circles on the bandsaw the same way you would cut any curved line; but if you wish to automatically gauge the cut or need many similar pieces, a pivot fixture can be used. One that you can make is detailed in Figure 14-38. It is important that the fixture be situated so the pivot point is directly on line with the tips of the blade's teeth and that the blade be sharp and free of lead.

The best way to work is to first cut the piece or pieces square

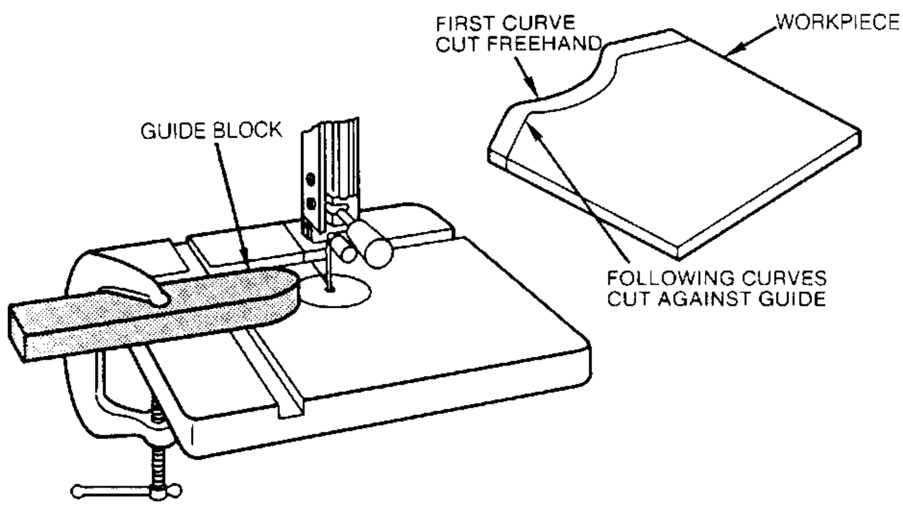


Figure 14-37. *Irregular parallel curve cutting can be accomplished this way. Be sure the first cut that you do freehand is sanded smooth.*

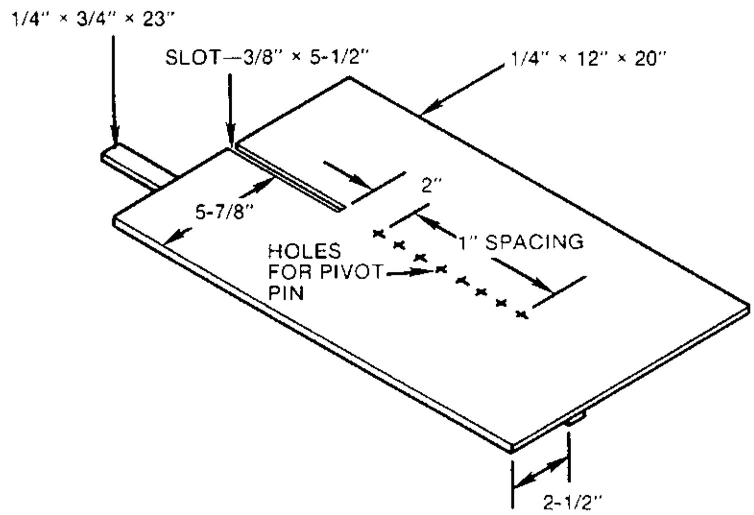


Figure 14-38. *Construction details of a pivot sawing fixture.*

Figure 14-39. *Using the pivot sawing fixture to cut a circle. Take it very easy when you start the pass to give the blade a chance to get into the cut.*

with a side-length to match the diameter of the circle you need. Hold the workpiece against the blade as you press it down on the pivot point. When you start the blade turning, it will crowd the workpiece a bit, so you must be careful to allow the blade to work into the stock. After that it's just a question of rotating the workpiece to complete the pass (Figure 14-39).

COMPOUND CUTTING

By cutting the pattern in more than one side of the workpiece—compound cutting—you can make the stock appear to curve through three dimensions, as if you had carved it. This is an intriguing bandsaw technique that's useful on a wide variety of projects. You can use it to remove stock and simplify your lathe work, make cabriole legs for tables and chairs (Figure 14-40), or do "bandsaw sculpture"—animal shapes, patterned posts and rails, fascinating lamp bases (Figure 14-41).

The sketch in Figure 14-42 is a simplified version of how stock

Figure 14-40. *The classic cabriole leg is shaped by doing compound cutting, a technique that belongs almost exclusively to the bandsaw.*

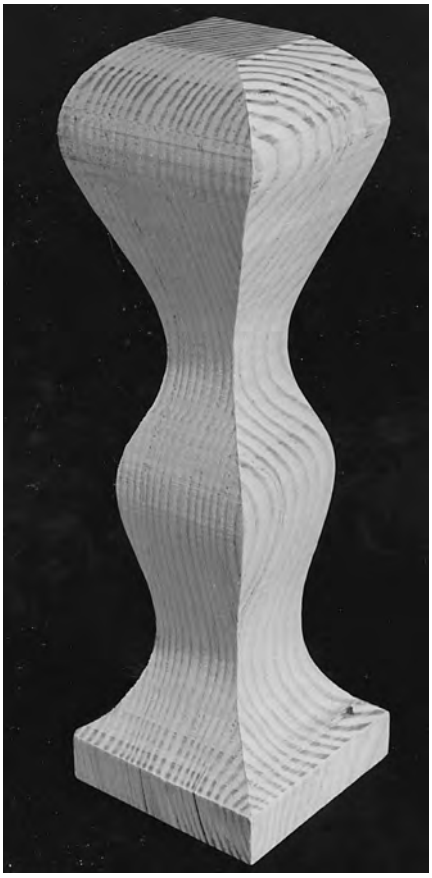


Figure 14-41. *Unusual lamp bases can be made using the compound cutting technique.*

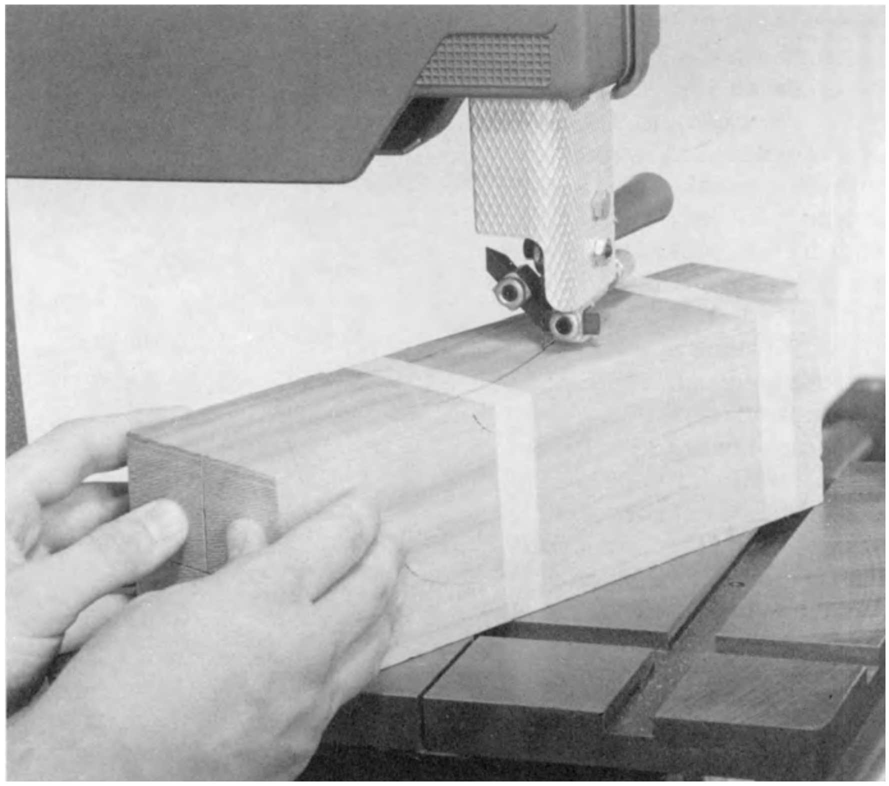


Figure 14-43. *The waste pieces that fall away after one side of the stock is cut are replaced either by nailing or taping. Then the second side of the workpiece is cut.*

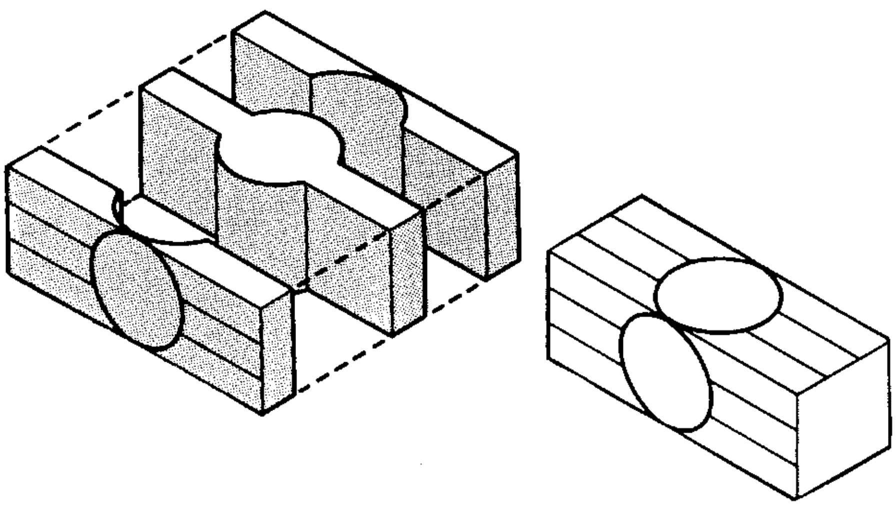


Figure 14-42. *When doing the layout for compound cutting, the pattern must be marked on adjacent sides of the workpiece.*

should be marked to prepare it for compound cutting. A pattern is used to mark the stock on two adjacent faces. The stock is bandsawed by following the pattern on one side of the stock. Then the waste pieces are put back in their original positions either by tack-nailing or by using masking tape. Then the workpiece is bandsawed on the second side (Figure 14-43). When the second phase of cutting is complete, the waste pieces fall away to reveal the finished piece.

Don't be too quick to discard the waste pieces. Some of them, as shown in Figure 14-44, end up themselves as interesting pieces that can be utilized on other projects.

CUTTING PARTICLE BOARD, PLASTICS, AND METALS

As mentioned earlier, your bandsaw will also cut materials other than solid wood and plywood. These include particle board, plastic, plastic laminates, and soft, non-ferrous metals such as brass, copper, and aluminum. ***Warning: Before cutting metals, clean sawdust out of the bandsaw because hot pieces of metal could ignite sawdust. Also remember that particle board releases toxic formaldehyde gas when cut. When cutting particle board, always work in a well-ventilated room.***

Caution: When cutting materials other than wood, always use a combination blade. You can ruin a woodworking blade immediately if you attempt to use it on tough materials like these. Even a combination blade will dull rapidly if you use it constantly for cutting these materials. Also, work at 'Slow' speed.

Feed the stock very slowly—give the blade plenty of time to cut. When cutting nonferrous metal, put a drop or two of oil on the pattern line every inch or so to help keep the blade from overheating (Figure 14-45). ***Warning: If you're cutting round stock, such as pipe, hold it securely with a miter gauge or V-block to help prevent the teeth from catching it and spinning it out of your hands.***

Caution: When you're finished cutting particle board, plastics, or metals, remove the bandsaw cover and clean the tires thoroughly with a stiff bristle brush. If you don't, the filings and chips will become imbedded in the tires and damage them. Also clean the blade.

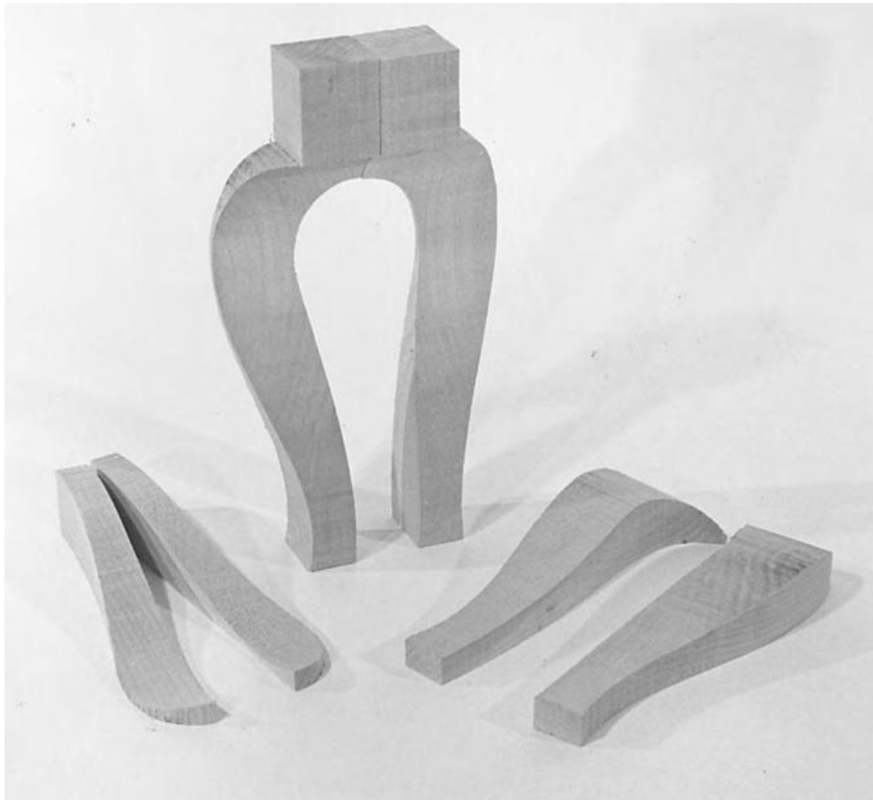


Figure 14-44. *Don't be too hasty in discarding the waste pieces that result from compound cutting. They might come in handy on some future project.*

Figure 14-45. *When cutting metal, apply oil to the cutting line to help keep the blade from overheating.*

Chapter 15
Scroll Saw

In many ways, the scroll saw is the ultimate piece of equipment for "fancy" woodworking. It can make straight or very complex curved cuts in a variety of materials including hard or soft woods, plastics, non-ferrous metals, ivory and mother-of-pearl. It's also one of the only machines which can make piercing cuts—like a donut hole—in the center of a workpiece.

These capabilities make the scroll saw ideal for cutting intricate scrollwork or making tiny models and miniatures. It's perfect for inlay, marquetry (inlaid veneer) and intarsia (wood mosaic). And with the proper blade installed, it even cuts finely enough for ornamentation or jewelry making.

Many woodworkers are confused about the difference between a jigsaw and a scroll saw because the terms are often used almost interchangeably. In fact, the scroll saw can do just about anything a jigsaw can do, but it does it better! That's because of differences in the way the two machines operate.

A conventional jigsaw powers the blade down through the cut and uses a spring to pull it back up. Since the spring is seldom fast enough to keep pace with the lower power cylinder, the blade tends to bend in the middle which produces a rough cut and leads to premature blade breakage.

With the scroll saw, however, the blade is suspended between two parallel arms. These arms move up and down with the blade, so the blade is under constant tension during both the up and down stroke. This reduces blade bending and breakage—and the slight forward and backward motion of the blade allows the teeth to cut smoothly, so sanding is often completely unnecessary.

SCROLL SAW—MODELS, SETUP AND FEATURES

The scroll saw is available in two models. One can be installed at the power mount end of the Mark V (Figure 15-1) and the other is a freestanding unit with a separate motor and stand (Figure 15-2). To set up your scroll saw, follow the instructions in the Owners Manual that came with your scroll saw.

Important features and capacities of the two scroll saw models are:

- With the proper blade installed, the scroll saw will cut stock up to 2″ thick.
- It has a throat depth of 20″ which means you can cut to the center of a 40″ wide workpiece.
- The blade mounting blocks will accept blades ranging from 1/4″ wide (very heavy) to 6/0 (very fine). The stroke of the blade is 1-3/32″.

SCROLL SAW BLADES

The scroll saw accepts virtually all standard 5″ jigsaw or scroll saw blades with plain, straight ends. Blade selection will be based on the thickness and type of material being cut; the amount of fine detail in the project; the cutting speed; and the desired quality of the finished cut.

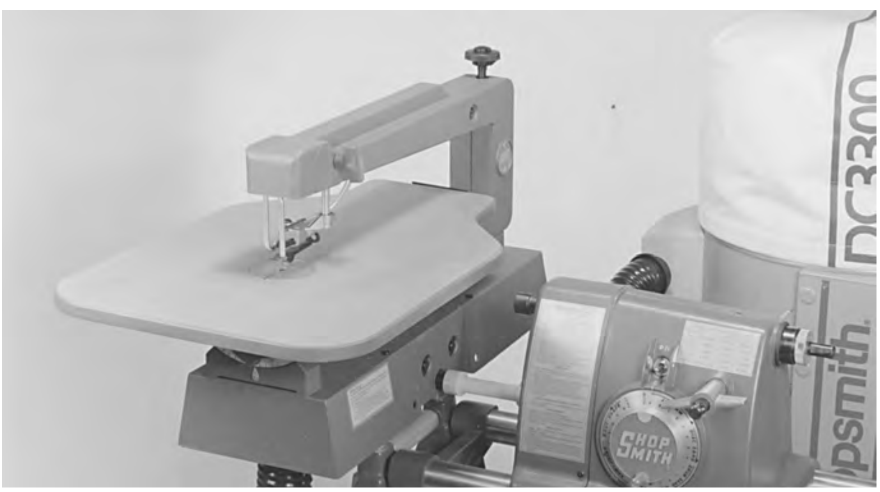


Figure 15-1. *One model of the scroll saw mounts on the Mark V.*

Figure 15-2. *A freestanding model is also available.*

Table 15-1: Scroll Saw Blades

	Teeth Per Inch	Saw Kerf	Blade Width	Use to Cut	Stock Thickness	Minimum Radius	Tension Clicks*	Mark V Mounted Unit		Freestanding Unit	
								Speed Range	Strokes per Min.	Speed Range	Strokes per Min.
	9, with 3 Reverse	.030"	.100"	Hard and Soft Wood, Plywood, Plastic	1/4" - 2"	1/8	25	Slow-O	280-1200	1-10	500-1200
	9-1/2	.024"	.062"	Hard and Soft Wood, Plywood, Plastic, Paper, Felt, Bone	1/8" - 1-1/4"	3/32	22	Slow-I	280-700	1-6	500-720
	11-1/2	.018"	.053"		1/16" - 1"	1/16	19	Slow-L	280-930	1-8	500-930
	12-1/2	.016"	.038"	Hard and Soft Wood, Plywood, Plastic, Bone, Horn, Paper	1/32" - 3/4"	3/64	17	Slow-N	280-1110	1-9	500-1130
	20	.012"	.029"	Hard and Soft Wood, Veneer, Bone, Fiber, Ivory, Plastic, Mother-of-Pearl	1/64" - 1/4"	1/32	15	Slow-O	280-1200	1-10	500-1200
	57	.010"	.021"	Hard and Soft Wood, Veneer, Bone, Fiber, Ivory, Plastic, Mother-of-Pearl, Non-Ferrous Metal	.020"-1/8"	1/64	10	Slow-H	280-630	1-5	500-650
	65	.009"	.017"		.015"-1/8"	1/64	8	Slow-G	280-570	1-3	500-560
	80	.007"	.014"		.010"-1/8"	1/64	5	Slow-F	280-510	1-2	500-530

*Start counting when the knob starts to tighten and the sound of the clicks becomes quieter.

NOTE: This chart gives recommended operational ranges. Woodcutting is done at fast speeds while plastics, bone, mother-of-pearl, non-ferrous metals, etc. are cut at the low end of the speed range for a given blade. Some experimentation may be necessary. The scroll saw accepts all standard 5" jigsaw, fret saw, and jeweler's blades.

Scroll saw blades are relatively inexpensive, so it's best to have several types and sizes of blades available for different jobs. Table 15-1 shows a number of common scroll saw blades and their intended uses. The following guidelines will also be helpful in selecting the best blade for your projects:

- For best results, use the thickest blade available that will make the necessary turns without binding or twisting.
- There should be at least two and preferably three teeth across the thickness of the workpiece. Cutting veneer or other very thin material may require blades with 60 to 80 teeth per inch.
- As the thickness of the stock increases, use a heavier blade with fewer teeth per inch. Only the coarsest blades have "set" in the teeth. Thin blades tend to bow in thick stock and fine-toothed blades may not be able to easily remove sawdust from the cut.
- Use a blade with hardened teeth for cutting aluminum, brass, silver and other non-ferrous metals. Wood cutting blades will dull very quickly in metal.
- Use the blade backup only when sawing stock over 3/4" thick. Otherwise adjust the backup away from the blade.

Two special types of blades are also available. First is a reverse tooth blade with the three lower teeth pointing up instead of down. These reversed teeth help eliminate splintering along the bottom side of the cut when working with thick stock. The second type is a spiral blade which will cut in any direction without turning the workpiece. Although spiral blades may be useful in certain situations, there are tradeoffs. Spiral blades tend to follow the grain of the wood instead of the intended cutting line—making it difficult to cut smooth, graceful curves—and the cut is much rougher, so more sanding is required.

SCROLL SAW SAFETY

Warning: Before using the scroll saw read and understand these important safety instructions:

- **Wear proper eye protection.**
- **Never reach beneath the table while the scroll saw is running.**
- **When removing the blade, release the blade tension before loosening the chuck locking pins.**
- **Never attempt to cut a radius that's too tight for the blade.**

• Never turn on the scroll saw with stock pressed against the blade.
• Never cut extremely small stock. Cut small components from larger stock.
• Adjust and lock the hold-down, check blade tension and adjust the blade backup as required for each operation.
• Install the blade with the teeth pointing toward the table.
• Before you turn on the machine, turn the drive shaft by hand to be sure the blade moves freely.
• Do not force stock against the blade or try to cut too quickly.
• Keep the table tilt locked.
• Do not use worn or damaged blades, or a worn blade backup.
• When mounting the scroll saw on the Mark V, secure the accessory mount lock, power plant lock, and the scroll saw mounting tubes.

PATTERNS AND LAYOUT

Full size patterns for scroll saw projects are available in magazines and books as well as from commercial suppliers who provide letter templates for signs or complete project plans. If your plans are not full size, they can be enlarged by methods such as the grid system (Figure 15-3) or by using a pantograph (Figure 15-4).

Another very effective way to produce full size patterns is by using a copier machine which can enlarge and reduce. By making an enlargement of an enlargement, small drawings can be quickly and accurately increased to many times their original size and the cost is minimal, even if several copies are required.

The full size pattern can then be transferred to the stock in several ways. For light colored wood you can use carbon paper or trace around a heavy paper cutout of the piece. On darker woods or for very accurate work it is usually easier to attach the pattern directly to the stock before cutting (Figure 15-5). This can be done with a thin coating of rubber cement or with a spray adhesive.

After the stock has been cut, you can easily remove the pattern by belt sanding. If the pattern is reversible, you can even leave it attached to the back side of the project. In either case, the pattern will be destroyed, so you will want to make copies for duplicates or in case of cutting mistakes.

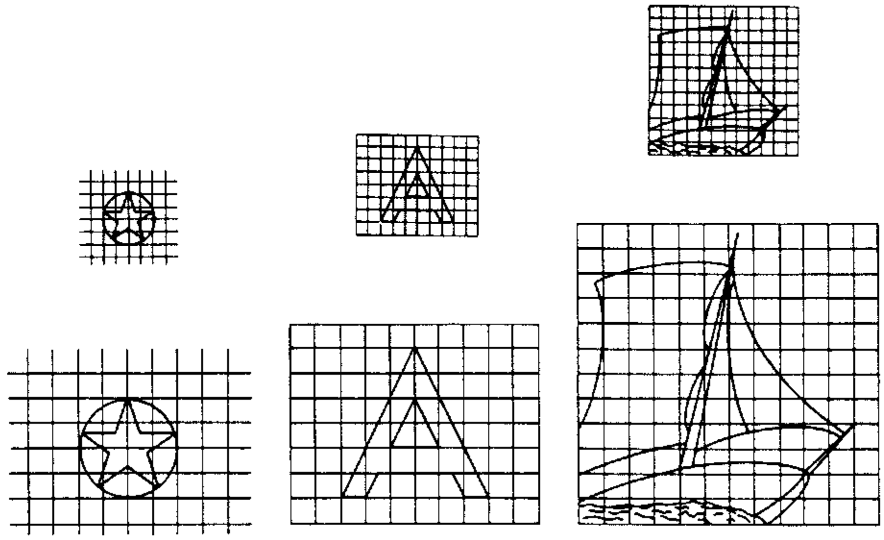


Figure 15-3. *The grid system is commonly used to enlarge an illustration to create full size patterns.*

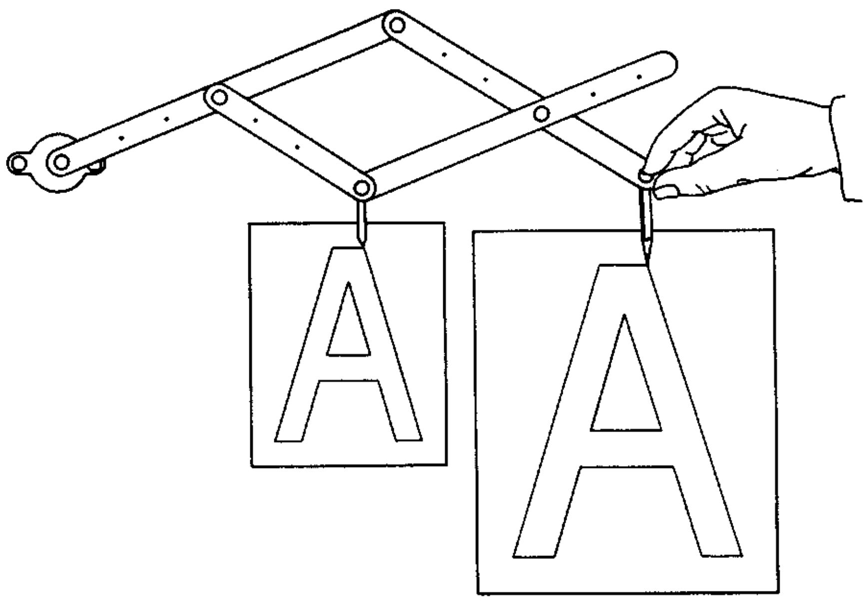


Figure 15-4. *A pantograph makes enlarging or reducing plans quick and easy.*

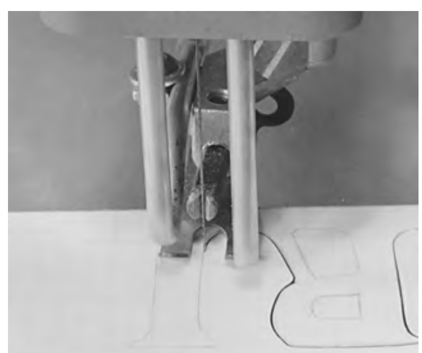


Figure 15-5. *With dark woods or for more accurate results, patterns can be mounted directly to the stock.*

SCROLL SAW SPEEDS AND FEEDS

Machine speed (in strokes per minute) is determined by the type and thickness of material being cut and the blade in use. Refer to Table 15-1 for the recommended speeds for various blades and materials.

For most general scroll work in hard or soft wood the higher recommended speeds will be best. Slower speeds should be used when working with very thin blades or hard, brittle materials or nonferrous metals. Slower speeds are also good for thin stock or delicate materials such as veneer.

Some woods, such as walnut, tend to burn at higher cutting speeds, so both speed and feed rates must be reduced. A little practice and experimentation will be time well spent.

BASIC SCROLL SAW TECHNIQUES

After selecting and installing the correct blade, adjusting the blade tension, checking the speed setting and adjusting the work hold-down, you're ready to begin cutting. If you have a tall stool handy, you may want to work sitting down instead of standing. It's a lot more relaxing—especially for long sessions.

Before cutting thick stock, it's a good idea to be sure the table is square to the blade. This can be checked with a square or a thick piece of scrap wood. Just feed the scrap stock into the blade enough to score the wood slightly—then swing the piece around behind the blade (Figure 15-6). If the table and blade are square, the blade will be aligned perfectly with the kerf. If not, adjust the table to eliminate **half** the difference and try again.

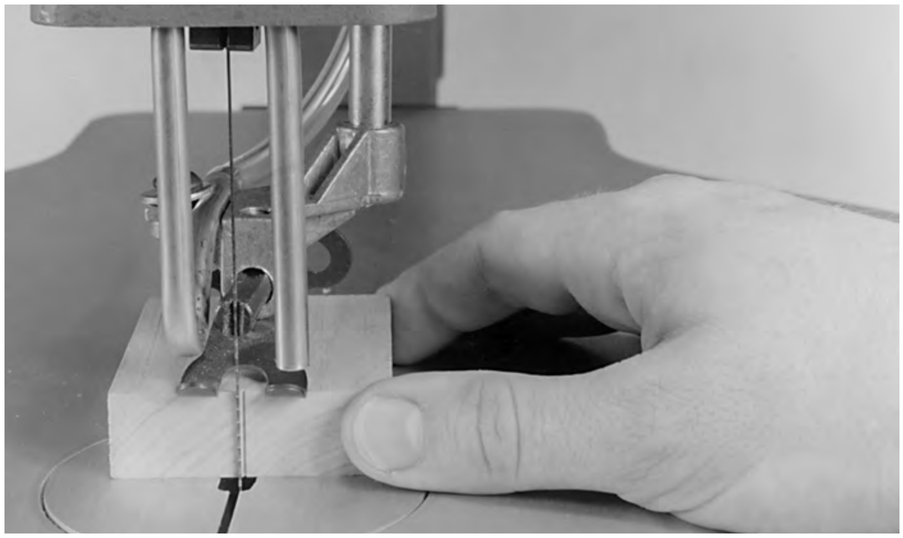


Figure 15-6. *A scoring cut in a thick piece of scrap is a way to check that the blade and table are square.*

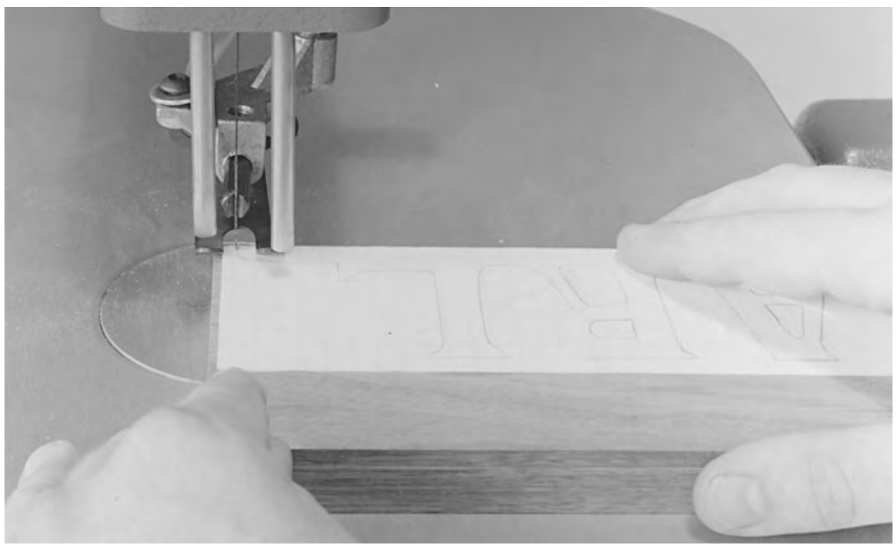


Figure 15-7. *An outside corner makes the best starting point. Avoid starting at a curve—especially when cutting parallel to the grain.*

Selecting a Starting Point

The best place to begin cutting is almost always at an outside corner (Figure 15-7). Then when you come around the workpiece you can finish off with a sharp, clean corner with little or no sanding.

If you must begin cutting along a curve—such as when sawing a round circle—begin cutting across the grain, not parallel to it. This reduces the tendency for the blade to follow the grain and make a bump or dip where the cut begins and ends. You may even want to begin and end the cut slightly outside the pattern line and then sand away the excess to produce a perfectly smooth curve.

Simple Cuts

For general cutting, press the stock lightly against the table and feed it smoothly into the blade. When properly adjusted, the hold-down will minimize vibration and yet be loose enough to allow the stock to move freely.

The scroll saw cuts fairly quickly, but don't try to force the stock or you'll bend the blade and reduce the accuracy of your cut. In most cases, slower feed rates will result in a smoother finished cut. This is especially true when cutting very soft or stringy woods and less critical on harder woods such as maple or oak.

If you're new to the scroll saw, you may be tempted to cut slightly outside your pattern line and then sand away the excess. Although this can be done, the scroll saw cuts so smoothly that sanding is seldom required. Therefore, practice cutting right on the pattern line and eliminate the extra work, except for special situations as mentioned above.

On straight cuts—especially with heavier blades—you may find that the blade tends to "lead" or cut slightly to one side of your intended line. This is caused by the set of the blade or minor imperfections in the teeth which cannot be eliminated during manufacturing. It's easy to compensate for this problem by feeding the stock at a slight angle—usually two to four degrees.

You may also notice a tendency for the blade to follow the grain of the wood when you are ripping or cutting parallel to the grain. This problem can be eliminated by slowing your feed rate to give the blade plenty of time to cut.

Corners and Tight Turns

Although a constant tension scroll saw will permit you to make turns in an area only slightly larger than the width of the blade, no machine can cut a sharp, square inside or outside corner in a single pass. Therefore, some compromise or combination of techniques must be used.

Outside corners are usually cut in one of two ways. One method is to cut completely across the stock and out, then turn the workpiece and begin cutting in the new direction (Figure 15-8A). The other method is similar, but you simply loop around in a scrap area and come into the corner from the new direction (Figure 15-8B).

Sharp, clean inside corners must also be cut in two passes which intersect at the corner. This can be done by cutting into the corner from one direction, then backing the blade out through the kerf and approaching the cut from another angle (Figure 15-9A). An alternative is to cut into the corner from one angle, back up slightly and cut across the corner, then come back to clean out the small remaining piece of scrap (Figure 15-9B).

Many scroll saw projects do not require perfectly square corners and a tight radius turn will be all that's required. Unlike a bandsaw or jigsaw, the scroll saw lets you turn almost on-the-spot by spinning the workpiece around the

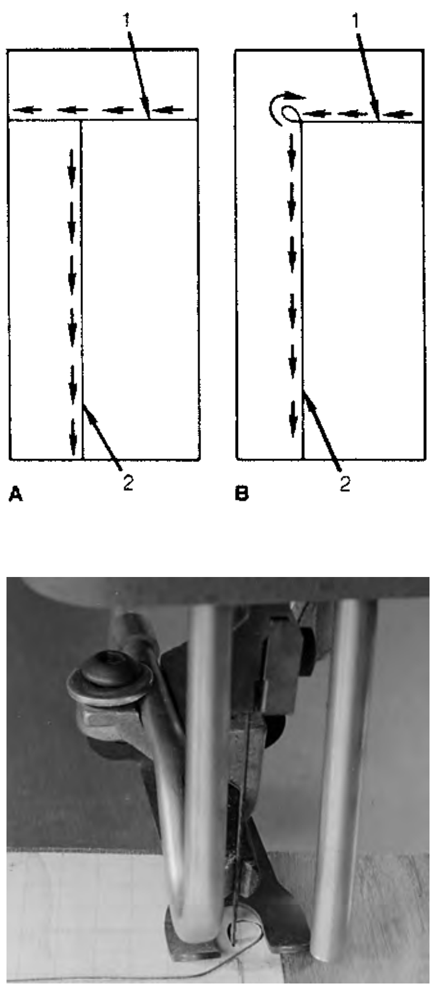


Figure 15-8. Sharp outside corners can be cut: (A) in two passes or (B) by looping around in the scrap area.

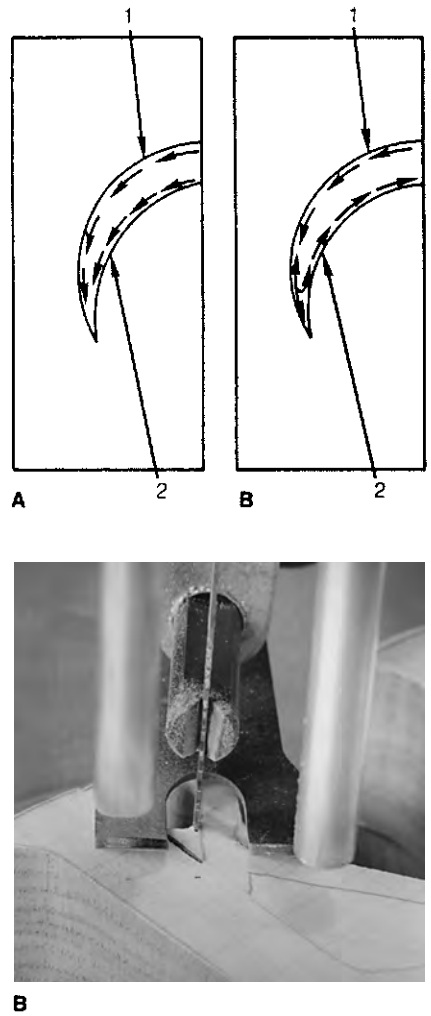


Figure 15-9. Sharp inside corners may be cut: (A) in two passes or (B) by cutting across the corner, then coming back to remove the remaining scrap.

blade. Just hold the stock against the table and spin it smoothly and quickly, being careful not to press sideways and deflect the blade.

This spinning technique is easy to learn. Practice making these on-the-spot turns with a scrap piece of 1/4" thick stock until you can make a cut, turn 180° and come back out the original kerf (Figure 15-10).

Planning Complex Cuts

Always take a minute to plan your cuts—especially in delicate or intricately detailed scrollwork. Whenever possible, break complex designs up into several simple curves or shapes and don't hesitate to back up along the kerf or

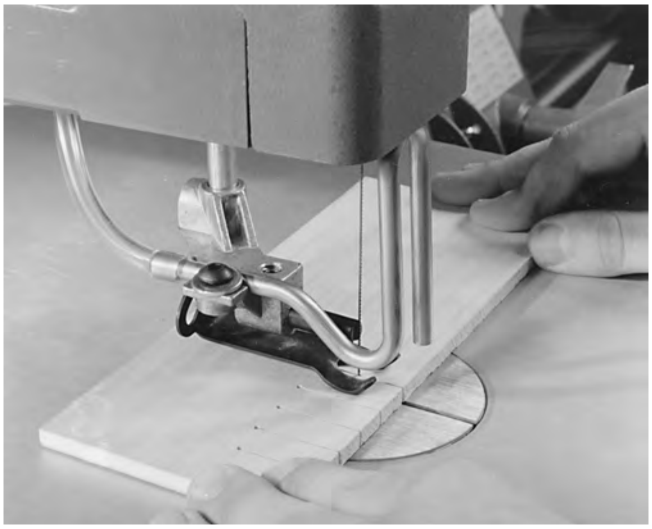


Figure 15-10. With a little practice the scroll saw can make 180° turns in little more than the width of the blade.

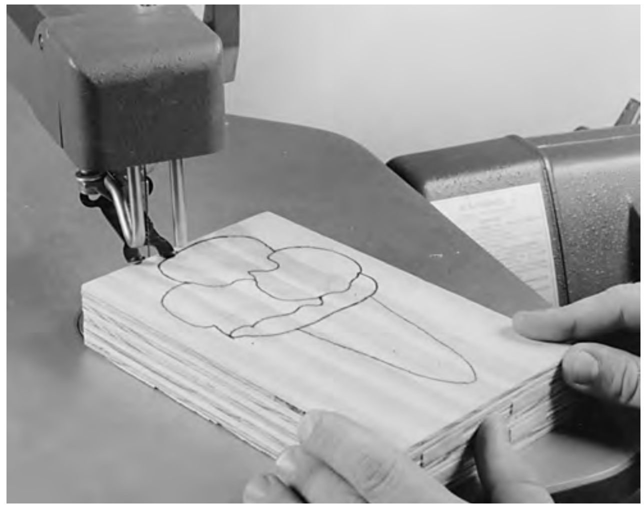


Figure 15-11. Several layers of material can be stacked, fastened together temporarily and cut all at one time for duplicate parts.

leave the pattern line and cut into the waste area to get a better angle for the next section.

In some cases—such as cutting inlays or matching parts—there will be no waste stock, so the entire shape must be cut in a single pass. In these cases, you may want to simplify the design to make cutting easier or you can practice cutting the shape in scrap stock to locate trouble spots and develop confidence.

PAD SAWING

Pad sawing—or cutting several layers of material at once—is a great way to save time when you need duplicate pieces for a project (Figure 15-11). You can also create special effects by stacking different types of woods and then mixing colors and textures during final assembly (Figure 15-12).

For pad sawing, transfer your pattern to the top piece and then stack as many layers as you need—up to 2″ thick. You can hold the layers together temporarily with nails or brads in the scrap area, by taping around the outside of the stack, or with double-faced tape between each layer.

It's also a good idea to be sure the table and blade are square before starting the cut. Even a slight angle will result in finished pieces of different sizes.

Figure 15-12. Mix woods of different colors and textures to create unique effects.

PIERCING CUTS

One of the most useful features of the scroll saw is its ability to make cutouts in the center of a workpiece. These piercing cuts are made by unclamping one end of the blade, threading it through a starting hole and then reinstalling the blade before making the cut (Figure 15-13).

The starting hole should be located close to the layout line—preferably close to an inside corner to reduce wasted effort cutting across the scrap. The starting hole should also be 3/4″ in diameter whenever possible. This saves time because the mounting block and blade can pass through the hole.

On more delicate work the starting hole can be only slightly larger than the width of the blade, but the blade must be removed from the upper blade mounting block, threaded through the hole and then reinstalled. When removing

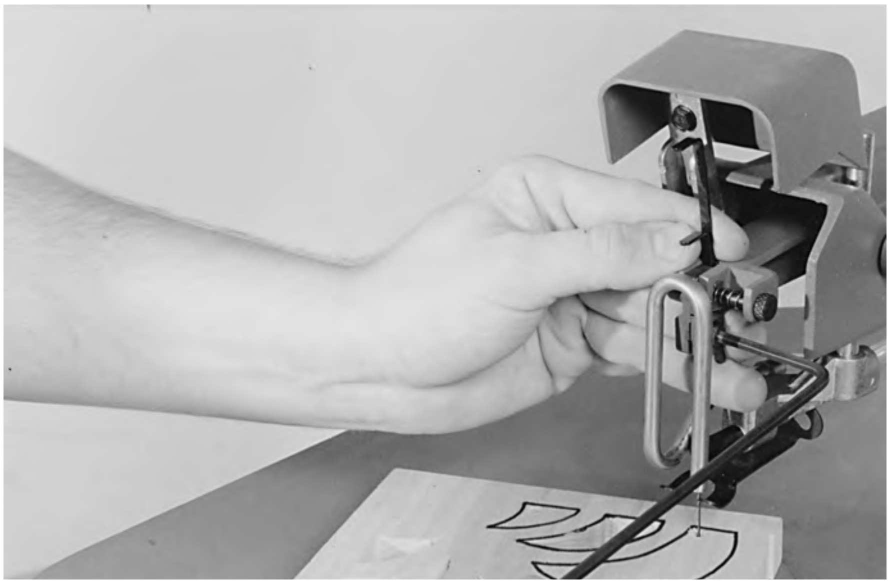


Figure 15-13. For piercing cuts, drill a starting hole close to a corner and thread the blade through it.

and remounting the blade use the blade clamp shim to prevent the mounting block from turning and be careful not to bend the blade. Be sure the blade is properly seated in the mounting block and readjust the blade tension before cutting.

BEVELS AND CHAMFERS

The scroll saw table tilts either right or left and locks at any angle from "0" to 45°. This allows you to add decorative bevels or chamfers to workpieces and also makes it possible to cut inlay or relief pieces which will fit into the background with no visible saw kerf. These inlay techniques are described later.

In general scrollwork, almost any shape can be cut with a beveled edge; however, the complexity of the shape and angle and direction of the bevel will limit how smoothly and accurately the cut can be made. For example, outside curves, such as a circle, can be cut very easily even with a 45° bevel, but tight inside curves become more and more difficult as the radius gets smaller and the angle of bevel increases.

It is also important to keep the workpiece on one side of the blade if the bevel is to point in the same direction—either in or out—all the way around the piece. This can limit the complexity of your designs because tight curves and corners may have to be cut in a single pass instead of backing up and approaching them from the opposite direction. Advance planning and your own skills are especially important when cutting pieces where the bevel will be visible on the finished project.

The best way to master bevel cutting is to practice with scrap stock before beginning on a project. Depending on whether you are right or left handed, you'll probably find it more comfortable to tilt the table one way or the other and turn the workpiece either clockwise or counterclockwise. The table tilt and direction of rotation will also determine which way the bevel faces.

Chamfers are similar to bevels except that only a portion of the edge is cut at an angle, so a second pass must be made after the piece is cut to shape.

A common chamfer angle of 45° results in the same amount of stock being cut from the face and the edge of the piece. Other angles will change this relationship. Depending on the angle of cut, the chamfer line can be marked on either the face or the edge of the workpiece to serve as a cutting guide (Figure 15-14).

As with beveling, accurate chamfering is difficult—especially on tight inside turns, so after the chamfer is cut, go back over the edges with sandpaper or a file to remove rough spots or other imperfections.

SOLID WOOD INLAYS

Flush inlays of complimentary or contrasting woods can be used to accent your most sophisticated projects. They can be made with

A

B

Figure 15-14. When chamfering irregular shapes, (A) draw a gauging line around the workpiece and then (B) saw to the line with the table tilted.

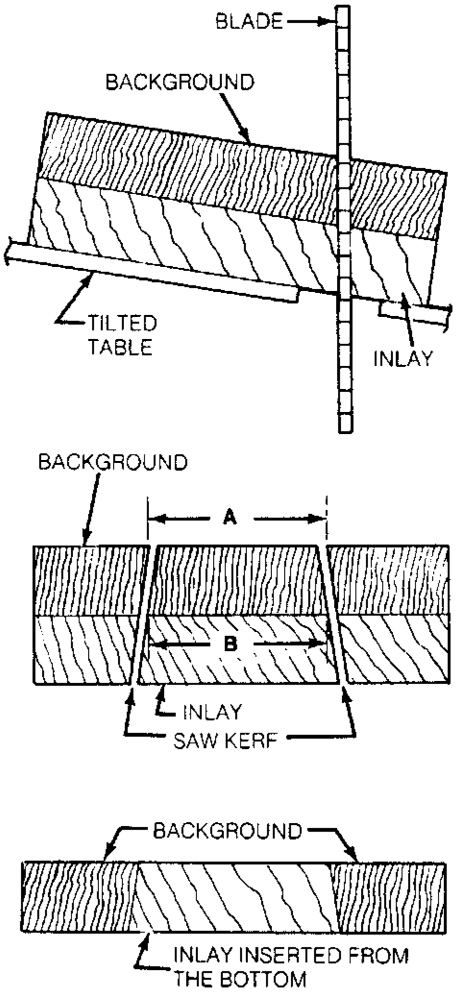


Figure 15-15. When sawing inlays, experiment with the table tilt until distances "A" and "B" are equal. The inlay will then fit snugly into the background.

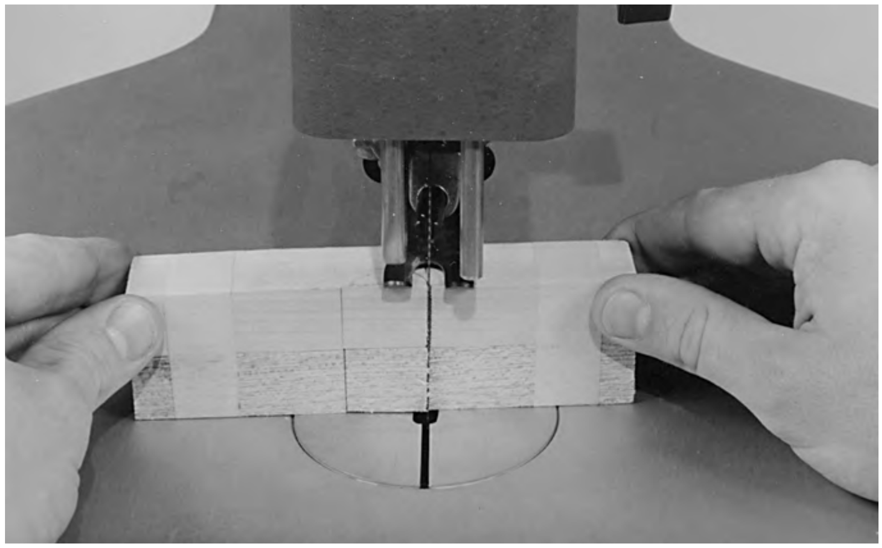


Figure 15-16. Tape scrap pieces of the background and inlay stock together. Make trial cuts until pieces fit correctly.

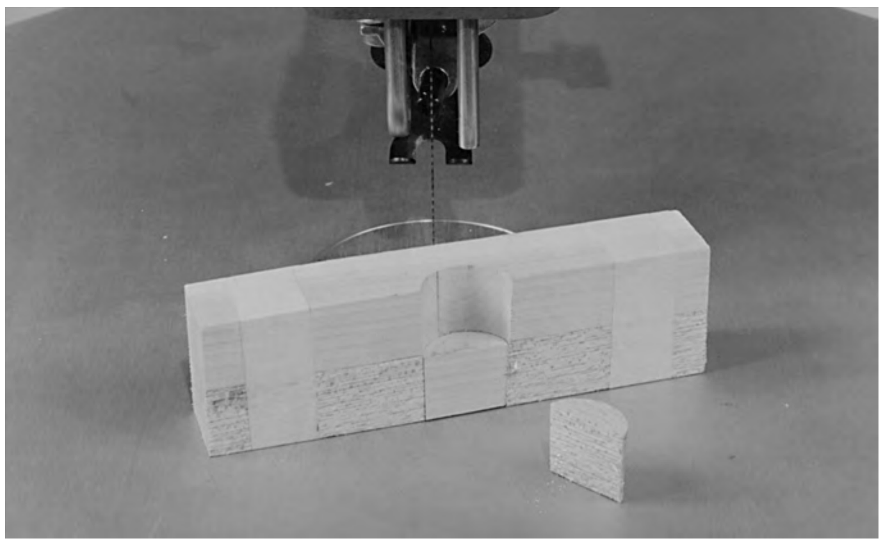


Figure 15-17. Fit the inlay pieces into the background.

no visible gap or saw kerf thanks to the scroll saw's piercing and bevel cutting capabilities. But professional looking inlays require patience and practice because a very slight bevel angle is used and both the background and insert pieces are cut at one time. This means there will be no waste area for repositioning the stock, so your planning, setups and cuts must be made very accurately.

After selecting your pattern and stock, the correct table tilt must be determined. This angle will usually be between one and eight degrees, depending on the thickness of the stock and the width of the saw kerf. It is easiest to find this angle by trial and error (Figure 15-15).

You should also consider which way the table will tilt and which direction the stock will be rotated during the cut. Either direction will work as long as you plan it that way. For example, tilting the table to the right and rotating the stock clockwise will make the lower piece fit into the upper one. Tilting to the left or cutting counterclockwise will make the upper piece fit into the lower one.

When your setup is ready for a test, tape scrap pieces of the background and inlay stock together and cut out a trial piece at the edge of the stock (Figure 15-16). Be sure to rotate the test piece in the same direction you will be using for your final cuts. Then try fitting the inlay test piece into the background (Figure 15-17). When the correct angle and direction of rotation is used, the inlay piece will fit snugly into the background with only enough room to allow for glue. If the test piece is too small or too big, adjust the table tilt slightly and try again until the pieces fit correctly.

You may also want to increase the blade tension somewhat for cutting inlays because bulges or bowed cuts can ruin your project. This increased tension will cause blades to break more frequently, but with a little practice, you'll find a good compromise.

When everything is ready, fasten the inlay and background pieces together as you would for pad sawing and drill a hole to insert the blade. This hole must be drilled at the same angle as the table tilt, so cut a piece of scrap or use your test piece as a drilling guide (Figure 15-18). Since this hole must be filled when the project is complete, make it as small as possible for the blade you're using and drill close to an inside corner or other inconspicuous location.

Finally, if you're making duplicates or cutting several designs with the same stock and blade, go ahead and finish them all while the setup is correct. Any change in blade width or stock thickness will require a new setup.

RAISED OR RECESSED INSERTS

Raised reliefs or recessed designs are cut very much like inlays, but two different pieces of stock are not usually required. The desired shape can often be cut on a bevel from a single piece of stock and then raised above or lowered into the background to produce a three dimensional effect (Figure 15-19). Contrasting stains or other techniques can then be used to highlight important areas or create special effects.

Table tilt and blade angle are less critical than they are for inlays. Any angle will work as long as it is wide enough to cover the saw kerf. The greater the table angle, the less relief or recessing you will achieve. With a little experimentation you can create striking designs with multiple levels above and below the basic background.

Also think carefully about the direction of rotation of the workpiece

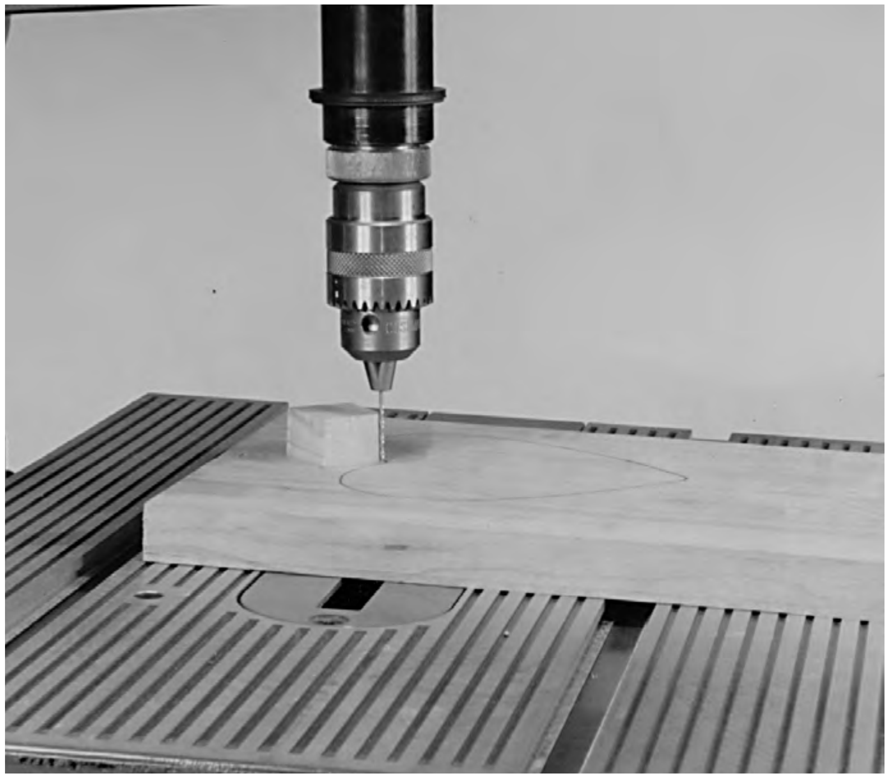


Figure 15-18. Use your test piece as a guide for drilling a hole for the blade at the proper angle.

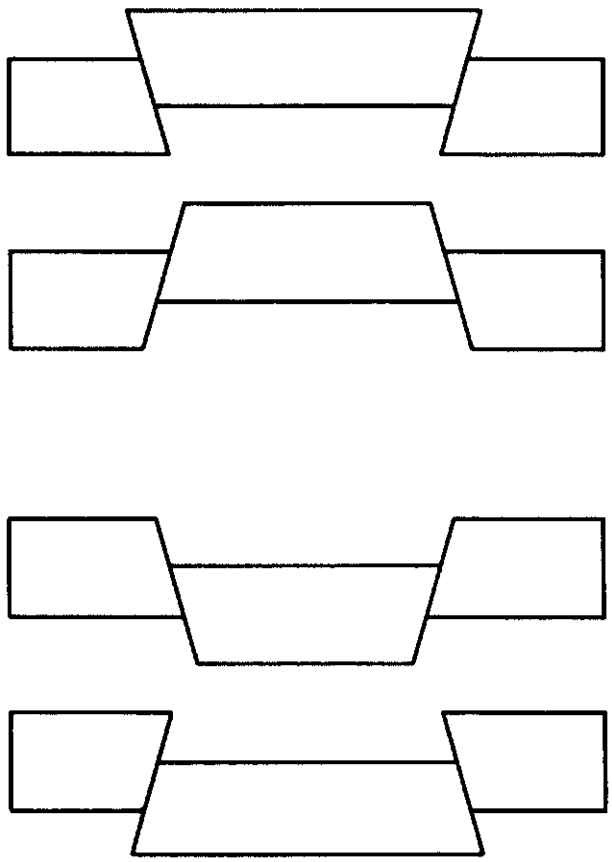


Figure 15-19. Reliefs and recessed inlays may be cut to install from either the front or back.

into the blade. One direction will produce a raised relief—the other a lowered recess. Either can be attractive as long as it's what you had planned.

Reliefs, recesses and inlays can also be accented by sculpting the edges of the insert, background or both (Figure 15-20). This is often done by rounding over the edges with sandpaper or a file to create a visual distinction or to accentuate the shadow line where the two pieces come together.

When you're ready to assemble your relief or recessed pieces, hot melt glue fillets on the back side are an effective way of joining the pieces. These fillets are strong enough to hold most decorative projects and yet they won't run onto the edges or face of the project like most woodworking glues, so you save cleanup time and frustration.

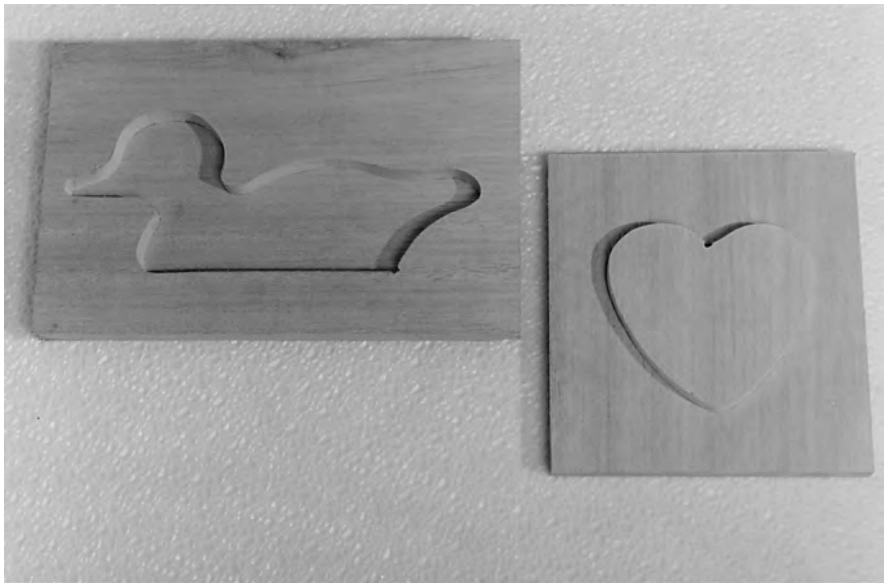


Figure 15-20. *Bevel cutting can produce recessed or raised relief projects like this. One or both edges may be rounded over to accentuate certain designs or produce special effects.*

SMALL PIECES AND THIN STOCK

In addition to its other capabilities, the scroll saw is the most delicate and precise cutting tool commonly available to the home craftsman. This makes it ideal for sawing very thin materials such as plastics and veneers, cutting extremely small pieces for models and miniatures, or even creating custom jewelry and decorative ornaments.

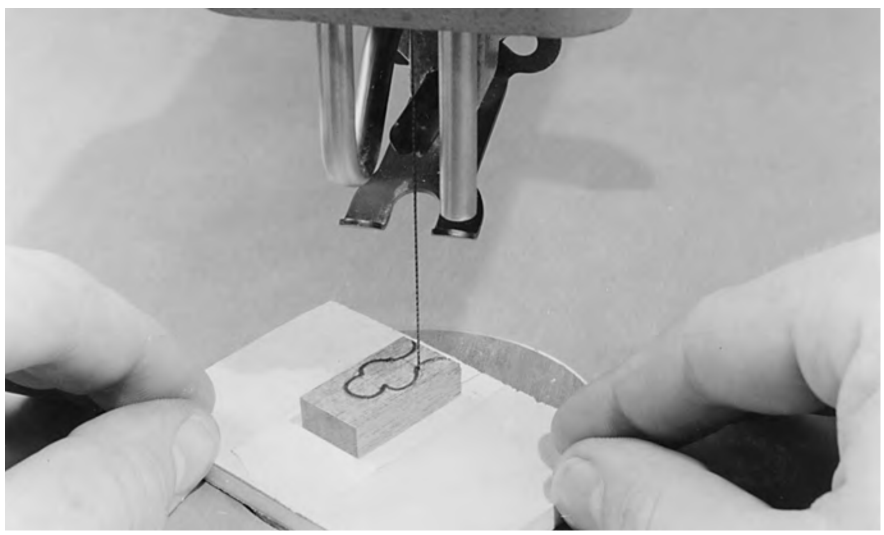


Figure 15-21. *Cut small components from larger stock or tape the stock to a scrap of plywood, posterboard or cardboard for safety and better control.*

Small Pieces

Cutting very small pieces presents two immediate problems. First, the workpiece is often too small to control by hand and still keep your fingers a safe distance from the blade. Secondly, the normal blade opening in the table insert may be too large to support the piece properly.

To achieve better control, small components should be cut from a larger, easier to manage piece of stock. A suitable piece of scrap is often available and the waste is insignificant.

If you must work with a tiny piece, use double-sided carpet tape to mount it temporarily on a scrap of plywood, posterboard or cardboard (Figure 15-21). In this case, the hold-down will probably be too large to function properly, so lift it out of the way for better visibility and press down on the backup stock to prevent it from lifting or fluttering with each upstroke of the blade.

Additional support for cutting very tiny pieces can be achieved by making either a special table insert or complete table covering from hardboard. This covering may be attached to the scroll saw table with double faced tape.

To make a table covering, layout and drill a small hole for the blade in the center of the insert (Figure 15-22). Refer to the Scroll Saw Owners Manual if the blade is not centered in the insert.

Check the blade tension and speed setting before beginning your cut. A blade with too little

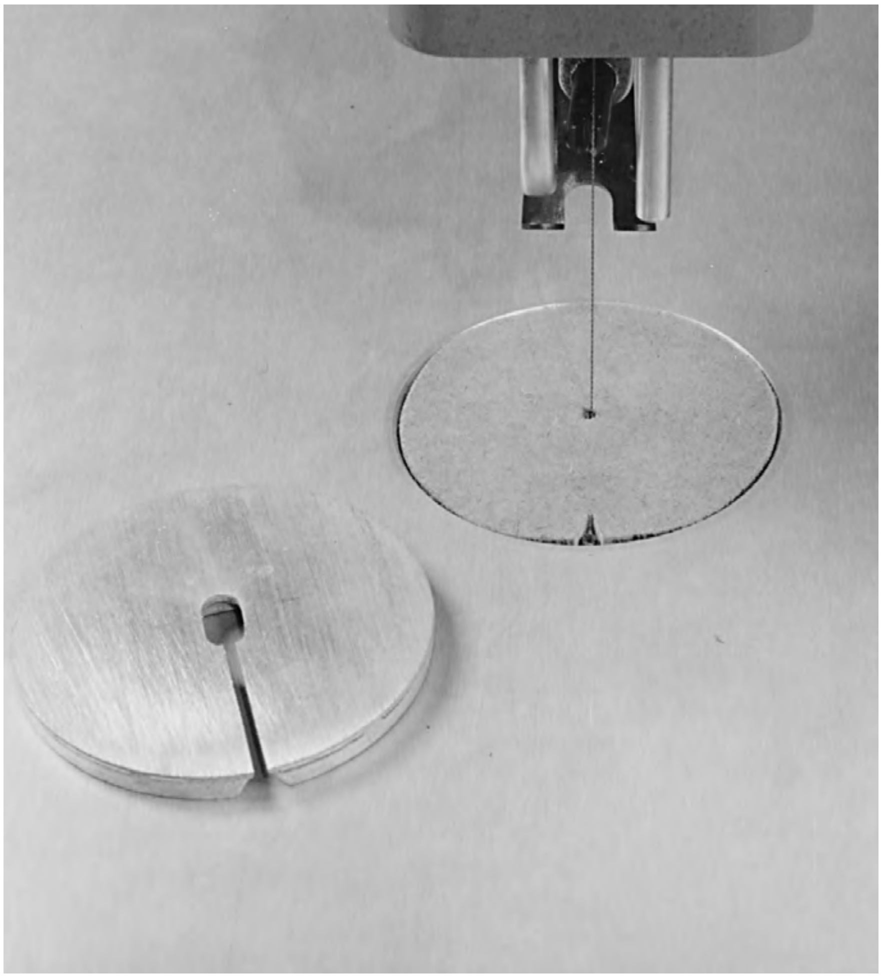


Figure 15-22. Make an auxiliary table insert out of hardboard to provide extra support for cutting small pieces or thin stock. A hole drilled in the center of the insert accommodates the blade.

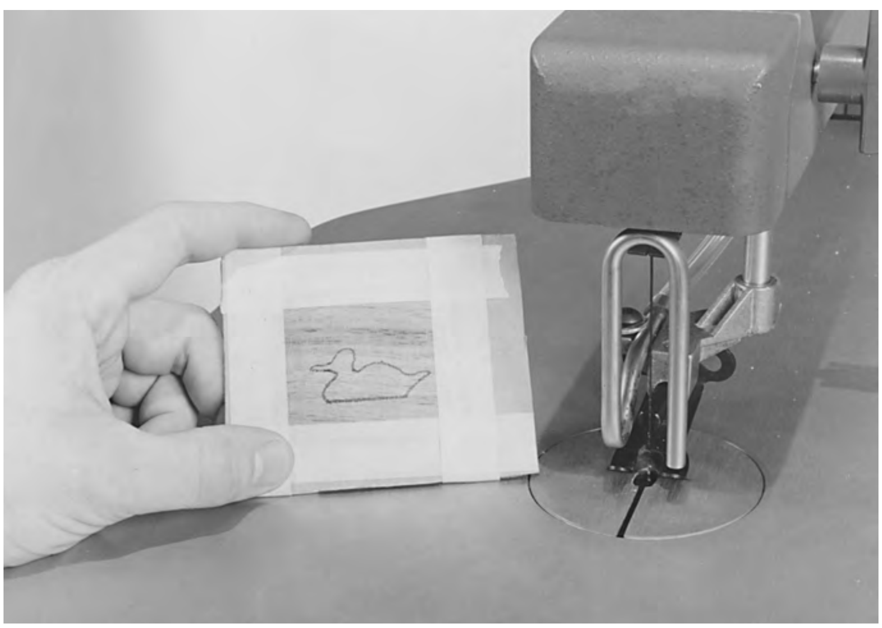


Figure 15-23. Tape veneer to cardboard or posterboard for added support and a cleaner cut.

tension will be difficult to control, especially for fine detail. Many people also find that slower speeds are less distracting for close work.

Thin Stock and Veneers

Veneers and other thin materials must be handled carefully to prevent splintering and tearing. Choose a very fine blade and adjust the tension to the highest recommended setting. Reduce the tension slightly if blades begin to break frequently. Also select the lowest speed setting—especially if the material is brittle or the piece requires intricate detail.

Even if you are using the special insert or table covering mentioned above, you'll get better results by supporting veneers during the cut. This is easily done by taping the veneer to a piece of cardboard or posterboard (Figure 15-23). Many people sandwich the veneer between two layers of posterboard to prevent fluttering.

If they are available and suitable for your project, the new adhesive-backed veneers seem to splinter somewhat less than ordinary types, but even these cut smoother when an additional backup is used.

CUTTING METAL, PLASTIC AND OTHER MATERIALS

In addition to its woodworking capabilities, the scroll saw can be used to cut a wide variety of materials including non-ferrous metals, rigid plastics and even such unusual items as bone, ivory, mother-of-pearl, rubber, cork and paper.

Obviously the characteristics of these materials vary greatly, so it is impossible to provide complete instructions in a limited space. The following suggestions should be used as a guide to help you get started, but you'll need to experiment to find the best techniques for each material.

Metal Cutting

Metals vary widely in hardness and ease of cutting, but all metals require blades which have hardened teeth. These blades are identified as suitable for metal cutting and are available from heavy duty sizes down to extra fine jeweler's blades. *Caution: Trying to cut metal with an ordinary woodworking blade will dull the teeth and ruin the blade almost immediately.*

Some metals may be cut dry while others require lubrication. When using lubricating fluids, disconnect the air blower tube to keep from blowing the fluid away from the cutting line.

Ideal cutting speeds also vary from metal to metal, but when in doubt it's usually best to start slow before trying faster speeds.

Many of the softer metals—such as silver, gold, copper and brass—seem to be almost self-lubricating and cut well dry. Aluminum, although a soft metal, cuts better when a light oil or a tap and die lubricant is used.

Although some very hard metals such as steel can also be cut with the scroll saw if necessary, it is difficult to do and not generally recommended. ***Warning: If you must try it, use slow speeds and feed rates, keep the blade lubricated to reduce dulling, and never attempt to cut steel more than 1/4" thick.***

Thin sheets of metal often form a burr on the bottom side. This can be minimized by backing up the metal with a piece of plywood or similar material. Any remaining burrs can be removed with emery cloth or a file. *Caution: Cutting metal will leave abrasive dust on the scroll saw and the Mark V. Always clean up carefully after each work session to protect your equipment.*

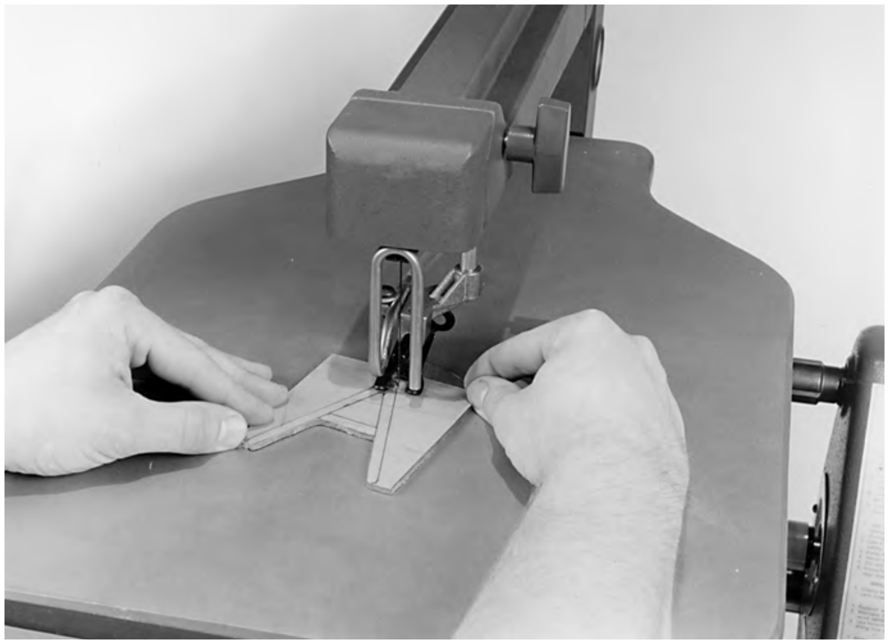


Figure 15-24. *When cutting plastics, leave the protective paper in place or tape both sides of the cutline to reduce heat and scratching.*

Plastics

Plastics vary even more widely than metal in density and ease of cutting. In general, use the coarsest blade available which has at least three teeth in contact with the work and does not produce chipping on the bottom side.

The harder and denser varieties of plastics often cut like wood, so fairly high speeds and somewhat finer blades may be used.

Medium-hard plastics such as acrylics are often difficult to cut because they create more friction and heat. As the heat builds up, the plastic starts to melt and weld itself back together. These materials should be cut with the protective paper covering still intact or with a piece of masking tape applied to the cut line to promote cooling (Figure 15-24). Select a blade with some set in the teeth to promote chip removal and slow down or stop completely at the first sign of melting.

For very soft plastics such as polystyrene or polyethylenes, reduce the speed and select a very coarse blade with maximum set in the teeth.

Use the dust blower when cutting plastics to help cool the blade and rub the cutline with paraffin or a crayon for lubrication.

Other Materials

Very soft materials such as leather, paper or cloth can be cut by sandwiching them between layers of posterboard or plywood. Use a high speed setting and a fairly coarse blade.

Hard, brittle materials such as bone, ivory or mother-of-pearl are best cut with a jeweler's blade.

Remember, experimentation is often necessary because these brief suggestions cannot possibly cover every situation.

Chapter 16
Jigsaw

The Shopsmith Jigsaw is no longer manufactured. However, information about the jigsaw is included in this book as a reference for those woodworkers who purchased one when it was part of the Shopsmith Woodworking System.

Because the jigsaw can cut curves of very short radius with an extremely fine kerf, it is especially adapted to intricate scrollwork and fretwork. It is also used for piercing cuts, pad sawing and cutting components for inlay, intarsia (wood mosaic), marquetry (inlaid veneer), and intricately pieced design work in metals.

JIGSAW—SETUP AND FEATURES

To set up your jigsaw, follow the instructions in the Owners Manual that came with your jigsaw. Some of the special features of the jigsaw are:

- The jigsaw mounts on the Mark V (Figure 16-1) or a Shopsmith Power Stand.
- When the jigsaw is mounted on the Mark V, a complementary tool can be run on the main spindle. An ideal combination, since you will be doing curve cutting, is jigsaw and drum sander (Figure 16-2). Another possibility is jigsaw and disc sander. Always remember: On dual setups, the speed range you use must be that of the slower tool.
- The jigsaw converts to a sabre saw for cutting large workpieces or making piercing cuts in thick stock.
- The jigsaw will cut stock up to 1-3/4" thick. The distance between the blade and the bend in the arm (throat distance) is 18", making it possible to saw to the center of a board 36" wide. With the arm removed, the size of stock that you can saw is limited only by what you can safely control.
- The blade chucks will accept blades up to 1/4" wide, and 5" long. These chucks can be indexed 90°, so that you can work with the width of the blade either perpendicular or parallel to the arm. When the blade width is parallel to the arm, you have an unlimited cutoff capacity. The stroke of the blade is 7/8".
- The table can be tilted from "0" to 45° right (away from the arm). It has an adjustable positive stop at "0."
- The jigsaw has a blower that keeps the cutline clear.

JIGSAW BLADES

The jigsaw will mount three types of blades: regular jigsaw (or fret saw) blades, sabre saw blades, and jeweler's blades. Within each of these categories, there are many different blade sizes that are classified by blade

Figure 16-1. *The jigsaw can be mounted on the Mark V as shown or on a Shopsmith Power Stand.*

Figure 16-2. *The jigsaw can be used in combination with the drum sander as shown, or the disc sander.*

width, thickness, and number of teeth per inch. Choosing the right blade for the job will depend on:

- the kind of material you're about to cut
- the thickness of the material
- the intricacy of the pattern
- the accuracy and smoothness of cut you want.

Choose jeweler's blades for delicate scrollwork in veneers, thin woods, nonferrous metals, plastic, mother-of-pearl, and abalone thinner than 1/8". Thin, fine-toothed jigsaw blades will cut intricate patterns in stock 1/8" to 1/2" thick. Medium-width, medium-toothed blades will cut uncomplicated patterns in wood 1/4" thick or thicker. Coarse, heavy blades work well when sawing long curves in thick materials. Some wide blades have fine, tempered teeth for cutting plastics and metal 1/8" thick or thicker.

Sabre saw blades are useful for sawing uncomplicated patterns and long curves in large workpieces. The blade you select should cut with at least three teeth in contact with the stock at all times.

Figure 16-3. Illustrations from magazines, posters, calendars, or photographs can be rubber cemented directly to the workpiece.

PATTERNS AND LAYOUT

Original designs can be drawn full-size either on the stock or on paper that can be attached to the work with rubber cement.

A popular way to do jigsaw projects is shown in Figure 16-3. An illustration taken from a magazine, poster, calendar, or even a photograph is rubber cemented to a workpiece and cut out on the jigsaw.

The squares method, shown in Figure 16-4, is often used to duplicate a drawing, plan, or illustration in a larger or smaller size.

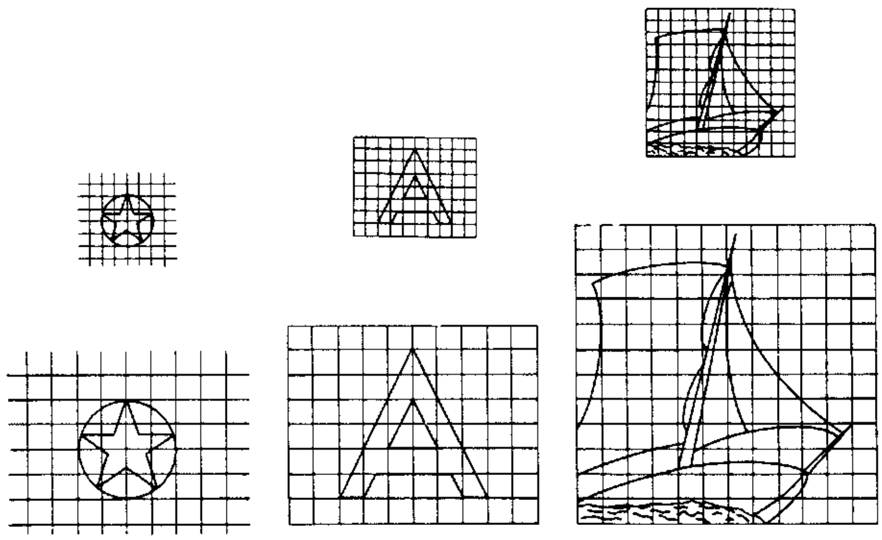


Figure 16-4. The squares method is commonly used to enlarge or reduce an illustration for jigsawing.

Many woodworkers who do a lot of jigsaw projects avoid the layout involved in the squares method by using a pantograph. This is a special, adjustable tool that is hinged in such a fashion that a tracer, used to follow the pattern, moves a marker that duplicates the pattern.

More methods of work layout are shown in Figure 16-5. Some of the ideas make it possible, through joining, to form large items by using cutoffs that would otherwise be wasted. Two identical pieces can be formed by making one cut if you plan the layout carefully. When many parts are cut from the same strip or panel, it's good practice to first make all the patterns so they can be positioned on the work for best grain patterns and least amount of waste.

Figure 16-6 shows some pattern ideas that can be used, for example, as shelf support components. When duplicating these or when putting your own ideas on paper, a French curve (Figure 16-7) can be very helpful.

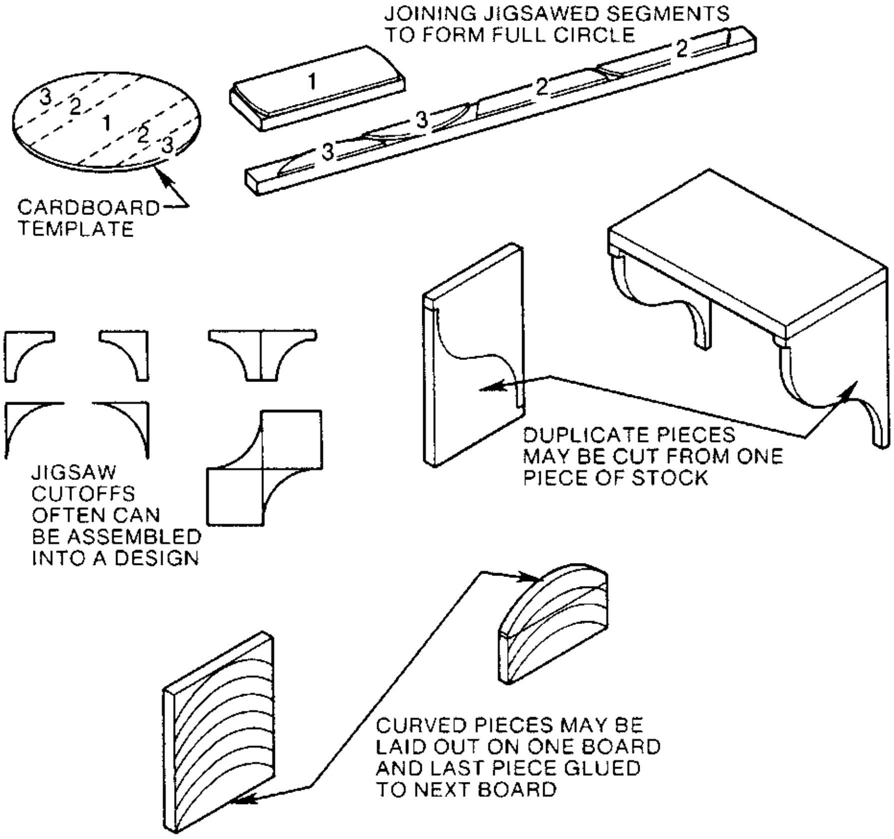


Figure 16-5. *You can reduce waste and speed up production if you pre-plan cuts.*

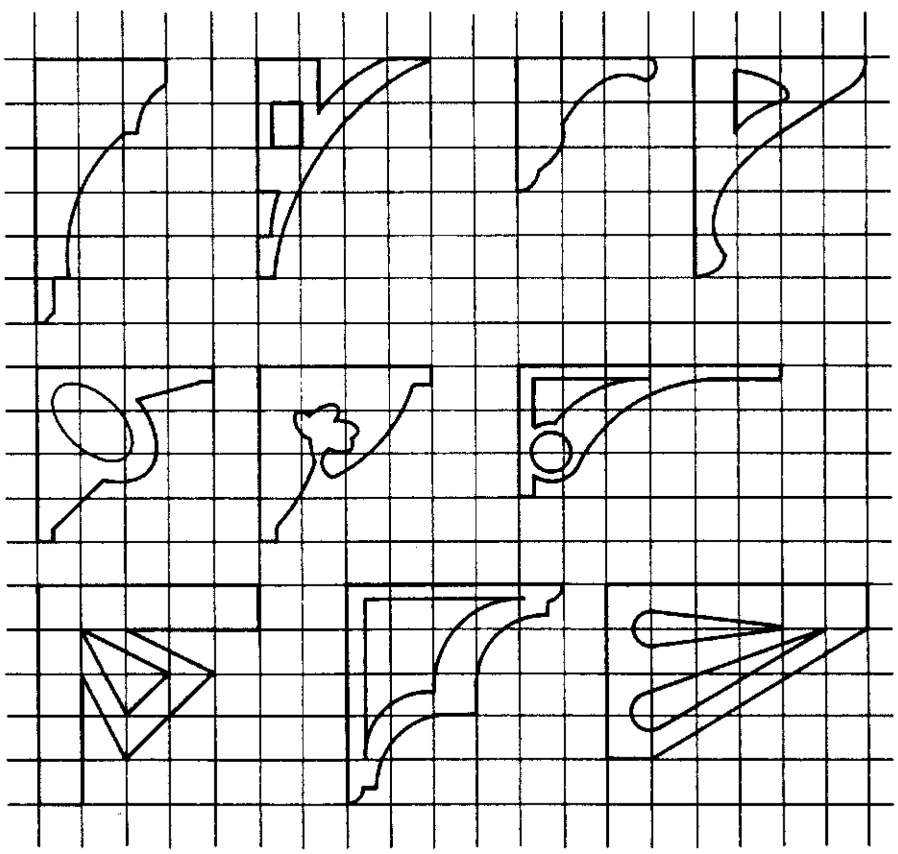


Figure 16-6. *Typical jigsaw patterns for shelf support components.*

JIGSAW SAFETY

Warning: Before using the jigsaw read and understand these important safety instructions:

Danger Zone—The jigsaw danger zone is 3" out from the blade in all directions. When you're using the jigsaw as a sabre saw, the zone extends to 12" above the blade.

- **Wear proper eye protection.**
- **Remember that part of the blade extends beneath the table. Never reach beneath the table to adjust the table tilt, to tighten the Mark V accessory mount lock, or for any other reason while the machine is running. Turn off the jigsaw first and let the blade come to a complete stop.**
- **When removing jigsaw blades, remember that these blades are tensioned by a strong spring. If you loosen the locking screws in either chuck without first releasing the tension, the upper blade chuck will snap back in the tension tube, possibly damaging the jigsaw or injuring you.**
- **Always turn the jigsaw on first, then feed the workpiece into the blade. Never turn on the machine with stock pressed up against the blade.**
- **Don't use worn, dull or damaged blades. They have a tendency to heat up and snap while you're working.**
- **Recondition or replace worn blade guides immediately.**
- **If you're using a Shopsmith Power Stand, be sure you're using the proper pulley and belt combination and that the pulley and belt are properly guarded.**

JIGSAW SPEEDS

Before you begin any jigsaw operation, turn on the Mark V, set the speed dial, and let the machine come up to speed.

The speed of the jigsaw is determined by the blade you're using

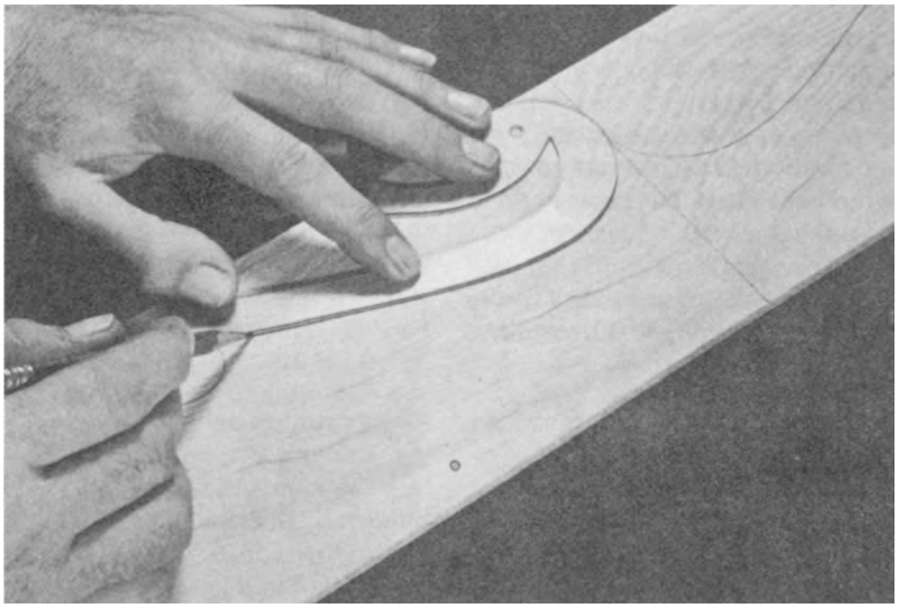


Figure 16-7. A French curve can be very useful when planning scrollwork designs.

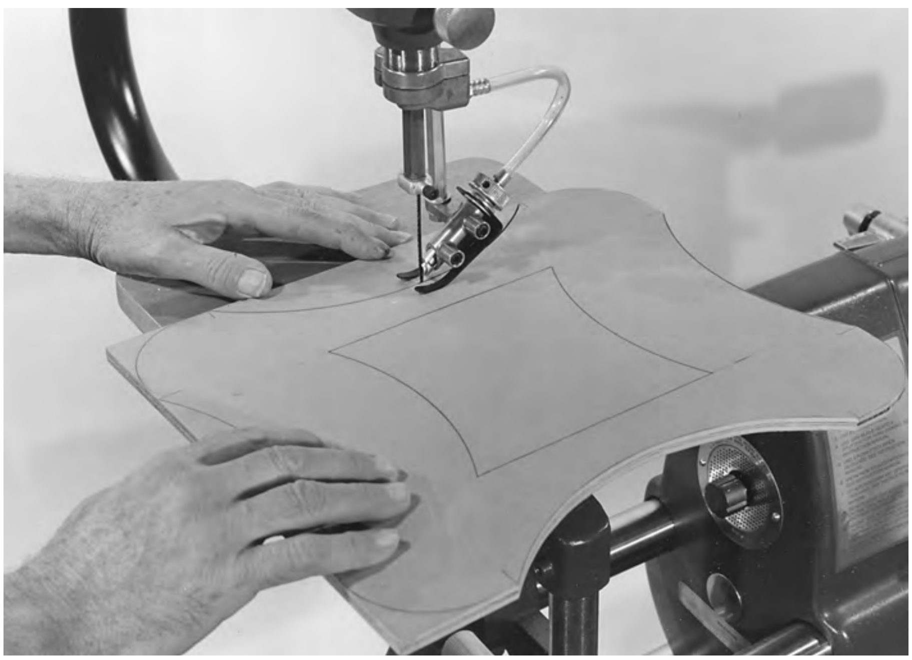


Figure 16-8. As you cut with the jigsaw, feed the work slowly. Do not force it or try to turn a corner that's too tight for the blade.

and the material you're cutting. **Use speeds between "Slow" (700 RPM) and "E" (1150 RPM).**

GENERAL SCROLLWORK

As you get ready to cut, adjust the height of the hold-down for the thickness of the workpiece. Give the drive shaft a few turns with your hand to make sure the blade is operating freely. Make a five-point check: all locks—power plant, carriage, table height, table tilt and quill—should be secured. Check that there is 30W light machine oil in the reservoir.

Take a comfortable stance in front of the blade, with the teeth pointing toward you. Your position is determined by whatever gives you the most control over the workpiece you're about to cut. For some patterns, you may find it necessary to shift positions as you cut, from directly in front of the blade to one side of it.

Turn on the jigsaw, set the speed dial, and let the jigsaw come up to speed. Then slowly feed the workpiece into the blade. Use both hands to guide the workpiece, and keep it pressed firmly down against the table (Figure 16-8).

Feed the workpiece forward using very light pressure. Do not force the workpiece. Force feeding will not speed up the operation; instead, the blade twists and runs off course. If you press too hard, the blade will break.

Using side pressure (against the flat of the blade) or trying to turn a radius too small for the blade will also cause a blade to run off course or break, giving you an inaccurate cut. Feed the workpiece directly against the teeth, even when cutting curves. To determine if a curve is too small for the blade, use this rule of thumb: the smallest circle you can accurately cut will have a radius twice the width of the blade you're using. If you're using a blade 1/4" wide, don't try to turn corners with a radius of less than 1/2".

Here are a few tips to help you get good results from jigsaw cutting:

Cutting Complex Patterns— Break complicated cuts up into simpler curves and lines. Don't hesitate to leave the pattern line, sawing into the waste stock; then loop around and attempt the next part of the cut from a better angle. Carefully plan your cuts before you begin.

Sometimes, you'll want to cut complex patterns, but there will be no waste stock in your design—this is often the case when cutting matching parts. In order to do this, modify the pattern so that it can be cut without departing from the line. Or, select a smaller blade that will cut all the curves and corners in one pass.

Cutting Sharp Corners—If your design calls for sharp corners where two lines intersect, there are several ways to cut these with the jigsaw.

To cut sharp exterior corners, cut the first line and keep on going past the corner. Loop around in the waste portion of the stock, and come back to cut the second line. Or, cut the first line and go past the corner to the edge of the workpiece. Remove a portion of the waste, turn the workpiece, and cut in from the edge to the second line (Figure 16-9).

To cut sharp interior corners, cut the first line up to the corner; then back the blade out of the stock and cut the second line. Or, cut the first line up to the corner and back up several blade widths. Turn into the waste stock, leaving the first line and getting in position to cut the second. Cut the second line (all but a small portion near the corner), remove the waste, then go back and cut the last part of the second line up to the corner (Figure 16-10).

Cutting Thin or Small Stock—When cutting veneer or very thin materials, it's helpful to tape the workpiece to a sheet of heavy posterboard; then cut the workpiece and the posterboard. (Don't use corrugated cardboard.) The posterboard adds extra support and keeps parts of the workpiece from breaking off and falling through the hole in the table insert (Figure 16-11). If the pattern is very complex and/or the materials very fragile, you may have to sandwich the stock between two pieces of posterboard.

This technique also comes in handy when you need to cut stock that's too small to safely control. Simply attach it to a larger sheet of posterboard; then hold onto the posterboard and use it to guide the stock.

Cutting Identical Pieces—If you need to cut several identical parts to a project, you can use a technique called pad sawing. Stack up the workpieces and tape them together. The stack should be no thicker than 1-3/4". Saw the entire stack at once; then remove the tape. Each piece will be identical (Figure 16-12).

If you're pad sawing a stack of veneer, put a sheet of posterboard on the bottom and the top of the

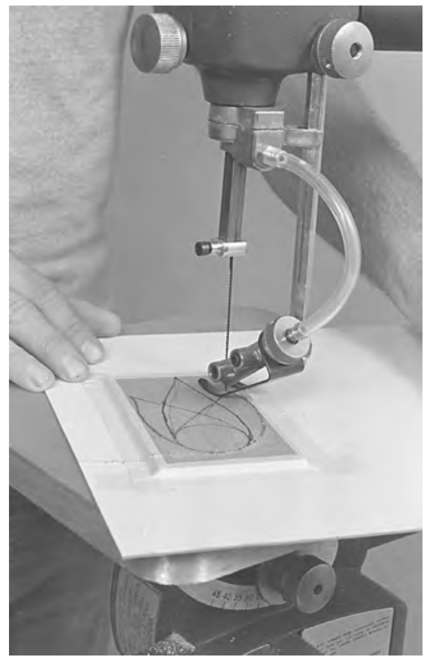


Figure 16-11. *When cutting thin or small workpieces, tape them to a sheet of posterboard. This adds both support and control.*

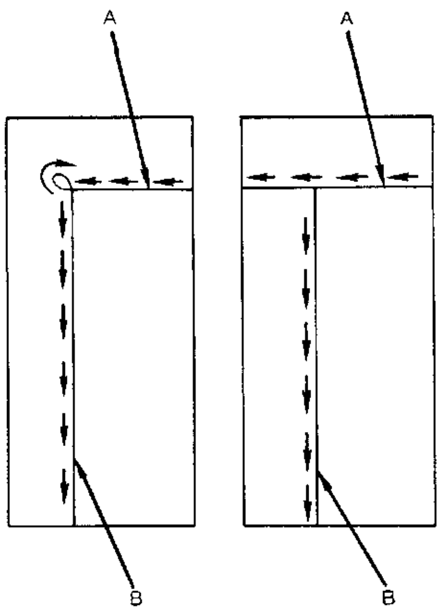


Figure 16-9. Here are two methods for cutting an exterior corner. In the first method, cut line A; then loop around in the waste stock to cut line B. In the second, cut line A and continue past the corner to the edge of the workpiece. Turn the workpiece and cut in from the edge to line B.

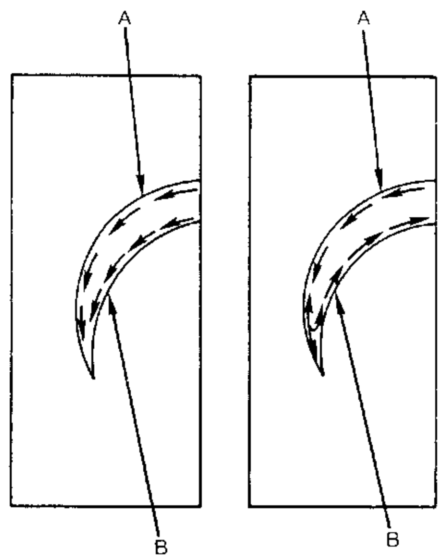


Figure 16-10. Here are two methods for cutting interior corners. In the first method, cut line A, back completely out of the stock, and cut line B. In the second, cut line A up to the corner. Back up, turn into the waste stock, and cut line B—all but a small part near the corner. Remove the waste stock; then go back and cut that small portion of line B up to the corner.

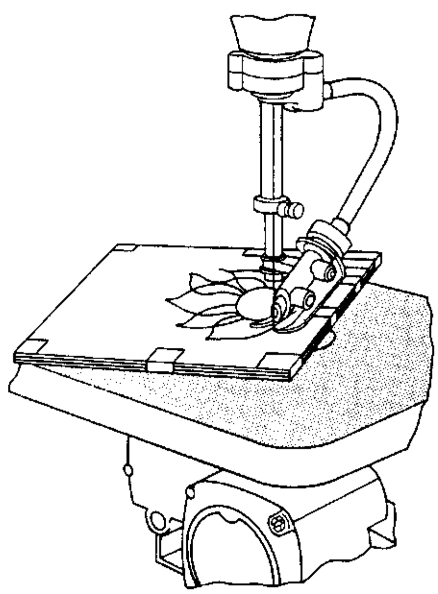


Figure 16-12. If you need to cut identical parts, stack up the workpieces and tape them together. Cut them all at once. This is called pad sawing.

stack to prevent small pieces from breaking off. Draw your pattern on the top sheet of posterboard.

Inlay Work—Inlay design work or pictures are made by using the pad method of sawing shown in Figure 16-13.

The veneers selected are fastened together between top and bottom boards with nails driven through waste areas. The picture or design is on the top board. Since all the veneers are cut at the same time, any piece cut out of one will fit the corresponding hole in another. The veneers should be selected for contrasting colors and grains.

Inlays are also made by jigsawing a form from a piece of stock and gluing it into place in a recess carved or routed out for it. This is called intarsia and is shown in Figure 16-14.

Cutting Thick Stock—When you must cut thick stock, take your time. Use as wide a blade as possible, coarse teeth, and a slow speed (Figure 16-15). The jigsaw is not designed to cut through thick stock as quickly as a bandsaw or table saw. Remember, heavy forward pressure won't hasten the operation—it only makes the cut inaccurate and it may cause the blade to break.

Straight Cutting—The jigsaw isn't as fast a cutter as a table saw or bandsaw, but if you have it set up and need to do some straight cutting, there's no need to change to another machine. Just accept that the cuts will take a bit longer to do. You can guide the work freehand, but it's more convenient and you'll work more accurately if you make the fence shown in Figure 16-16.

When ripping, clamp the fence to the table so the distance from blade to fence will equal the cut width you need. Hold the work snugly against the fence and move it forward slowly to make the cut (Figure 16-17). A wide, coarse

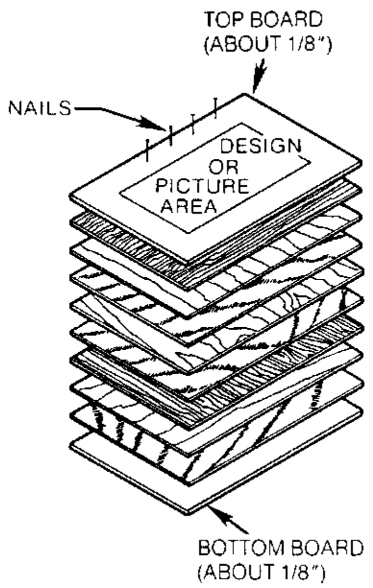


Figure 16-13. Inlay work is done by making a "pad" of veneers. After cutting, each piece will fit the corresponding hole in another.

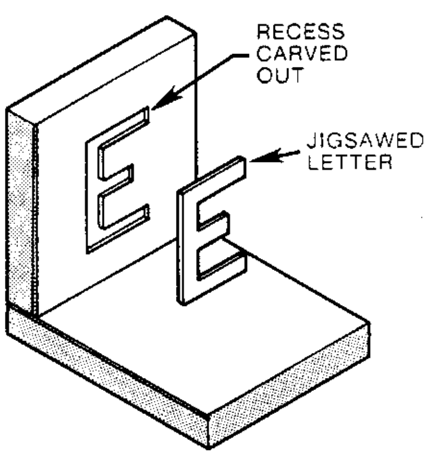


Figure 16-14. Intarsia is done by gluing a design into a recess that was routed for it. Make the design first and use it as a pattern for the routing.

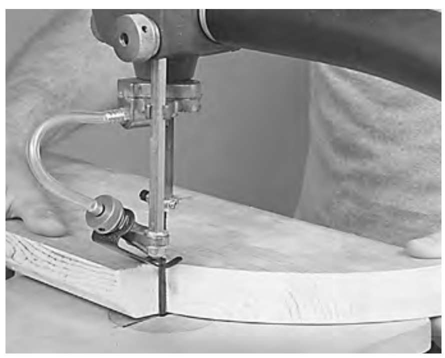
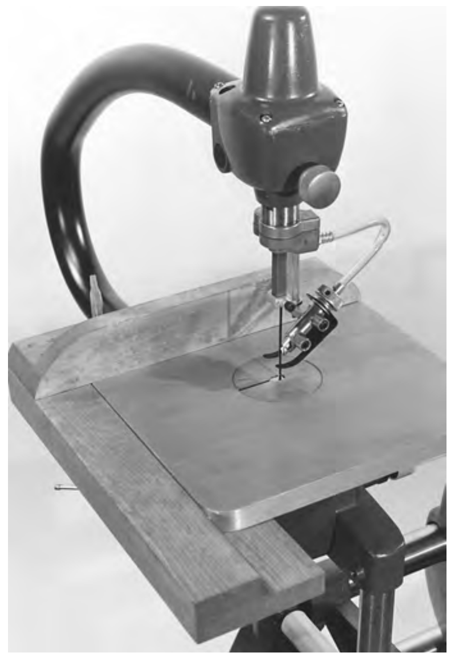


Figure 16-15. A wide, coarse blade will do a fast job when cutting thick stock. One with fine teeth will cut more slowly but with a smoother finish.



A

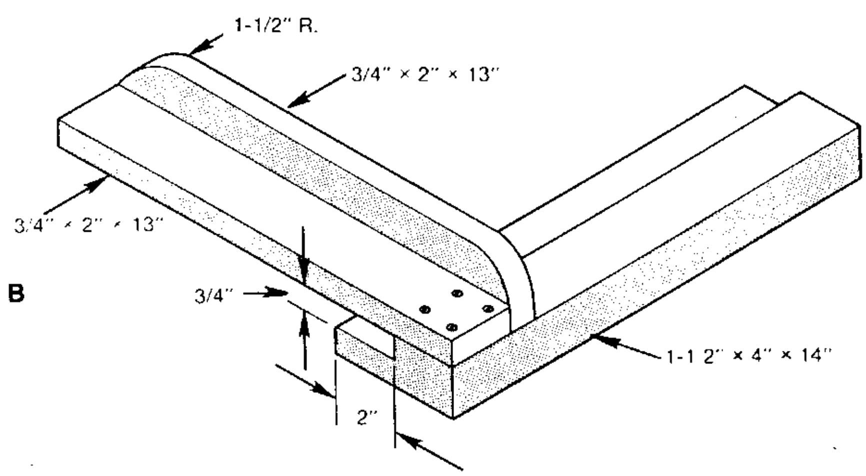


Figure 16-16. (A) A jigsaw fence that you can make is held to the table with a clamp. (B) Construction details for the jigsaw fence.

blade will make this type of cutting easier to do, but a medium-width blade with finer teeth will produce smoother cuts.

You can use the jigsaw fence to gauge cutoffs; thus, you can work as shown in Figure 16-18 to produce duplicate pieces. The "miter gauge" is a triangular piece of wood that has been carefully checked to be sure the edges that will bear against the fence and the work form a 90° angle.

Use the same setup when you need to cut dowels (Figure 16-19). Adjust the spring hold-down just tight enough so the dowel won't bob up and down with the blade. Also, hold the dowel tightly so it won't turn as the cut is made.

Cutting Bevels—On many types of inlay work and on heavy stock, bevel cuts are used so that any internal piece will jam tight when pushed through the piece from which it has been cut. The bevel may range from 1° to 10° and is adjusted by setting the table to the angle desired (Figure 16-20).

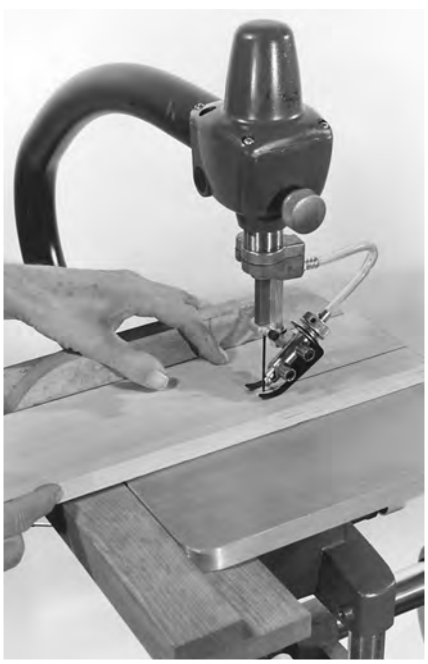


Figure 16-17. *Using the fence to make a straight cut. Don't expect the jigsaw to cut as quickly as a table saw or bandsaw. The blade will wander if you try to rush.*

Cut precisely on the line, but keep the work always on the same side of the blade. It cannot be swung completely, since this would change the direction of the bevel; then the pieces wouldn't fit.

Figure 16-21 shows how bevel-cut parts fit together. In (A) is shown a kerf that was cut with the table in a normal, horizontal position. In inlay work, this kerf (very slight when the proper blade is used) is sealed with a filler, which also provides a defining border around each of the pieces.

For a closed kerf line, the table is set for a bevel that produces the results shown in (B). When part 2 is jammed into part 1, the two pieces form a perfect closed joint.

Figure 16-18. *The fence can be used as a cutoff gauge. Be sure the triangular piece used as a miter gauge is square to the fence.*

Figure 16-19. *Use the jigsaw fence for cutting dowels. Hold the dowel firmly or it will tend to rotate during the cut.*

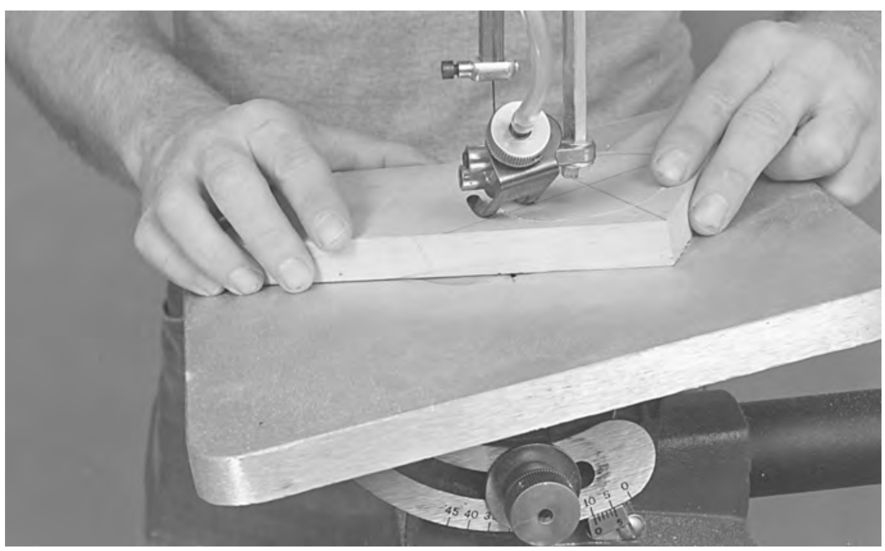


Figure 16-20. *You can cut bevels by tilting the table to the angle you need.*

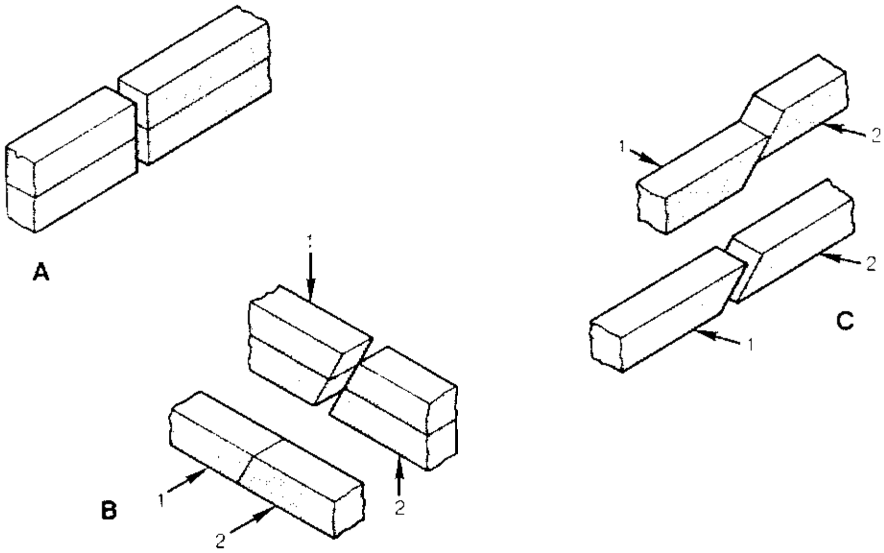
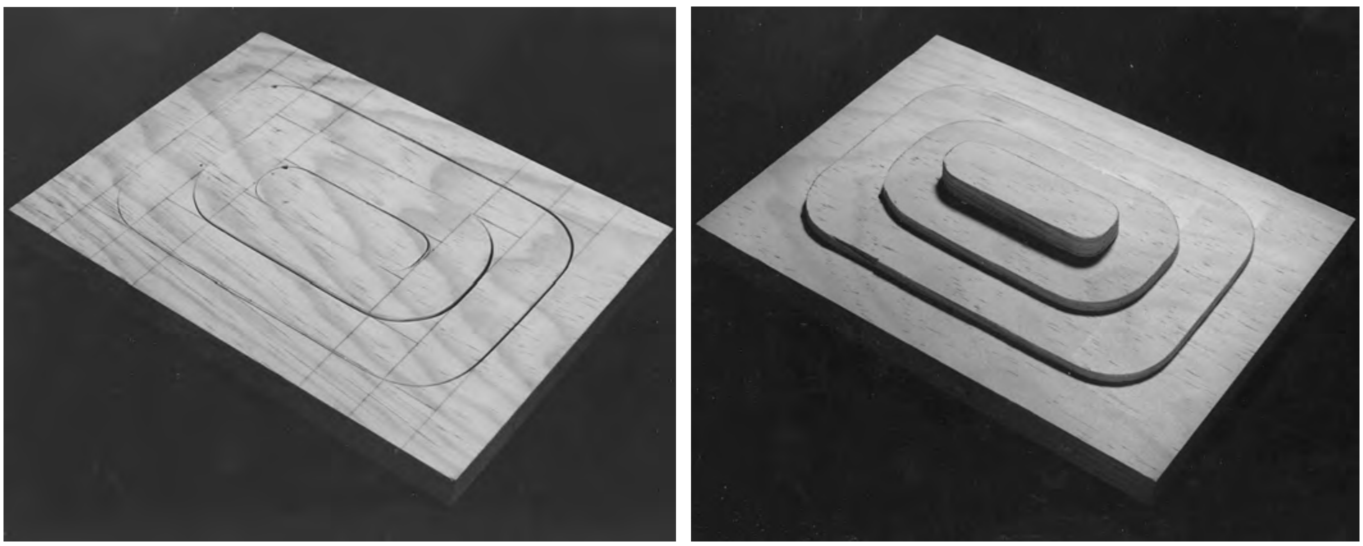


Figure 16-21. This is how bevel cut pieces fit together.



A B

Figure 16-22. (A) Bevel cutting, done on one piece of stock, can produce deep projects. (B) Each piece fits into its neighbor.

On heavier stock, bevel-cut pieces can be joined with the cut-out piece raised above the surface of the piece from which it was cut (C). An application of this technique is shown in Figure 16-22. This is a good method of making raised bases, or hollow projects. The method may also be used to build up stock to be mounted and shaped on the lathe.

Model-boat builders will find the technique of value in forming boat hulls.

The layout of the pieces is made on the surface of the board, which is then bevel-cut in the manner explained.

Figure 16-23. The bevel cutting technique is often used by model builders to shape hollow boat hulls.

When the pieces are extended, the boat hull takes the shape shown in Figure 16-23, ready for final finishing.

PIERCING CUTS

As mentioned earlier, one of the biggest advantages of the jigsaw is that it can cut internal curves and designs in a workpiece without having to cut through the stock from the outside edge. This operation is called piercing.

To make a piercing cut, first drill a hole in the waste stock on the interior of the pattern. The diameter of the hole must be larger than the width of the blade. If you want to save the waste stock for later use, drill the hole near a corner in the pattern. Be careful not to drill through the pattern line.

Release the tension on the blade and loosen the upper blade chuck. Raise the hold-down and tension tube as far as they will go. Turn the drive shaft so that the lower chuck is at the bottom of the stroke. Then thread the upper end of the blade through the hole you've just drilled (Figure 16-24). If you need to, you can flex the blade slightly to one side. But be careful not to bend it so far as to kink the blade. Reinstall the upper end of the blade in the upper chuck, tension the blade, and adjust the height of the hold-down.

Cut out the waste stock from the interior of the pattern, being careful not to cut through the pattern (Figure 16-25). When the cut is complete, turn off the machine and let it come to a complete stop. Once more, release the tension on the blade, loosen the upper blade chuck, and raise the tension tube and hold-down. Finally, remove the workpiece from the jigsaw.

When a corner forms an arc, you can turn the corner in one continuous pass. If the corner is square, you can work as shown in Figure 16-26. Approach one corner from the blade insertion hole and then back out, either to the hole or far enough so you can make a second approach to clean out the corner. The third cut starts at the first corner and continues to the second one. Back out far enough so you can turn to approach the second corner from another direction. Continue to work this way until the cut is complete.

The size of the blade determines how far you must back out and how big a turn you must make to get set for the second approach at each corner. The finer the blade, the less room you'll need for the maneuver.

Cutting out a circle is a much simpler matter. Just make one approach to bring the blade to the line and then continue around until the cut is complete (Figure 16-27).

Two other cutting techniques are shown in Figure 16-28. In (A), the cut is the same as for a circle: one approach to the line and one continuous pass. In (B), the cut is made from the blade insertion hole to the corner. After backing out, the form is finished by cutting in the opposite direction; around

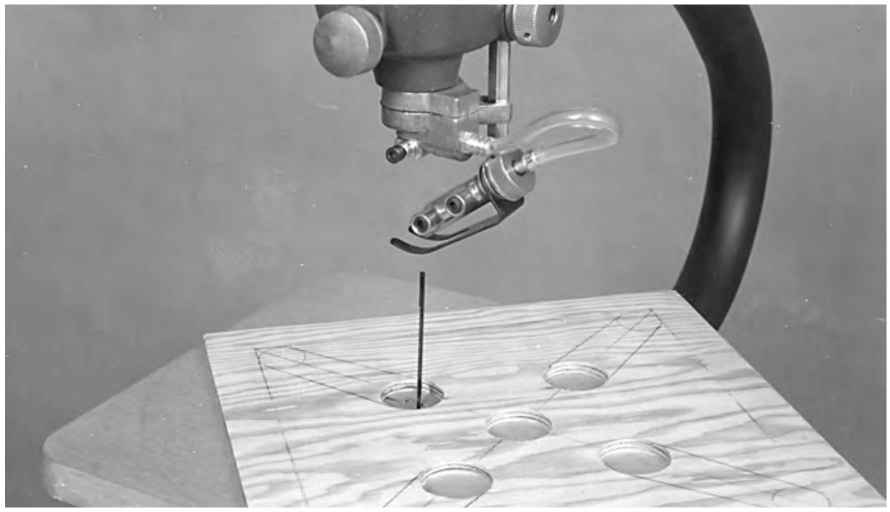


Figure 16-24. *Piercing is possible because the blade can pass through the work before it is gripped in the upper chuck.*

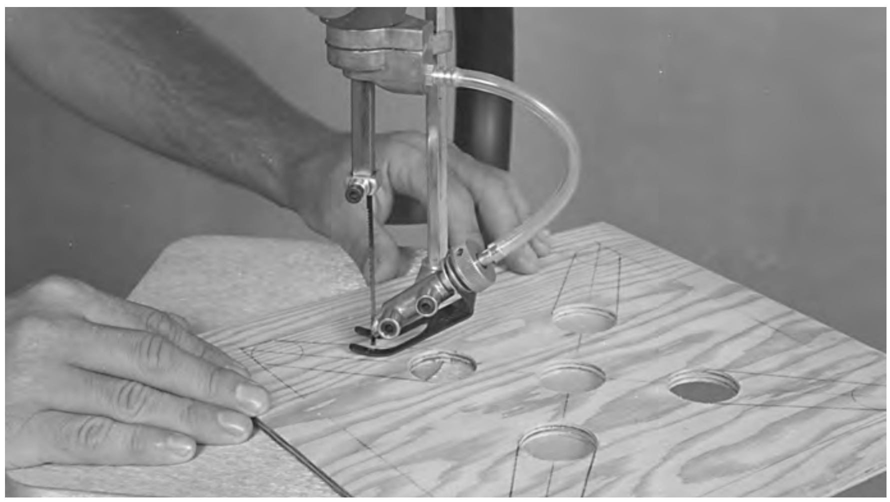


Figure 16-25. *Each piece to be cut out must have its own blade insertion hole. Often, as shown here, the holes can be part of the design.*

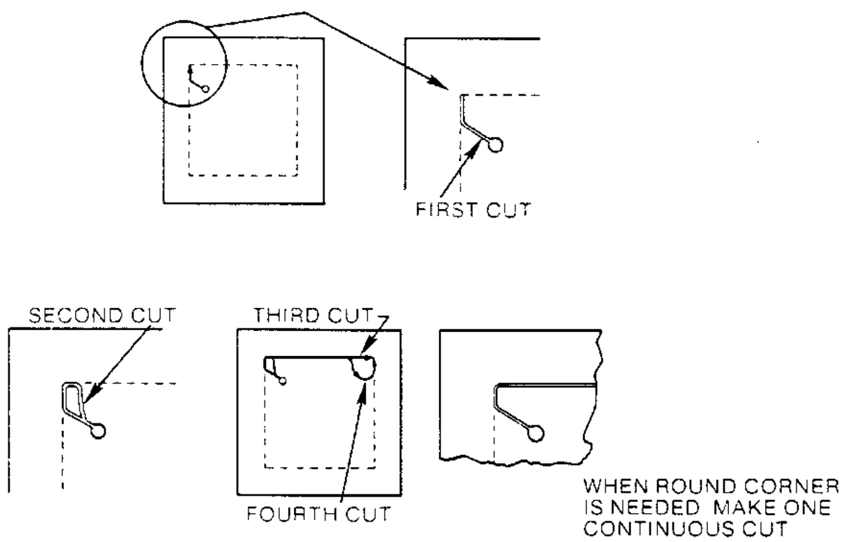


Figure 16-26. *Cutting techniques to follow when the work has square corners.*

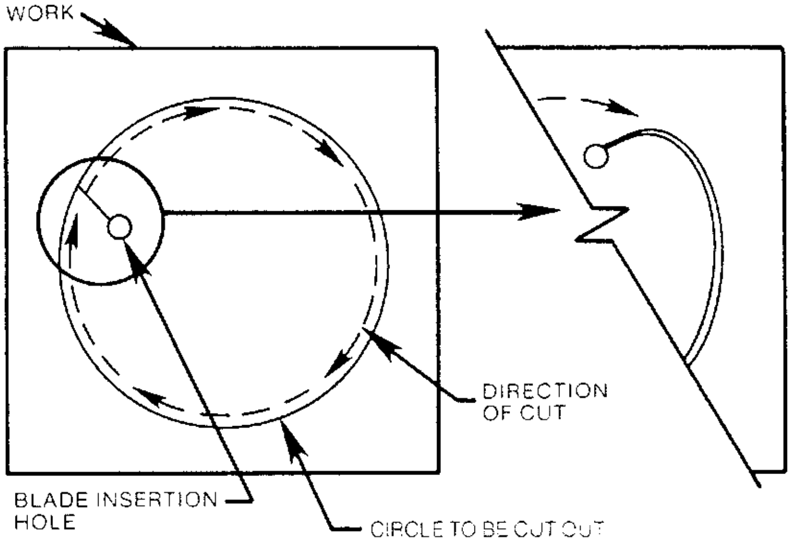


Figure 16-27. One continuous pass will cut out a circle. Drill the blade insertion hole close to the outline.

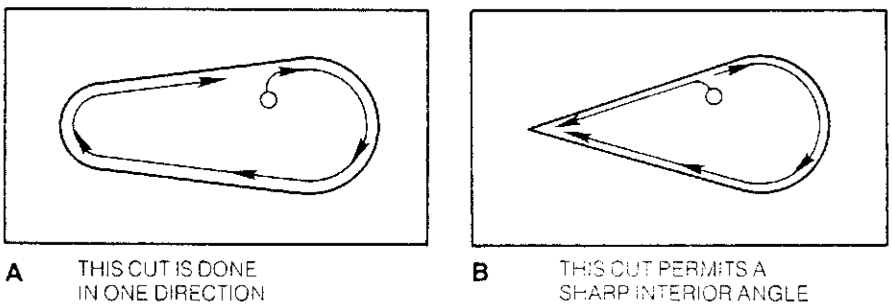


Figure 16-28. If you pre-plan the cutting technique, you'll usually save time and material.

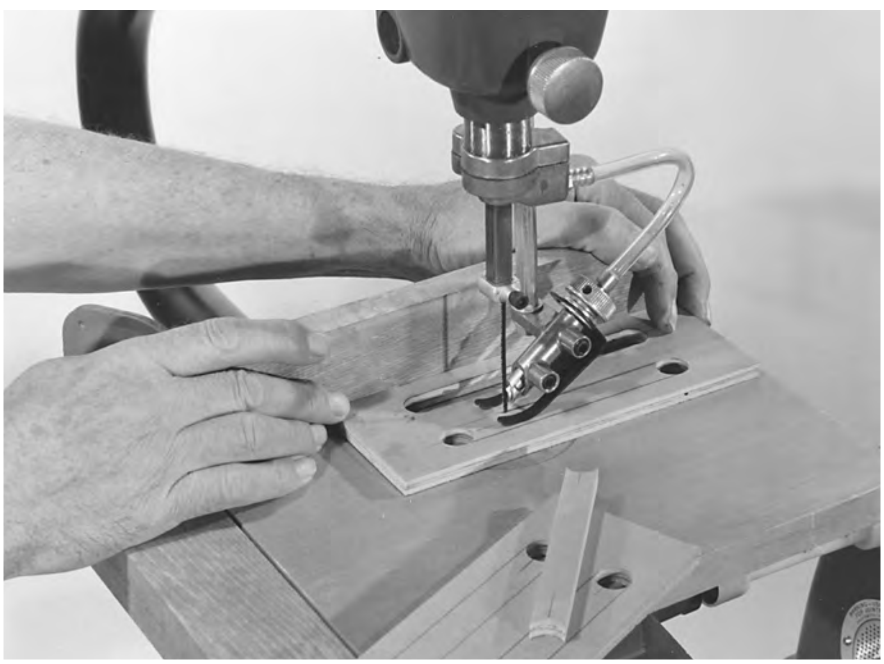


Figure 16-29. The fence helps to produce accurate slots. End holes of correct diameter are drilled on a common centerline.

the semi-circle and back to the point. It could also be done by drilling the blade insertion hole close to the point and cleaning it out by working as you would for a square corner, then finishing with a final, continuous pass.

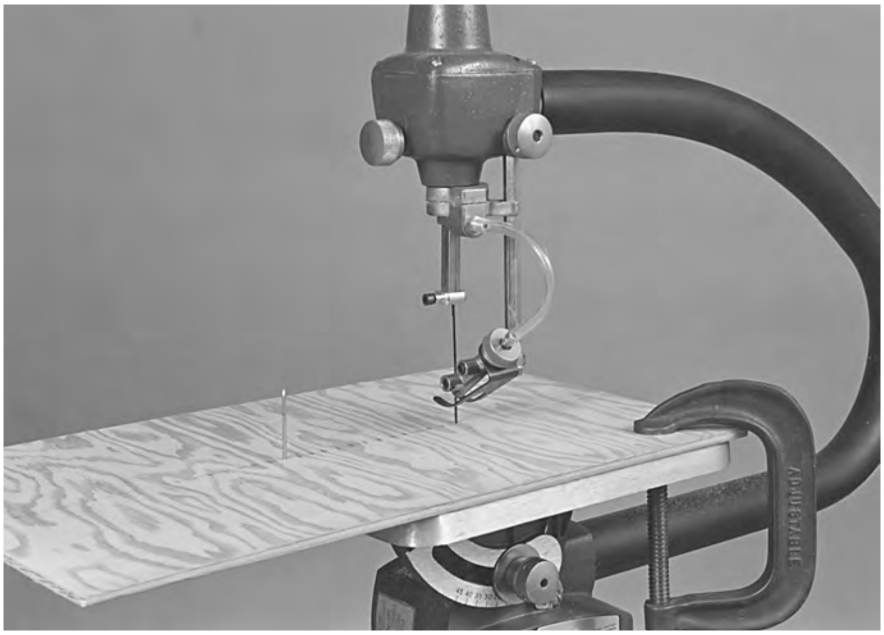
Internal slots are shaped as shown in Figure 16-29 with the aid of the fence shown in Figure 16-16. If the slots are to have round ends, first drill end holes with a bit that matches the slot width. Then, using the fence as a guide, use the piercing technique to clean out the waste. Work the same way if the slots will have square ends; but, after the initial cuts are made, work without the fence to clean out the corners.

CUTTING CIRCLES

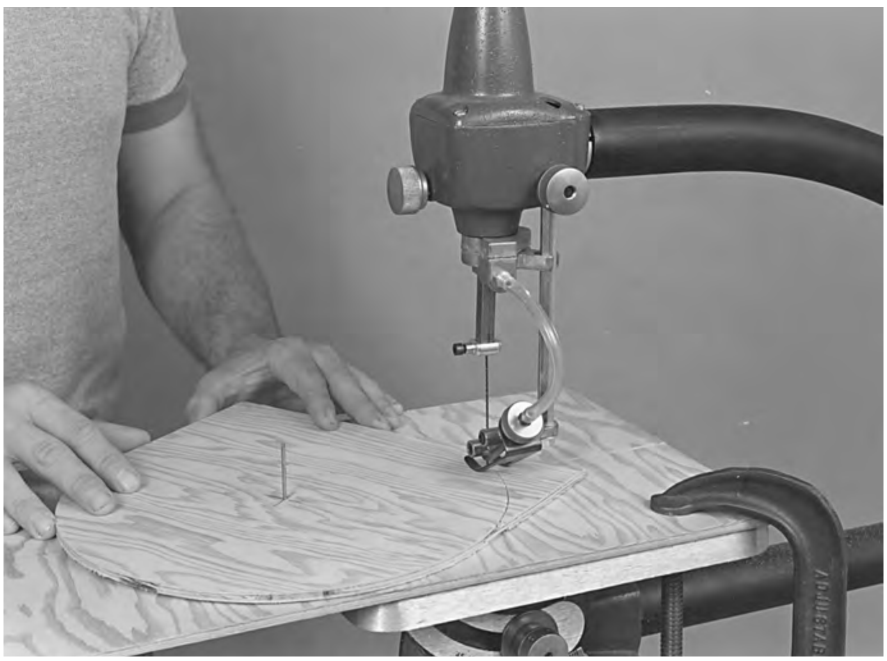
You can cut accurate circles using the pivot technique if you make a special platform to clamp to the table as shown in Figure 16-30. The platform, a piece of 1/4" plywood, has a series of equally spaced holes drilled on a common centerline. The pivot is a nail pushed through one of the holes; its distance from the blade is equal to the radius of the circle.

The work is center-drilled to fit over the nail and then rotated against the blade to make the cut. To start the cut, you can either drill a blade insertion hole or make a lead-in cut to the line before placing the work over the pivot. Be sure the holes in the platform line up with the tips of the saw teeth and that you rotate the work only as fast as the blade will cut.

If the jigsaw is mounted on the Mark V, you can use an unusual but effective setup to pivot cut very large circular pieces. Mount the rip fence on the worktable and place the lathe cup center in the hole in the top of the fence (Model 500) or in a hole drilled in a fence extension that is attached to the fence (Model 510). Adjust the height of the worktable so the



A



B

Figure 16-30. *(A) A special platform, clamped to the table, lets you pivot cut circles. Be sure the holes for the pivot nail are in line with the tips of the saw teeth. (B) You can start the job by using a blade insertion hole or by making a lead-in cut before mounting the work on the pivot. The pivot nail does not have to be as long as the one shown here.*

point on the cup center is a bit higher than the jigsaw table. The distance from the cup center point to the jigsaw blade will be the radius of the circle. When you work this way, the chucks will have to be indexed.

CUTTING METAL, PLASTICS, AND PAPER

When cutting metal, use a blade with 14 or more teeth per inch. If you're cutting steel or iron, use a "hardened" or tempered blade. These blades are heat treated for longer wear. The recommended speed setting for cutting metal is "Slow."

Thin sheet metal tends to bend down along the kerf while you're cutting. To help prevent this, make an auxiliary table of plywood with a throat hole just large enough to accommodate the blade (Figure 16-31). This will give you some extra support around the cutting edge. The frame on the bottom of the auxiliary table keeps it from shifting and the hold-down holds it securely to the jigsaw table.

Before you start cutting, put one to two drops of oil on the pattern line just in front of the blade. Repeat this every 1″ to 2″. This will lubricate the blade, helping it to run cooler and last longer (Figure 16-32). Another technique that helps when cutting metal is to lubricate the blade with beeswax. This will help when turning tight corners and will reduce blade breakage.

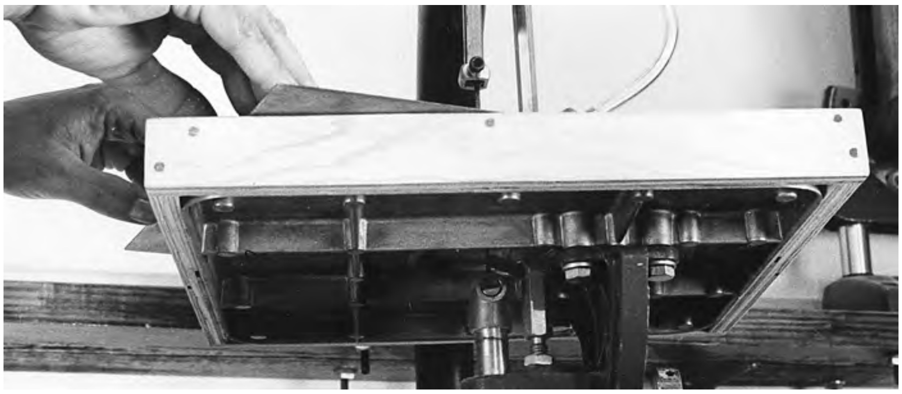
When you're finished, remove the blade and the auxiliary table. Wipe off any oil and/or beeswax that might have gotten on the jigsaw table. Remove the table; then clean away any metal filings from the lower blade chuck and base. This must be done every time you use the jigsaw to cut metal. If you don't, the metal filings may work their way between the moving parts of the jigsaw, causing them to wear prematurely.

One of the problems with metal cutting, especially if the material is thin, is the burrs that will accumulate as the blade cuts. This is normal; the blade might even bend the material at the cut area. To minimize the problem, use an auxiliary table with a blade insertion hole that is slightly larger than the blade. This can be the platform that you may have made for pivot cutting circles (Figure 16-33) or a special insert of 1/4″ hard board (Figure 16-34). Both methods will provide support at the cutting area to minimize burring and bending. Another way to avoid burrs and bends is to sandwich the work between sheets of thin plywood (Figure 16-35).

Cutting Plastics—When cutting plastics, use a skip-toothed blade. The extra space between the teeth helps to clear away the chips. The blade runs cooler and the workpiece doesn't get as hot. Regular woodcutting blades sometimes create so much heat that the plastic chips weld together and the blade binds.

Leave the protective paper on the plastic when you cut (Figure 16-36). This will keep it from getting scratched. If the plastic melts, you may be feeding the workpiece too slowly or the speed may be too fast.

Pad Sawing Paper—Sawing paper becomes a simple proce-



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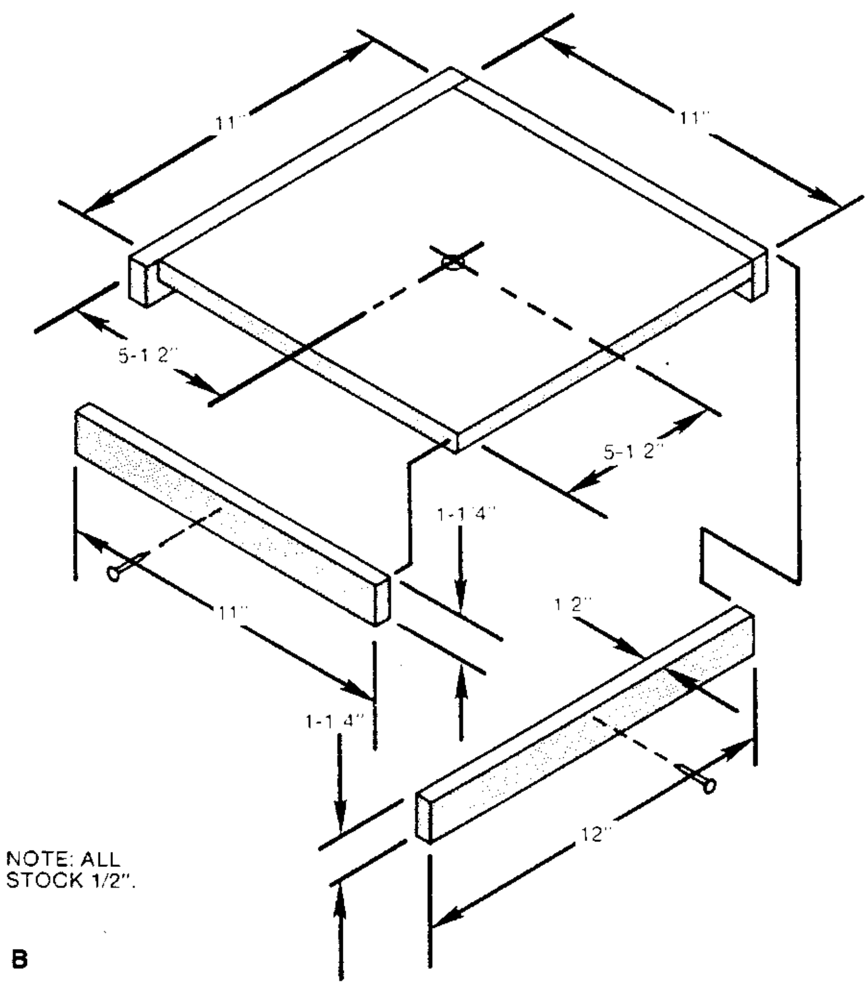


B

Figure 16-31. (A) This plywood table will give you added support when cutting thin metal. (B) Construction details of an auxiliary plywood table.

Figure 16-32. *When cutting metal, put one to two drops of oil in front of the blade on the pattern line every 1" to 2". This helps the blade run cooler and last longer.*

Figure 16-33. *You'll get minimum burring when sawing thin sheet metal if you provide support as close to the cutting area as possible. Here the circle cutting platform is used.*

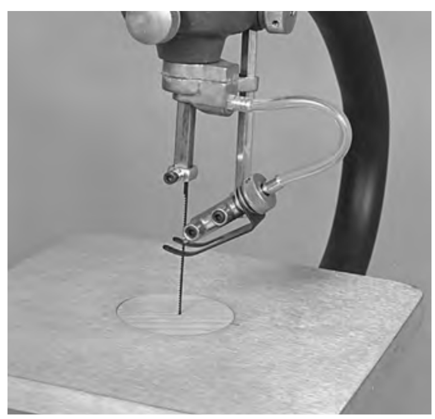


Figure 16-34. *You can also make a special insert. The size of the hole through the insert should be no more than the blade needs to get through.*

Figure 16-35. *Another way to saw thin sheet metal is to sandwich it between thin plywood.*

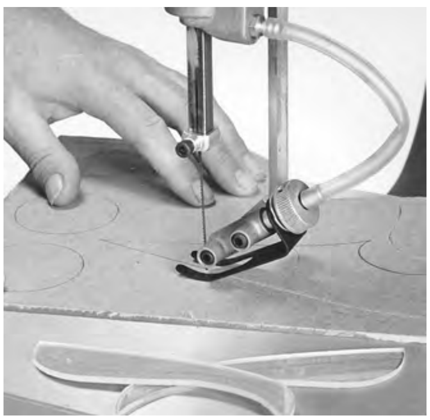


Figure 16-36. *Leave the protective paper on the plastic when you make the cut.*

dure when the sheets are sandwiched between thin plywood (Figure 16-37). The paper should be large enough so the nails holding the pad together can go through it in an area that is outside the pattern. If the edges of the sheets are to be bent back or otherwise hidden, the hole locations don't matter. Paper cut in this manner will have remarkably smooth edges.

SABRE SAWING

Your jigsaw can easily be converted to a sabre saw, following the procedures in the Owners Manual. This setup is useful when you need to cut patterns in large workpieces or make piercing cuts in thick stock.

Figure 16-37. *A pad of paper can be cut on the jigsaw; but, to avoid jagged edges, the sheets must be sandwiched between thin plywood.*

Figure 16-38. *Doing sabre sawing with the jigsaw's arm removed. Work carefully so you don't bend the blade or cause it to move off the cutline.*

If the workpiece is large enough, you may need additional support to cut it safely. Slide the Mark V worktable toward the power plant and lock it in place. Adjust the worktable so that it's at the same height as the jigsaw table. When you cut, let the workpiece rest on both tables. (Figure 16-38). Feed the workpiece slowly.

You can do sabre sawing even without removing the tubular arm

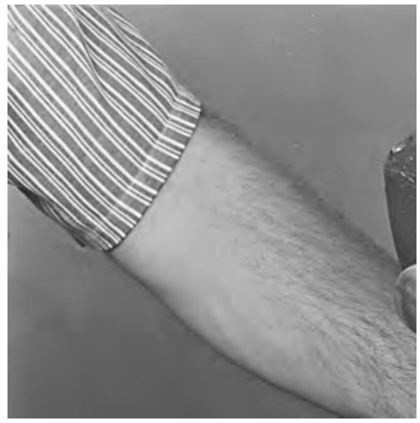


Figure 16-39. *You can use the sabre saw setup when doing piercing on heavy stock.*

Figure 16-40. *When blade length and stock thickness allow, you can use the blade guides and the spring hold-down when sabre sawing.*

if the work size permits; even piercing, when needed on heavy stock, can be done this way (Figure 16-39). When the blade is long enough and stock thickness allows it, the blade guides and spring hold-down can be utilized (Figure 16-40).

FILING

You can mount machine files in your jigsaw. These files are available in a variety of shapes, so that you can smooth the edges on the interior or exterior of almost any pattern.

When using a metal file, run the jigsaw at "Slow" speed. Feed the work gently against the file and keep the workpiece moving constantly (Figure 16-41). When

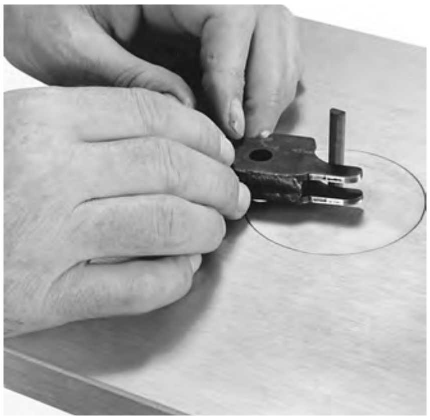


Figure 16-41. Work at a slow speed and use only enough feed pressure to keep the file cutting. Keep the work firmly on the table so it won't lift on the file's upstroke.

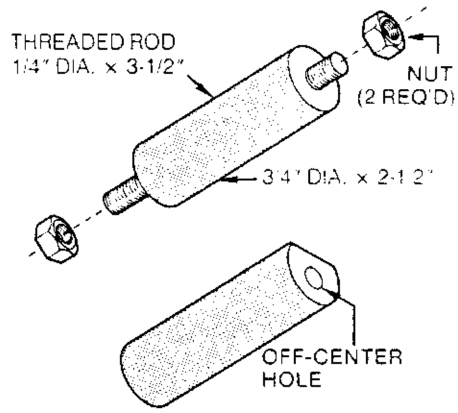


Figure 16-42. Two designs for making sanding sticks.

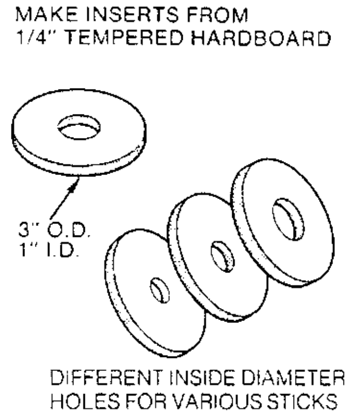


Figure 16-43. Make special table inserts that you can use with the sanding sticks.

you're finished, clean the table and lower chuck, and brush off the machine thoroughly to remove all metal filings.

You can use machine files to smooth the edges of wood, but use very light pressure. Otherwise, the files "load up" quickly. Sawdust becomes impacted between the grooves and must be cleaned out frequently.

SANDING

Special sanding sticks are available for jigsaw use, but it's not difficult to make your own (Figure 16-42). The sticks are just lengths of dowel, drilled to receive a section of threaded rod that can be gripped in the lower chuck like a file.

The abrasive paper can be cut from standard sheets and rubber cemented in place, or you can use readily available, self-adhesive types.

It's a good idea, when using sanding sticks, to make special inserts so the work will have maximum support close to the work area. You can make these of tempered hardboard with center holes drilled to accommodate sanding sticks of various diameters (Figure 16-43).

Like filing, the sanding action is up and down. Don't apply a lot of pressure against the sanding stick. Hold the work firmly enough so it won't be lifted by the upstroke (Figure 16-44). Keep turning the work so you will use all areas of the abrasive surface.

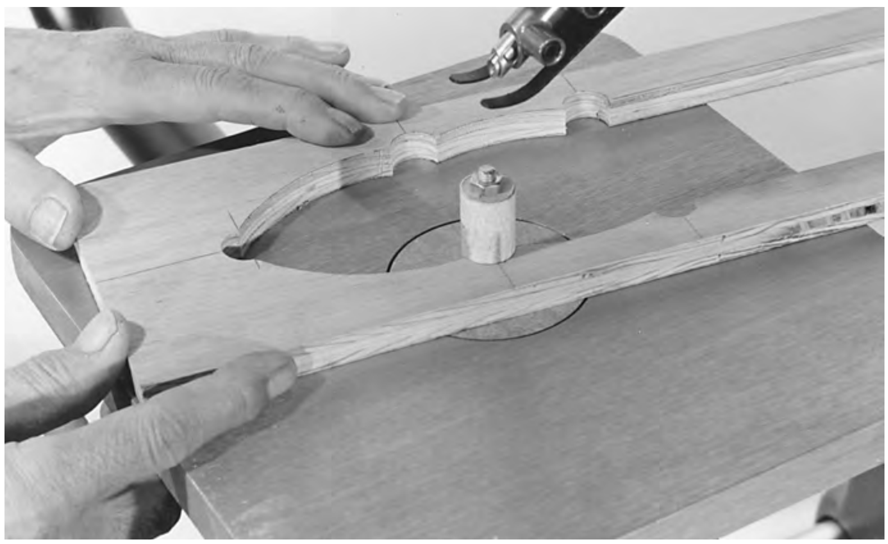


Figure 16-44. Keep turning the work so you will use all areas of the abrasive paper.

Chapter 17
Disc Sander

Sanding is easily the most tedious woodworking operation. It can sometimes take as long to hand sand a project as it takes to build it. Fortunately, you have four sanding choices with the Shopsmith Woodworking System: disc sander, drum sander, strip sander and belt sander. In this chapter, we will concern ourselves with the disc sander.

A disc sander can help eliminate some of the sanding tedium. It can't be used to fine sand, but it will remove saw marks from a ripped edge and smooth end grains. It can also be used to bring a workpiece to its final dimension, true-up joints and grind tools. Refer to Chapter 24 for how to grind tools on the disc sander.

DISC SANDER MODE—SETUP AND FEATURES

Use the accessories shown in Figure 17-1 for disc sanding operations. To set up your Mark V in the disc sander mode, follow the instructions in the Owners Manual that came with your machine.

As you work in the disc sanding mode, you'll find that the Mark V is an extremely capable disc sander with several special features:

• The 12" disc has a sanding surface of 113.04 sq. in.

• The rip fence functions as a backstop when sanding long or wide stock.

• Without a backstop, you can sand as big a workpiece as you can safely handle.

• The miter gauge can be used to hold stock at the proper angle to the disc.

• The table tilts from "0" to 45° right and the miter gauge can be adjusted from 30° left to 30° right to sand at a variety of angles.

• The rip fence can be offset to sand boards to a specific width.

• The quill feed and feed stop can be used to sand boards precisely to a specific dimension.

• You can sand without the rip fence or a miter gauge. This is particularly useful when sanding convex curves.

• A very practical setup is shown in Figure 17-2. By mounting a second disc on the upper auxiliary spindle, you can have two different abrasive grits available at the same time.

• The Model 510 lower saw guard accommodates the sanding disc. Connect the hose from your dust collection system to the dust chute in the guard for virtually dust-free sanding. For dust collection on the Model 500, a special disc sander dust chute is available.

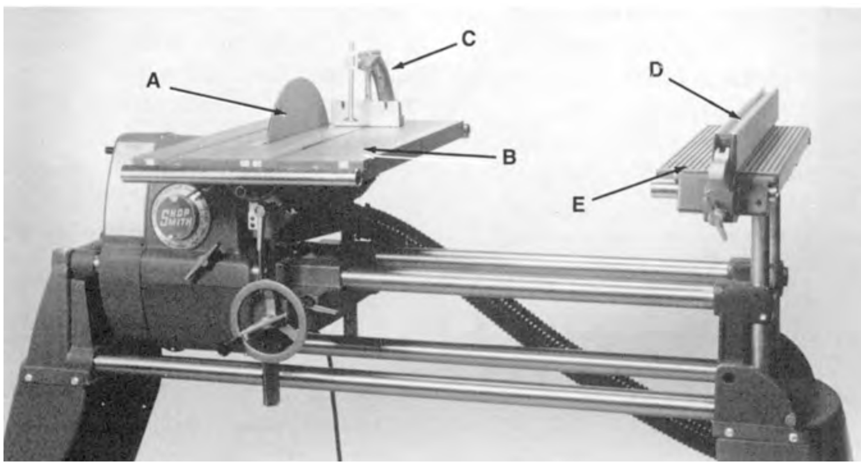


Figure 17-1. *The accessories that are used for disc sanding operations are the (A) sanding disc and sandpaper, (B) worktable, (C) miter gauge, (D) rip fence, and (E) extension table. The Model 510 is shown.*

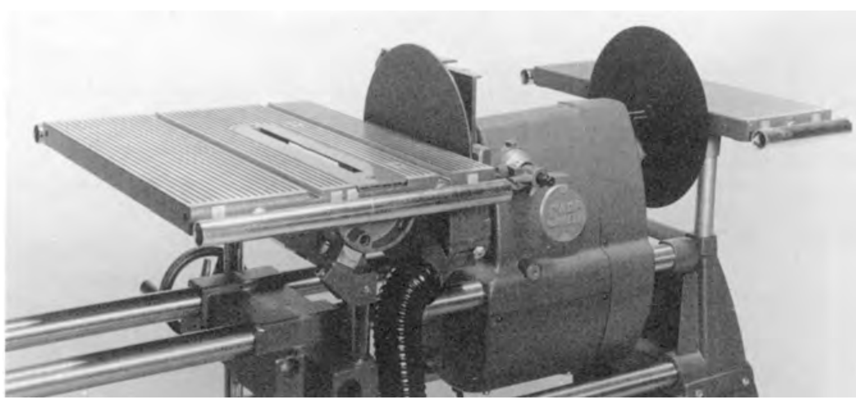


Figure 17-2. *Mount a second disc on the upper auxiliary spindle and you'll have two different abrasives available. The extension table supports the stock.*

SANDPAPER DISCS

The sandpaper discs are available in three garnet grits: coarse, medium, and fine. All three grits are "open coat"—only 40 to 60 percent of the disc surface is covered with abrasive material. This helps minimize "loading" at high speeds and extends the life of the disc.

The grit you choose depends on the work you have to do:

- *Coarse grit* will remove large amounts of stock quickly. It can be used to bring workpieces to their approximate dimensions; however, it leaves a rough surface. If you want a smooth finish, you must follow up a coarse grit with a medium or fine grit before hand sanding.
- *Medium grit* will remove small amounts of stock and can be used to bring workpieces to their final dimensions. It leaves a fairly smooth surface. From a medium grit, you can go straight to hand sanding.
- *Fine grit* leaves a smooth surface. It greatly reduces the time you need to spend hand sanding, though some hand sanding will still be required to remove swirl marks and obtain a perfectly smooth finish. Fine grit can also be used to grind and sharpen tools.

Caution: When using the sanding disc on the Model 500 that's not equipped with the special disc sander dust chute, place a wide scrap board on the way tubes directly under the disc. Sandpaper continually loses grit, and the board will keep this grit off the way tubes where it could scratch them. If you don't use a board to protect the tubes, be sure to clean the tubes thoroughly after you finish your sanding operations.

DISC SANDER SAFETY

Warning: Before using the disc sander, read and understand these important safety instructions:

Danger Zone—The danger zone on the Mark V when it is in the disc sander mode extends 3″ on all sides of the disc, plus 3′ in front and back of the disc. The reason for the extended danger zone in the front and back of the machine is the possibility of kickback.

Always keep your fingers, hands, and other parts of your body out of the danger zone. Once inside the danger zone, the slightest mistake can result in an injury.

When you work at the disc sander, always stand to one side of the disc, never directly in line with the plane of rotation. Use push sticks and other safety tools to help guide the workpieces close to the disc. This keeps your fingers out of danger. Never reach under the table while the sanding disc is running to tighten the locks or make adjustments. Remember, the danger zone extends under the table, too. Turn off the machine and let it come to a complete stop before making adjustments.

- **Always wear proper eye and ear protection, and a dust mask. If you're doing a large amount of sanding, you should wear a respirator.**
- **Turn on the Mark V, let the disc get up to speed, then feed the workpiece. Don't turn on the power with the stock laying on the worktable or already in contact with the disc.**
- **Never reach over the disc or behind it while it's running.**
- **Always sand on the downward motion side of the disc (Figure 17-3). The rotation helps to hold the workpiece against the table. If you sand on the upward motion side, the disc will lift the piece off the table and cause a kickback.**
- **Maintain a 1/16″ maximum clearance between the worktable and the disc. The one exception is when you use the quill to advance the disc. Then maintain a 1/2″ maximum clearance.**

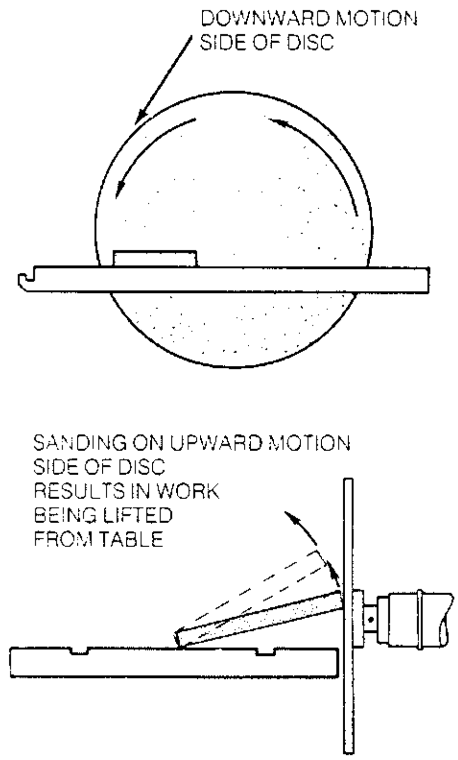


Figure 17-3. Always work on the downward motion side of the disc.

- **Do not sand the end grain of 3/4″ stock that is wider than 5-1/2″. The rotation of the disc may lift wider boards off the table.**
- **When you use the quill feed to advance the disc, attach the quill feed lever to the side of the power plant where you can reach it most easily.**
- **Always use the worktable; add the extension table if necessary.**
- **Never sand without a table supporting the stock.**
- **When using the quill feed to advance the disc, back up the stock with the rip fence. If the stock is too long to backstop, clamp the stock to the worktable or extension table.**

DISC SANDER SPEEDS

Before you begin any disc sanding operation, set the Mark V to run at the correct speed. To do this: turn the machine on, turn the speed dial to the correct speed and let the disc come up to speed.

Table 17-1: Disc Sander Speed Chart

Grit	Hardwood	Softwood
Coarse (60#)	D (1050 RPM)	E (1150 RPM)
Medium (80#)	F (1300 RPM)	G (1450 RPM)
Fine (100#)	G (1450 RPM)	H (1600 RPM)
Grinding or Sharpening Metal Tools — Slow (700 RPM)		

NOTE: These speeds are for 60 hz operations. For 50 hz operations, refer to Table 1-1.

Figure 17-4. *When using the quill feed, move the disc in and out as shown. Don't let the stock contact the abrasive for more than a few seconds at a time.*

The operating speeds for disc sanding are determined by the grit you're using and the material you're sanding. Generally, you can use faster speeds on softer woods. Faster speeds will also give you a smoother finish. Slower speeds reduce the risk of "burning" the workpiece and are better for sanding away large amounts of stock.

To help determine the right speed for the job, use Table 17-1. A good rule of thumb is: The softer the material or the finer the grit, the faster you can run the sander. However, don't run the sanding disc too fast or the wood may heat up and burn.

END GRAIN SANDING

End grain is harder to sand than any other surface, but the Mark V in the disc sander mode makes short work of this chore. You can also use the disc sander to sand workpieces to precisely the same length.

General End Grain Sanding

To sand end grain, position the worktable no farther than 1/16" away from the disc (if you're not using the quill feed) or 1/2" (if you are using the quill feed). Adjust the table height so that the underside of the table just clears the dust chute and the table is slightly above the center of the disc. When selecting the speed, keep in mind that you want to run the sanding disc a little slower than you would for other types of sanding because end grain will burn easily.

Use the miter gauge to align the workpiece with the disc. Check that the miter gauge is square to the disc, and mount it in the left table slot, closest to the disc. Position the gauge so it will guide the workpiece against the downward motion side of the disc; then lock the miter gauge in the slot.

Make a five-point check. If you plan to feed the stock into the disc, all five locks—power plant, carriage, table height, table tilt and quill—should be secure. If you want to use the quill to feed the disc into the stock, the quill lock should be loose. Stand to the right or left of the sanding disc. Turn on the Mark V and let the disc get up to speed.

If you're feeding the workpiece into the disc, place it against the face of the miter gauge and carefully feed it toward the disc until it lightly contacts the abrasive. Hold it there a few seconds, back it out, then feed it forward again. This back-and-forth motion will keep the end grain from heating up and burning. Repeat until the end grain is completely smooth.

If you feed the disc into the workpiece, use the quill feed to advance the disc until it lightly contacts the workpiece (Figure 17-4). Let it stay there a few seconds, back it off, and feed it forward again. Once again, a back-and-forth motion helps prevent burning. Repeat until the end grain is smooth.

As you work, don't press the workpiece and abrasive together too hard. Heavy pressure will cause the sandpaper to "load up" with sawdust and pitch. It will also increase the likelihood of burning. A light, momentary pressure is all that's needed.

Sanding to Exact Length

If you need to sand a number of boards to precisely the same length, use the rip fence mounted to the worktable or the extension table as a backstop. Position the backstop so that it will hold the end of the workpiece about 1/4" away from the sanding disc when the quill is completely retracted.

Set the depth control to halt the disc where you want to stop sanding. To do this easily, use a board that you've already sanded or scrap wood that you've cut off at the desired length (Figure 17-5).

Position the workpiece on the table, against the miter gauge and the rip fence, so that it overhangs the table slightly. Be sure the workpiece doesn't contact the sanding disc. Then make a five-point check. Four of the locks—power plant, carriage, table height, table tilt—should be secure. The quill lock should be loose. If the workpiece is long, use a miter gauge extension for more support.

Stand to one side or the other of the sanding disc. Squeeze the safety grip with one hand and turn on the Mark V. Let the disc get up to running speed; then, with the other hand, feed the disc forward slowly with the quill until it just contacts the workpiece.

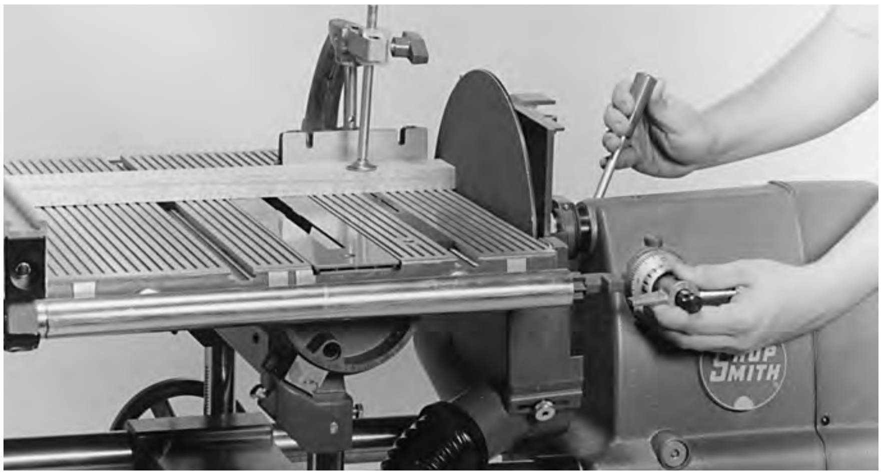


Figure 17-5. To sand boards to exact lengths, use the quill feed and set the feed stop to stop the disc where you want to finish sanding.

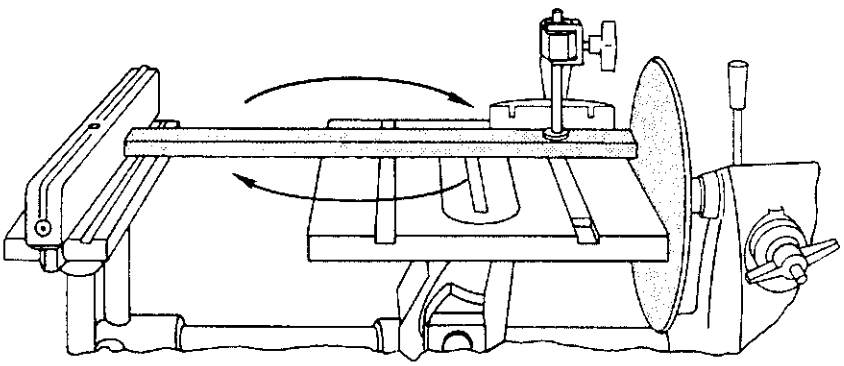
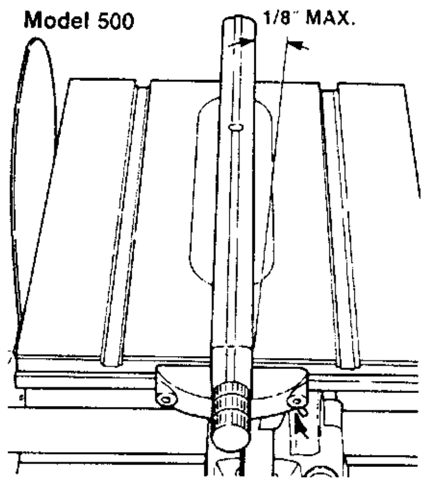


Figure 17-6. Sand one end of the board until it's smooth; then turn the board as shown and sand the other end until the depth control stops the sanding disc.



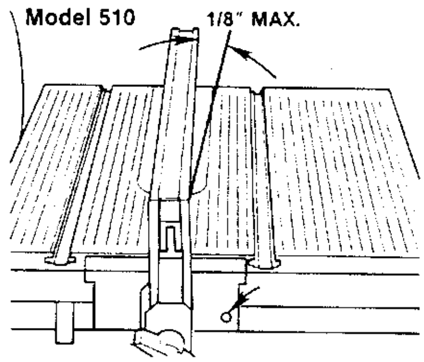


Figure 17-7. Offsetting the rip fence for edge sanding.

Advance the disc, back it off, then advance it again, lightly sanding the workpiece. Once again, light pressure is all that's needed. Don't extend the quill all the way at this time; just sand until the first end is smooth. When it is smooth, turn the board and sand the other end (Figure 17-6). This time, advance the disc until the depth control stops it.

Repeat this procedure as needed with the other boards you have to sand. When finished, they will all be exactly the same length.

EDGE SANDING

To remove saw marks from the edge of a board after ripping it or to true it up so that it's exactly the same width from one end to the other, sand the edge.

Mount a sanding disc and adjust the worktable height. Position the worktable so it is no farther than 1/16" away from the disc.

Mount the rip fence on the table, but don't lock it yet. Adjust the right-hand setscrew in the base to offset the fence (Figure 17-7). When properly adjusted, the rip fence should be 1/16"-1/8" closer to the disc at the front of the table than at the back.

Position the rip fence so that the edge of the stock just touches the downward side of the disc. Make fine adjustments with the quill feed.

Turn on the machine, set the speed dial and let the machine come up to speed. Feed the stock slowly **from the back** of the worktable toward the front (Figure 17-8). Repeat this procedure as needed until the board is the proper uniform width and all saw marks have been removed from the edge.

Sanding an Inside Corner

Although a disc won't sand perfectly to the inside of a right angle cut, you can get close enough so only a slight touch-up by hand will be needed. Make the first pass by starting at one end of the work and moving from the edge of the disc toward its center. Hold the work flat on the table and pass it slowly across the disc (Figure 17-9).

Smooth the second edge by following the same procedure or, if the edge is short enough, by moving the work directly forward against the disc (Figure 17-10). Work so the disc's rim will just miss touching the inside edges of the cut. If you force the work, the rim will mar it.

SANDING MITERS AND BEVELS

You can sand bevels and miters by tilting the table or adjusting the angle of the miter gauge, just as you do when sawing bevels and miters. Use the quill feed to move the disc toward the stock on the Model 500 (Figure 17-11).

When sanding angles on the Model 510, position the disc through the table saw insert (Figure 17-12).

TRUING MITERS AND BEVELS

Because it's difficult to accurately measure and cut mitered or beveled boards to precisely the same length, it's best to saw them slightly oversize; then sand them to the desired length. Sanded miter and bevel joints fit better.

To smooth an angled cut, don't change the tilt of the worktable or the angle of the miter gauge once you finish sawing. Instead, "borrow" the angles from the sawing setup. Raise the worktable and remove the saw blade and upper saw guard. On the Model 500 remove the lower saw guard also. On the Model 510, exchange the table saw insert for the disc sander insert. Mount a sanding disc; then readjust the table height and position the worktable for sanding. Clamp the workpiece in the miter gauge (Figure 17-13), and sand it at the same angle you cut it. The rip fence can also be used to back up the workpiece (Figure 17-14).

The procedure does not change if you are sanding a compound angle cut. Just keep the miter gauge and the worktable tilt at the same angles used to make the original saw cut (Figure 17-15).

Use the sanding-to-width technique when you need to sand a beveled edge (Figure 17-16). Remember that the fence is offset enough to provide clearance for the workpiece in the area indicated by the small arrow in the photograph.

When sanding bevels and miters, and especially if the angle is extreme, position the worktable and power plant at the right end of the machine. Length-of-work ca-

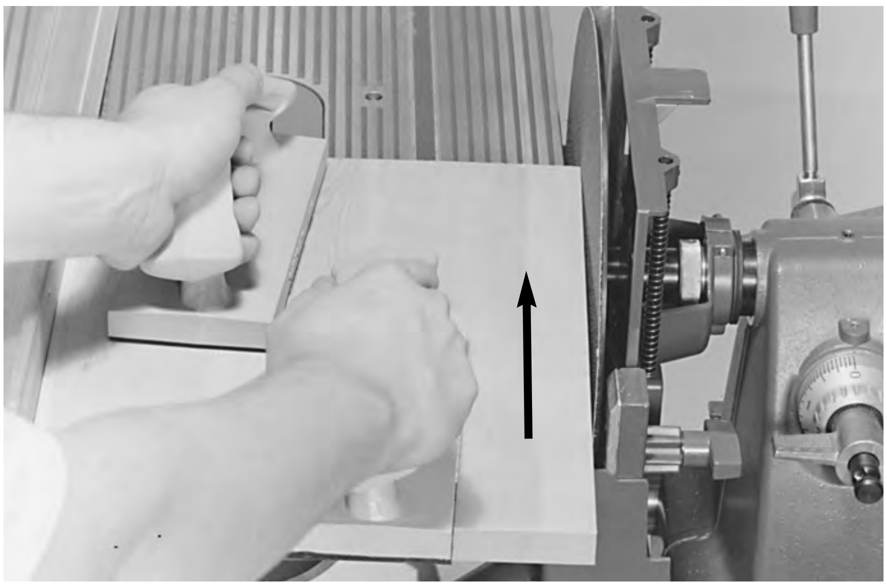


Figure 17-8. When edge sanding, feed the stock slowly from the back of the worktable to the front. Use a push stick and/or push blocks.

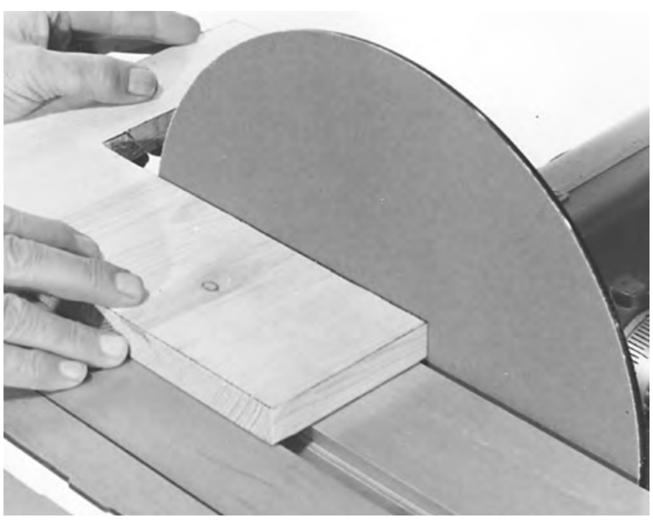


Figure 17-9. This is the first step when sanding to an inside corner. Make the pass to the point where the disc's rim just misses touching the corner.

Figure 17-10. The second pass can be across the disc or directly into it, depending on the length of the work. The corner will require a bit of hand finishing.

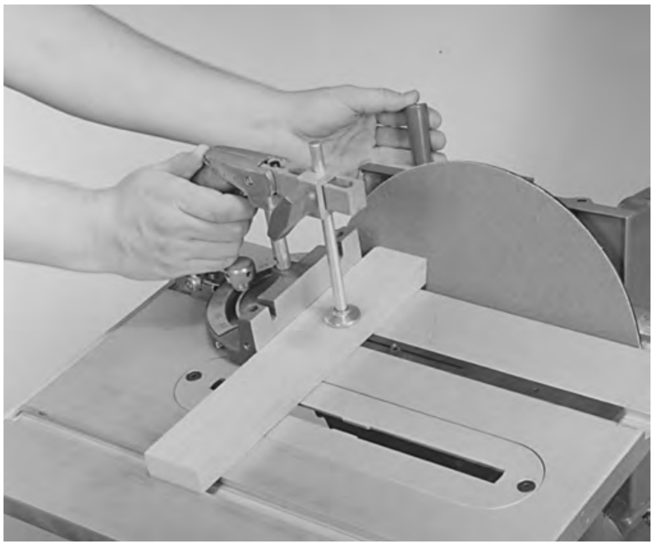
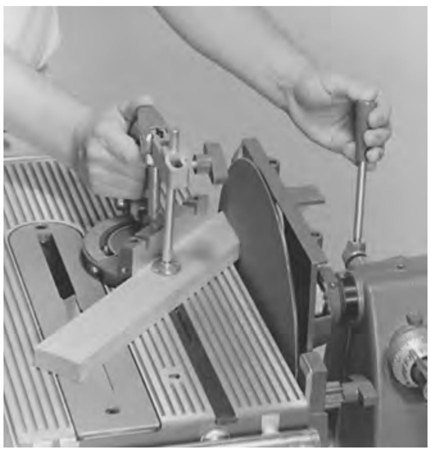


Figure 17-11. *When sanding angles on the Model 500 use the quill to move the disc toward the stock.*

Figure 17-12. *When sanding angles on the Model 510, position the sanding disc through the table saw insert.*



A

B

Figure 17-13. *To sand a miter or bevel, use the same setup you used to saw it: (A) miter gauge angled or (B) worktable tilted. On the Model 510 the disc is mounted through the insert.*

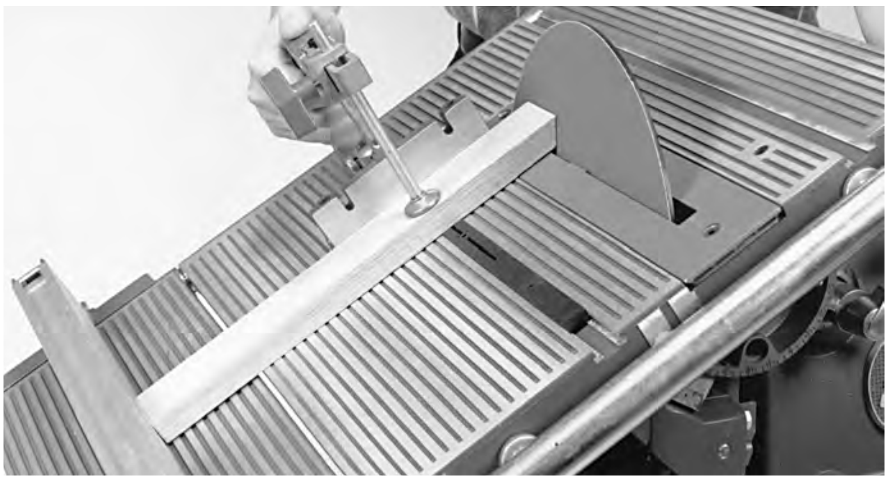


Figure 17-14. *The rip fence can also be used to back up the workpiece.*

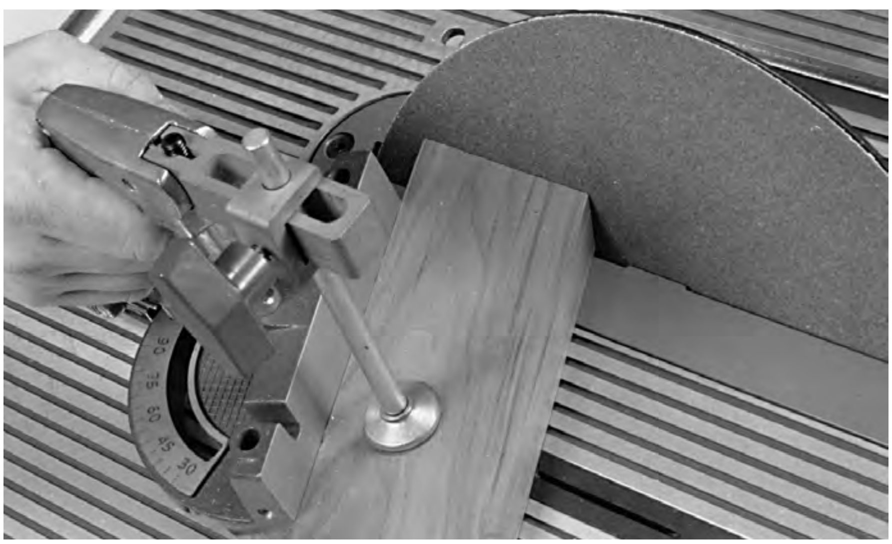


Figure 17-15. *When sanding compound miters, keep the miter gauge and the worktable tilt at the same angles used when making the saw cut.*

pacity will then be from the disc to the floor.

CHAMFERING

By tilting the worktable, you can also sand a chamfer on the edge of a board.

Tilt the worktable to the right. Offset the rip fence as you would for edge sanding and position the rip fence so that the edge of the board to be sanded will contact the downward motion side of the disc. Make fine adjustments with the quill feed.

Make a five-point check—all locks should be secure—then proceed as you would when edge sanding (Figure 17-17). Be careful not to take off too much stock in one pass.

End Chamfers—By using the miter gauge and a miter gauge stop rod, or by setting up the miter gauge and the rip fence, you can end chamfer any number of pieces so they will be exactly alike. The workpieces shown (Figure 17-18) are small, but there is no reason why the techniques can't be used on larger projects such as fence pickets or corner posts for box constructions.

Figure 17-16. *Boards can be sanded to width using this setup. In this case the worktable is tilted to sand a bevel. The large arrow indicates feed direction; the small one indicates the gap needed between the workpiece and the "rear" half of the disc.*

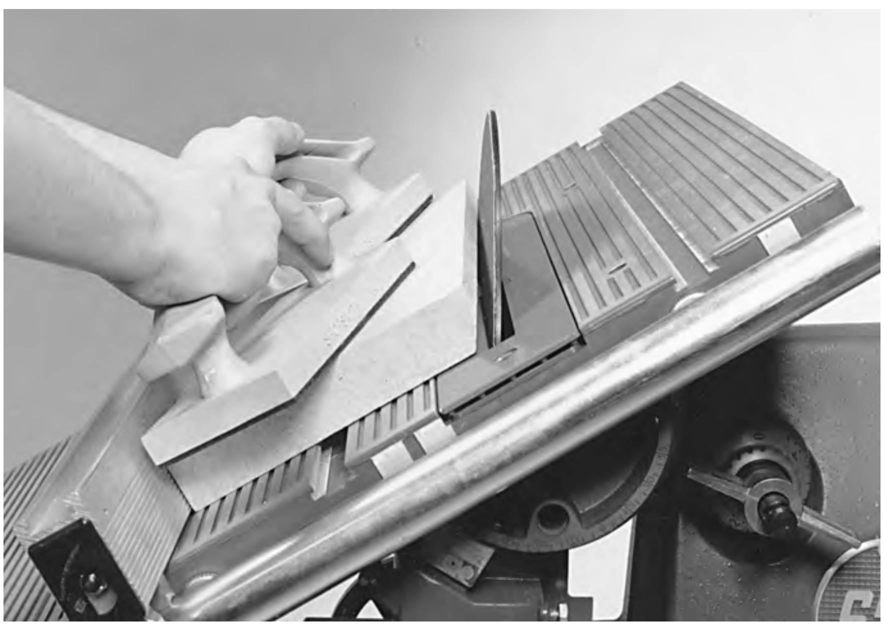
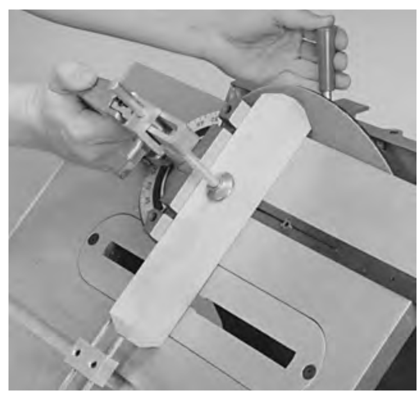


Figure 17-17. *To sand a chamfer in the edge of a board, tilt the worktable and proceed as you would when edge sanding. Don't take off too much stock in one pass.*

SANDING CURVES AND CIRCLES

To sand curves, move the work-piece in to contact the disc and then use a sweeping motion to maintain the work-to-disc contact throughout the pass (Figure 17-19). Feed should be light and smooth even when a great deal of material must be removed. Several light passes are always better than a single heavy one. The disc has a fast cutting action, so excessive

A



B

Figure 17-18. *(A) Perfect end chamfers are sanded by using a setup as shown and feeding the disc into the work-piece. (B) End chamfering can also be done (Model 500 only) by tilting the worktable and using the miter gauge stop rod and the miter gauge with safety grip.*

pressure can cause burn marks and will lead to premature clogging of the abrasive.

Sanding Curves to Width

You can guarantee that curved workpieces will be of uniform width throughout their length if you follow the procedure demonstrated in Figure 17-20.

The guide is clamped in place so the distance from the dowel to the disc will equal the width of the workpiece. The stock is then slowly passed between the dowel and the disc. There are two important factors: (1) The curve of the workpiece where it bears against the dowel must always be tangent to the disc; and (2) the inside edge of the workpiece must be smooth and parallel to the outside edge, something you can accomplish with a drum sander.

If there are bumps or hollows in the bearing edge of the workpiece, you will not get good results. The construction details of a guide you can make are shown in Figure 17-21.

Sanding Circles

Circular workpieces can be sanded freehand. But you will be more accurate, especially if you need duplicates, by using the pivot method of guiding the workpiece. The miter gauge, locked in place and with a pin threaded in the hole that is at the end of the bar, can be used as the pivot. You can also make a special fixture, like the one shown in Figure 17-22.

When setting up, place the workpiece on the fixture and position the worktable so the edge of the workpiece will be about 1/4" away from the disc. Advance the disc so it will start sanding the workpiece; then secure the disc's position by using the quill lock. The workpiece is then slowly rotated a full 360° (Figure 17-23).

Use the same procedure, but with the worktable tilted to the

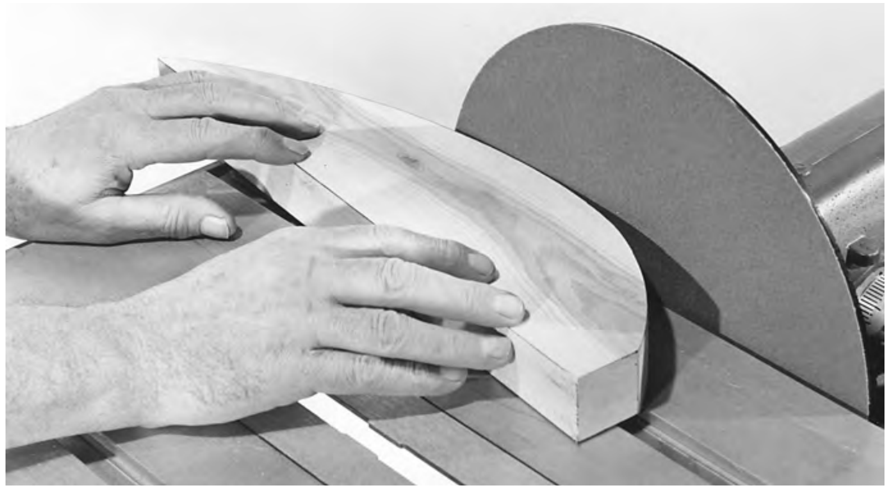


Figure 17-19. *Use a light, sweeping motion when smoothing outside curves. Don't hesitate at any point or the disc will sand a "flat."*

Figure 17-20. *Use a guide to sand curved workpieces to a uniform width. The edge that bears against the dowel must be smooth and true.*

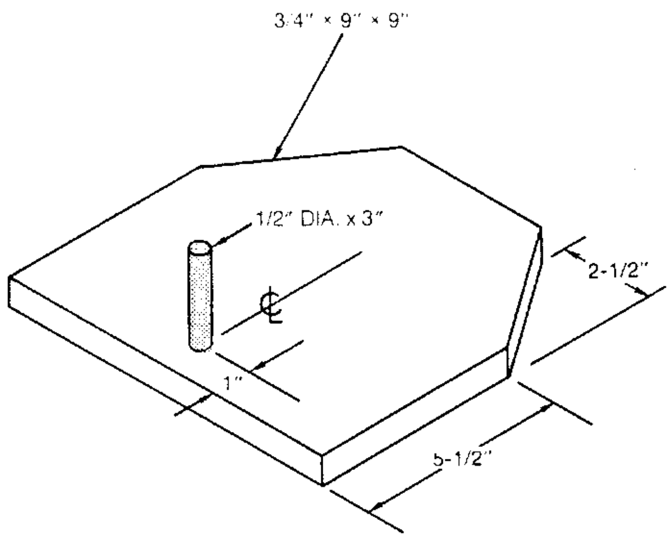


Figure 17-21. *Construction details of a guide for sanding curved workpieces to a uniform width.*

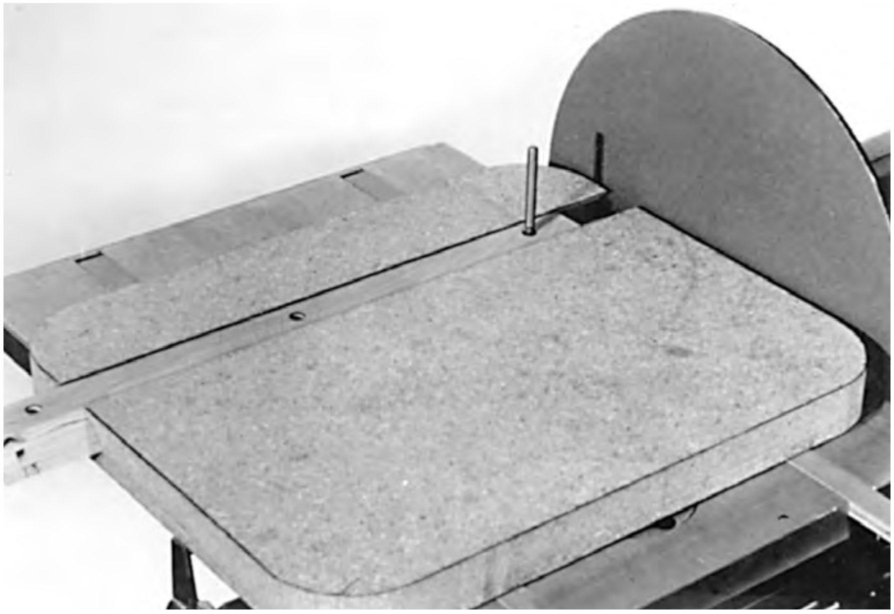


Figure 17-22. A special pivot fixture that you can make to sand perfect circles.

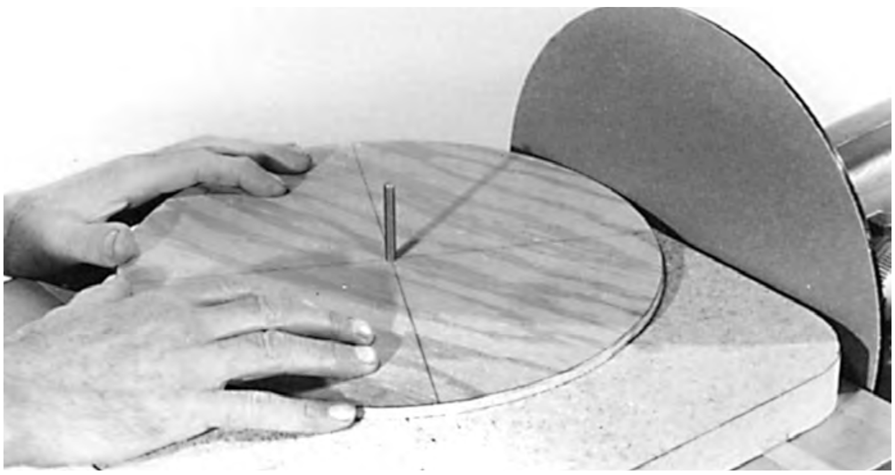


Figure 17-23. The workpiece is mounted on the pivot post and slowly rotated against the disc.

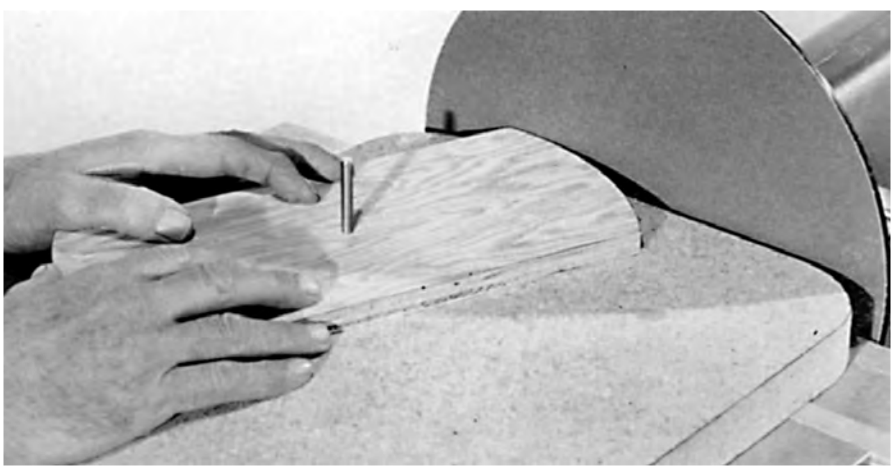


Figure 17-24. The pivot guide method can also be used to round off the ends of straight pieces.

right, when you need to bevel the edge of a circular workpiece.

The same arrangement is useful when you need to round off the ends of straight pieces (Figure 17-24). Drill a pivot hole at the center of the workpiece; then proceed to sand as if the workpiece were fully circular.

Construction details of the pivot fixture are shown in Figure 17-25. Notice that you can make pivots that are straight posts or are pointed. The short, pointed one can be used when the workpiece does not have a center hole. The L-shaped lock can be used to secure the sliding bar if you remove the table insert before putting the fixture in place. The pivots, if threaded deeply enough, will also serve to secure the bar in a particular position.

You can pivot sand exceptionally large circles using the following setup. For Model 500, place the rip fence on the extension table and mount the lathe cup center in the hole used for the mortising hold-down. For the Model 510, drill a 5/8″ dia. hole in the top of a rip fence extension. Mount the extension to the rip fence and mount the lathe cup center in the hole. Set the height of the extension table so the point of the cup center will be slightly above the surface of the worktable (Figure 17-26). Extend the quill so the distance from the disc to the point will equal the radius of the workpiece. Set and lock the depth control dial at "0."

After the workpiece is in position, advance and lock the quill (the amount of extension will be controlled by the depth control); then slowly rotate the workpiece until its entire circumference is sanded. Remember that the cup center point is just a pivot guide; the workpiece must rest solidly on the worktable.

Sanding Round Corners

One method of sanding round corners is shown in Figure 17-27.

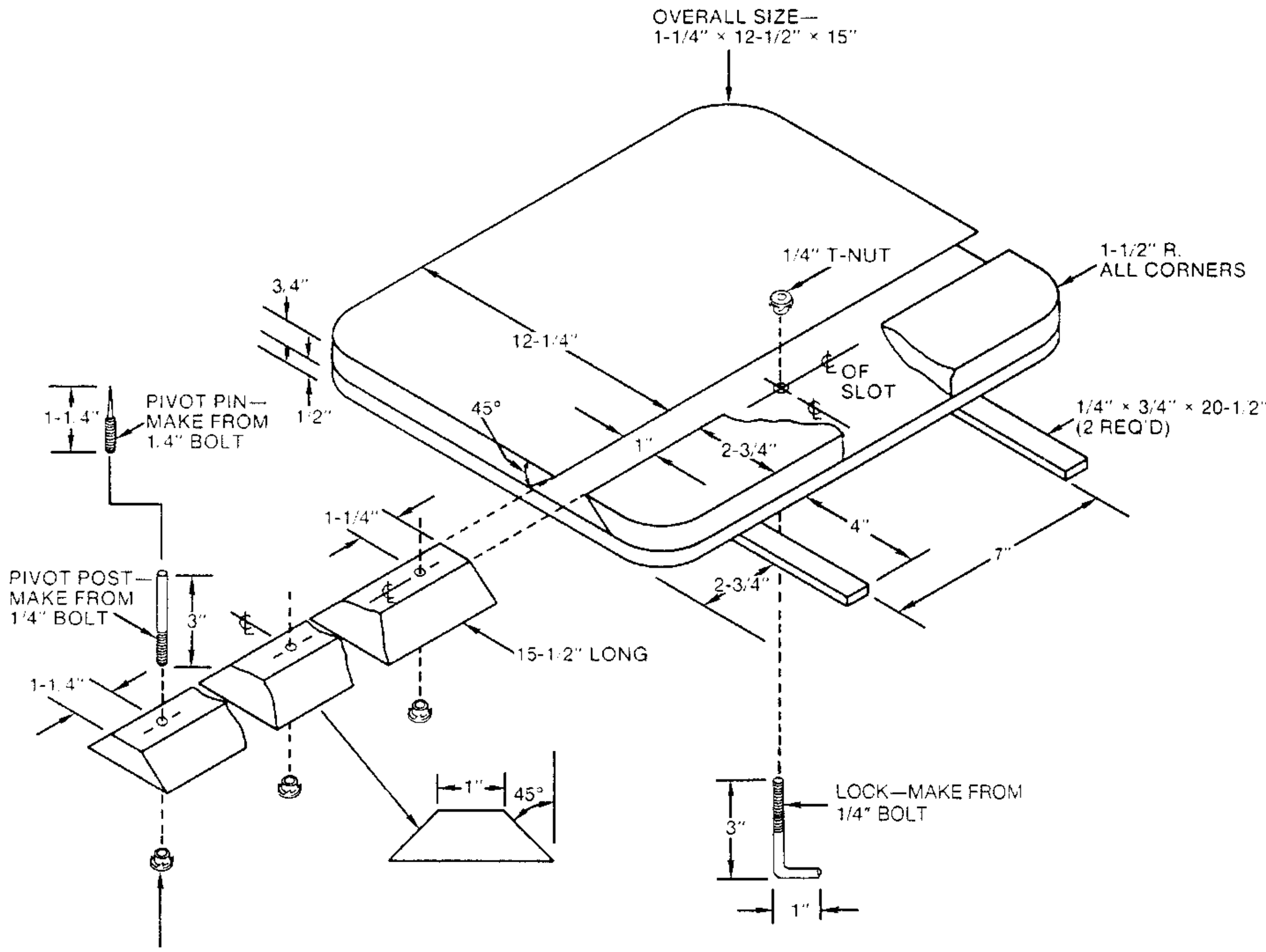
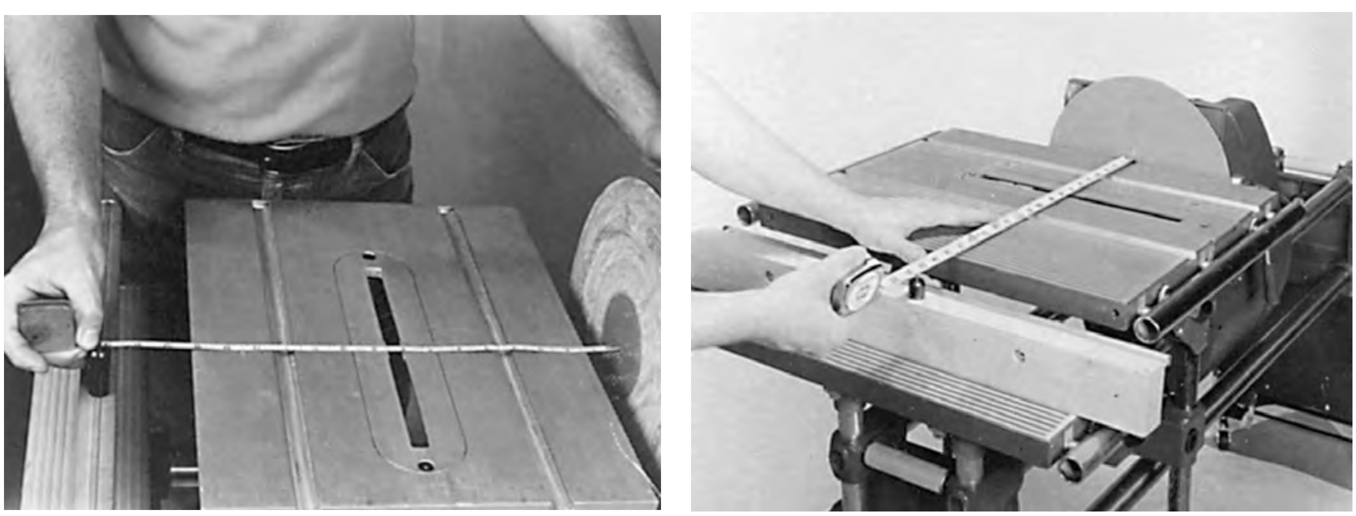


Figure 17-25. Construction details of the pivot fixture. Notice the two types of pivot posts; one has a point to be used when the workpiece does not have a center hole.



A **B**

***Figure 17-26.** To pivot sand extra-large circular workpieces, mount the lathe cup center to: (A) the rip fence of the Model 500 or (B) a rip fence extension on the Model 510.*

Figure 17-27. Corners can be rounded off by sanding to a line. The bulk of the waste should be removed with saw cuts before you begin.

Prepare the stock by sawing off the bulk of the waste material and then finish the shaping by using the disc sander.

When the radius of the corner isn't very large, the entire job can be done by sanding, a procedure that is especially applicable when you need many similar pieces. Set the miter gauge at 45° and use the miter gauge stop rod as a backup for the workpiece. Secure the workpiece by holding the safety grip and, with the depth control set to limit the disc's extension, feed the disc forward to sand to a line that is tangent to the curve (Figure 17-28).

After all corners have been sanded in this manner, finish the job freehand. There will be very little material left to remove.

Pointing or Chamfering Rounds

Pointing or chamfering dowels or rounds can be done freehand by setting the miter gauge to the angle you need and then using it as a guide as you rotate the workpiece against the disc (Figure 17-29). If

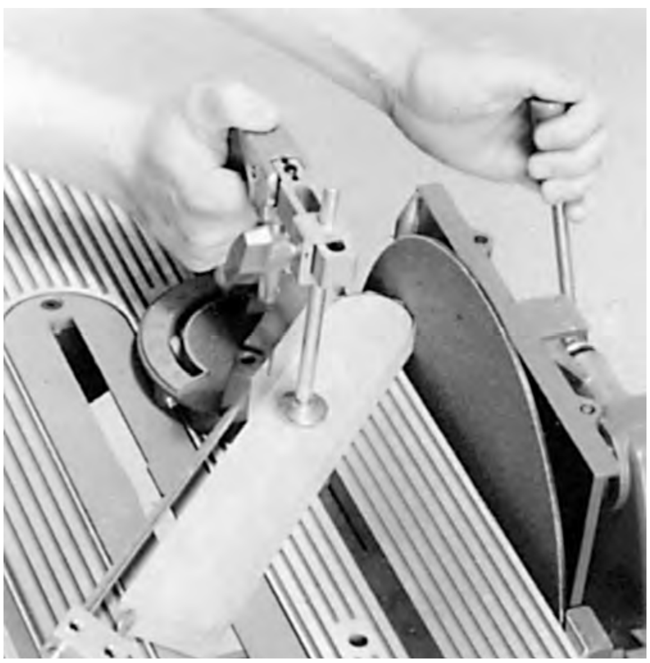


Figure 17-28. This is a setup that can be used if the corners are not too large. First sand to a line that is tangent to the curve. Finish rounding off by working freehand.

Figure 17-29. The ends of dowels or larger rounds can be pointed or chamfered freehand by angling the miter gauge.

you want more precise results or need to shape duplicate pieces, work as follows.

Use the miter gauge stop rod or a long extension with a stop block to back up the workpiece. Advance the disc to the point where it will form the chamfer or point you need while rotating the stock against the miter gauge.

PATTERN DISC SANDING

Pattern disc sanding is useful for sanding duplicate pieces, especially if they have an odd shape. The procedure is shown in Figure 17-30.

The guide, preferably metal, is attached to the edge of an auxiliary platform which is clamped to the worktable so the guide will be about 1/8" from the disc.

The workpiece, attached to the pattern, projects over the guide to contact the disc. Therefore, the distance from the guide to the disc and the thickness of the guide must be considered when shaping the pattern. The pattern must be smaller than the actual workpiece.

The workpiece is attached to the pattern by tack-nailing or using nail points projecting from the pattern. When you rough-cut the workpieces, try to leave the least amount of material for the disc sander to remove.

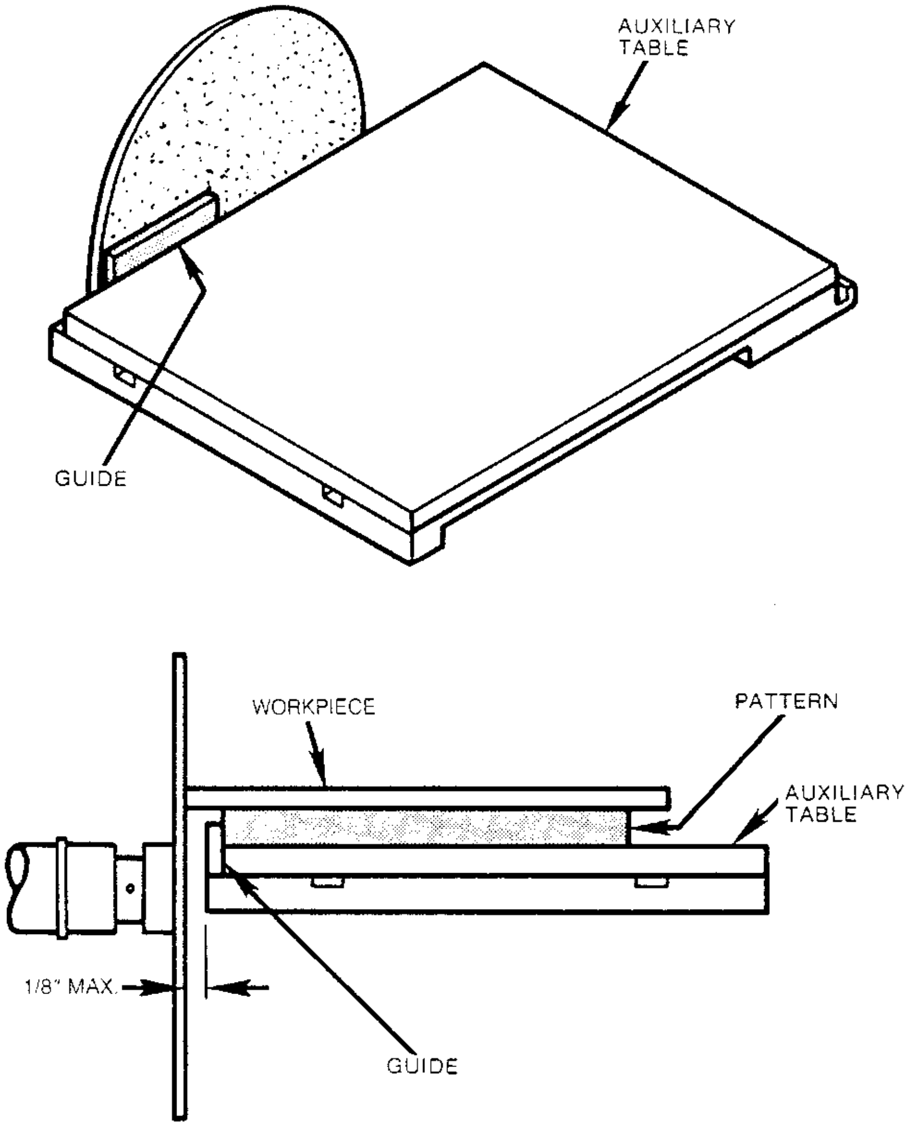


Figure 17-30. The pattern sanding procedure shown here is useful when many identical pieces are needed.

Chapter 18
Drum Sanding

The drum sander is a handy sanding device that's used to smooth regular or irregular concave or convex edges, cabriole legs and other odd shapes, and internal cutouts—it can even be used for edge sanding and surfacing. The drum sander mounts on the Mark V main spindle or the belt sander. On the Mark V it may be used in the vertical or horizontal position, whichever mode is more convenient for the job at hand.

TYPES OF DRUM SANDERS

The drum sander is 2-1/4″ in diameter and 3″ long (Figure 18-1). Abrasive sleeves are easily mounted or removed by loosening the hex bolt that is in the base of the drum. This action relaxes or expands the drum's rubber cylinder to either grip or release the sleeve. The grits are available in coarse (60#), medium (80#), and fine (100#).

The drum sander mounts on the Mark V main spindle or the belt sander auxiliary spindle. The special shaper/drum sander insert (Figure 18-2) is used for most operations. The shaper or rip fence, when used with the drum sander, can accurately control the drum's depth of cut when it is used to do edge sanding on straight edges.

Smaller drum sanders are available in sets that include drum diameters of 1-1/2″, 1″, 3/4″, and 1/2″. They are mounted in a three-jaw chuck or 1/4″ router chuck. ***Warning: Smaller drum sanders should be used with the special insert shown in Figure 18-3. The special insert provides support for the workpiece.***

Figure 18-1. *The drum sander is 2-1/4″ in diameter and 3″ long. It mounts on the Mark V main spindle or the belt sander auxiliary spindle.*

DRUM SANDER SAFETY

Warning: Before using the drum sander, read and understand these important safety instructions:

Danger Zone—The danger zone on the drum sander is the area 3″ around the drum.

- **Wear proper eye and ear protection, and a dust mask.**
- **Do not stand directly in line with the workpiece.**
- **When using the rip fence, avoid sanding workpieces with inconsistent widths.**
- **Do not sand more than 1/32″ off the workpiece in a single pass.**
- **Feed the workpiece against the rotation of the drum.**

Figure 18-2. *The drum sander is used with the drum sander/shaper insert. Model 500 is shown.*

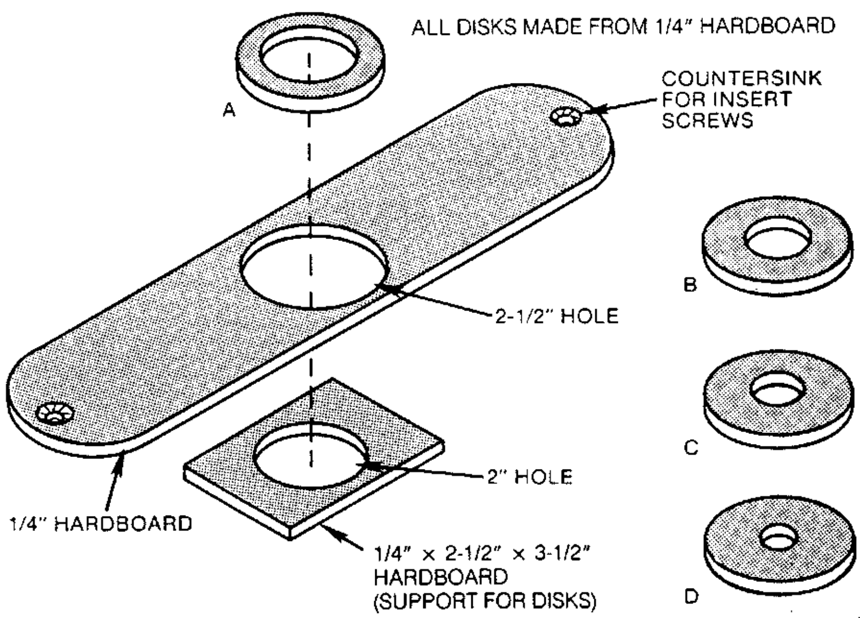


Figure 18-3. *Make the special insert and drill the mounting holes by using a drum sander insert as a pattern. All disks have a 2-1/2″ outside diameter and: (A) a 1-5/8″ inside diameter; (B) a 1-1/8″ inside diameter; (C) a 7/8″ inside diameter; or (D) a 5/8″ inside diameter.*

DRUM SANDER SPEEDS

Operate the drum sander at the speed recommended in Table 18-1. Start at a low speed and gradually increase to where you are getting the smoothness you need. The problem with excessive speed is that enough friction can occur to burn the wood unless the feed pressure is feather-light. Also, since friction heat can draw pitch or resin from the wood, excessive speeds cause more rapid filling and clogging of the abrasive. So work wisely at a reasonable speed and use only the amount of feed pressure required for the abrasive material to do its job.

EDGE SANDING

Most edge sanding is best done with the machine in the vertical position (Figure 18-4). The setup assures that sanded edges will be square to adjacent surfaces. Move the workpiece slowly, but keep it in constant motion. The drum will continue to sand if you hold the workpiece still and this will cause indentations that will spoil the edge. Move the workpiece from left to right, against the drum's direction of rotation.

Sanding operations will be most efficient and abrasive materials will last longer if you do initial cutting so there is the least amount of material for the sander to remove. When you are doing a lot of sanding, occasionally adjust the drum's vertical position so you will be using all of the abrasive surface.

Internal edges are sanded in a similar fashion, the only difference being that you position the workpiece before extending the quill (Figure 18-5). The drum sander's position is maintained by locking the quill.

You can smooth straight edges freehand by passing them across the drum; but a more efficient technique, when stock width permits, is to work with the rip fence as shown in Figure 18-6. The

Table 18-1: Drum Sanding Speed Chart

Abrasive	Hardwood	Softwood
Coarse	H (1600 RPM)	I (1750 RPM)
Medium	I (1750 RPM)	J (1900 RPM)
Fine	J (1900 RPM)	K (2050 RPM)

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

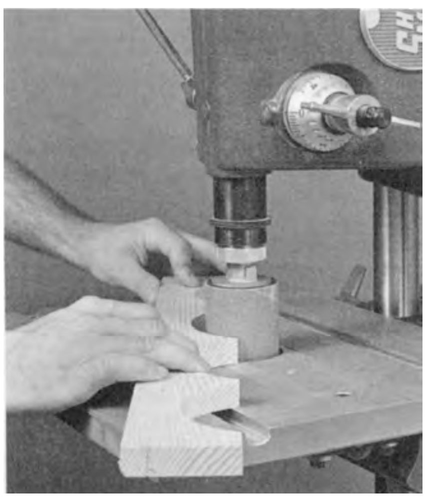


Figure 18-4. *Work this way when sanding edges. The setup assures that sanded edges will be square to adjacent surfaces.*

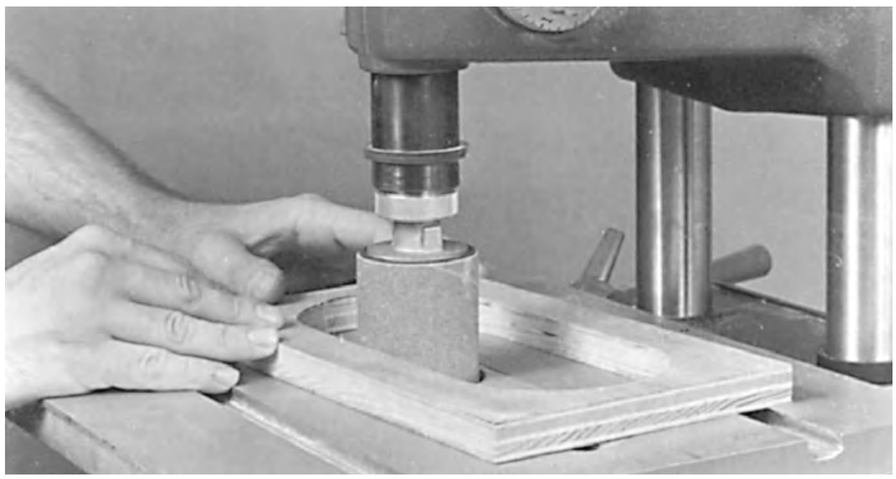


Figure 18-5. *To sand internal edges, position the stock before extending the quill.*

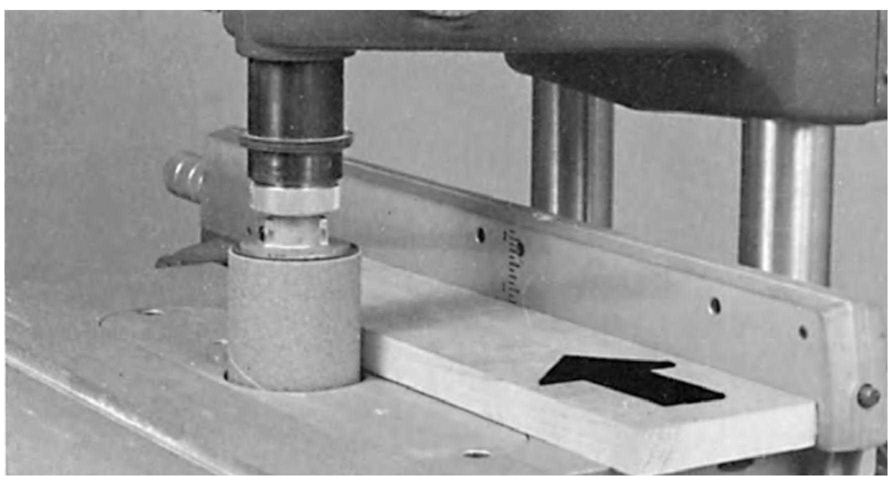


Figure 18-6. *Sand straight edges as shown when you wish to sand workpieces to an exact width.*

drum's depth of cut must be very light, only enough to smooth the edge. When the fence is situated between the drum and the way tubes, the pass is made from right to left. This setup is also used to edge sand any number of pieces to exactly the same width.

The same setup can be used if you work with the shaper fence. The amount of material to be sanded off is controlled by adjusting the infeed fence as you would when doing a shaping cut that removes the entire edge of the stock. There is no limit to how wide the stock can be when you are using the drum sander/shaper fence arrangement.

SURFACE SANDING

Surface sanding is done with the Mark V set in the horizontal position. Place the stock at the edge of the table; then position and raise the table so the stock just touches the abrasive sleeve. Remove the stock and turn on the motor; then feed the stock, between the drum and table, against the drum's direction of rotation. This means standing behind the Mark V and moving the stock toward the speed dial side of the power plant (Figure 18-7). ***Warning: Do not stand directly in line with the stock.***

Stock that is wider than the drum can handle in a single pass can be sanded by making additional passes. An example procedure, with the fence used as a guide, is shown in Figure 18-8. Assuming that the width of the stock is less than twice the length of the drum, set the fence to accommodate the width of the stock and make one pass with the stock riding against the fence. Then, after turning the stock end-for-end, make a second pass.

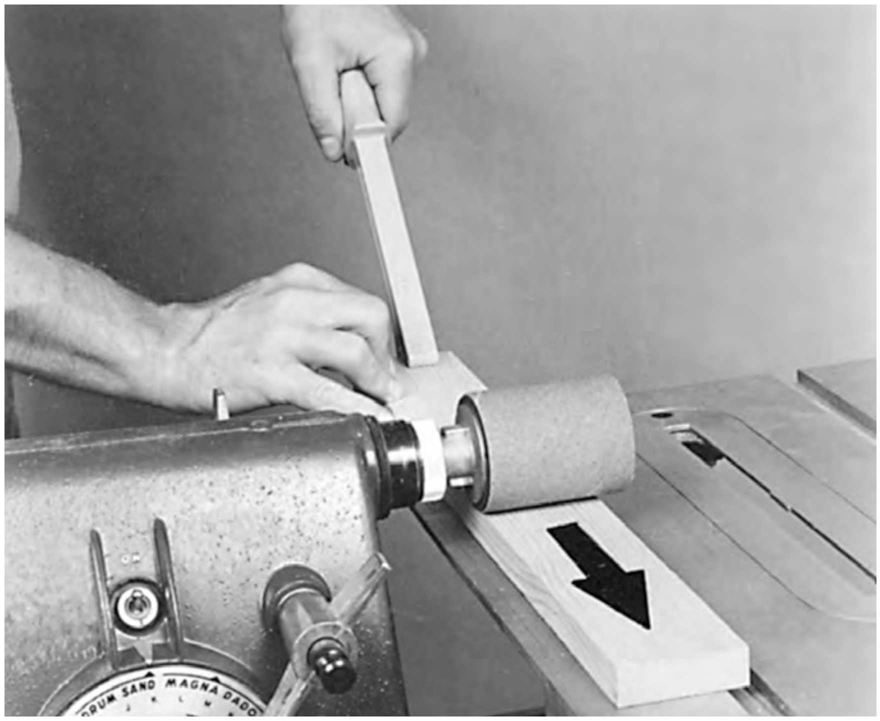


Figure 18-7. *You can do surface sanding by passing the stock between the drum and the table. Keep the stock moving and don't try to remove too much material in a single pass.*

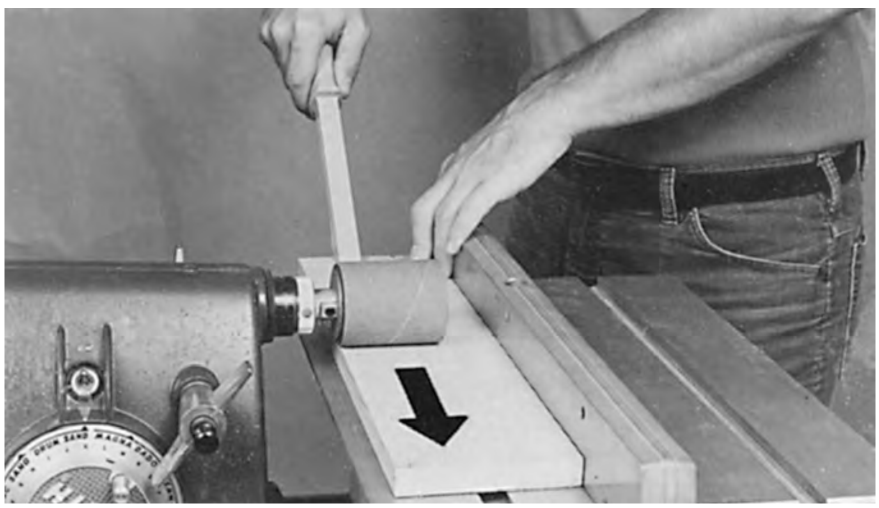


Figure 18-8. *One way to surface sand wide stock. After making the first pass, turn the stock end-for-end and make a second pass.*

Surfacing Thin Slats

Surface sanding thin material can be difficult to do, especially if you want the slats to have a uniform thickness. As long as the slats are not wider than 2-1/2", the work can be done accurately and efficiently by using the setup shown in Figure 18-9. Position the fence so the drum will bear lightly against the slat. The slats are fed in at the rear and pulled out at the front of the machine. Be sure to keep them moving. Any hesitation will cause the drum to form an indentation.

Making a Drum for Thickness Sanding

A drum sander you can make, and which is used with the Mark V in the lathe mode, is shown in Figure 18-10. The drum affords several advantages: It can surface sand material more than 12" wide; the large table surface provides excellent support for the workpiece; and if the drum is accurately made

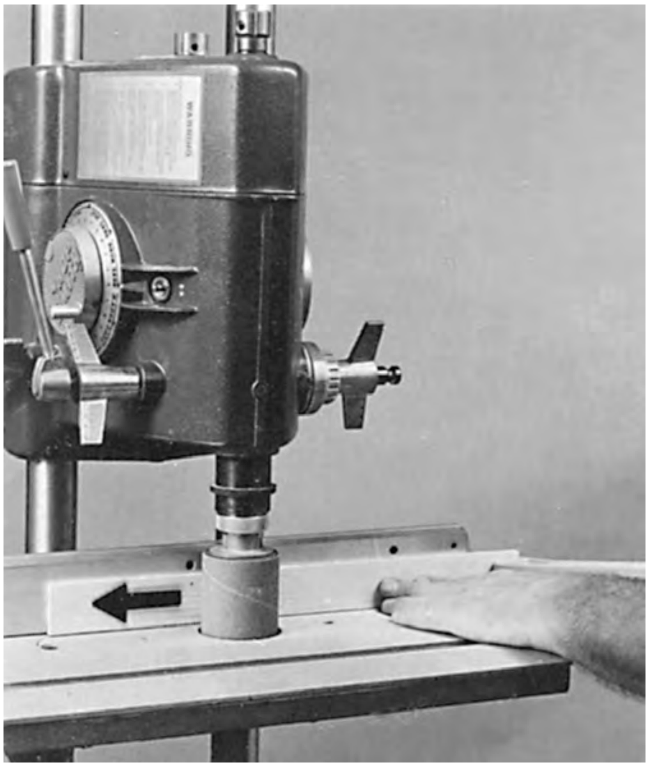


Figure 18-9. This is about the only way you can surface sand thin slats so all will be of equal thickness throughout their lengths.

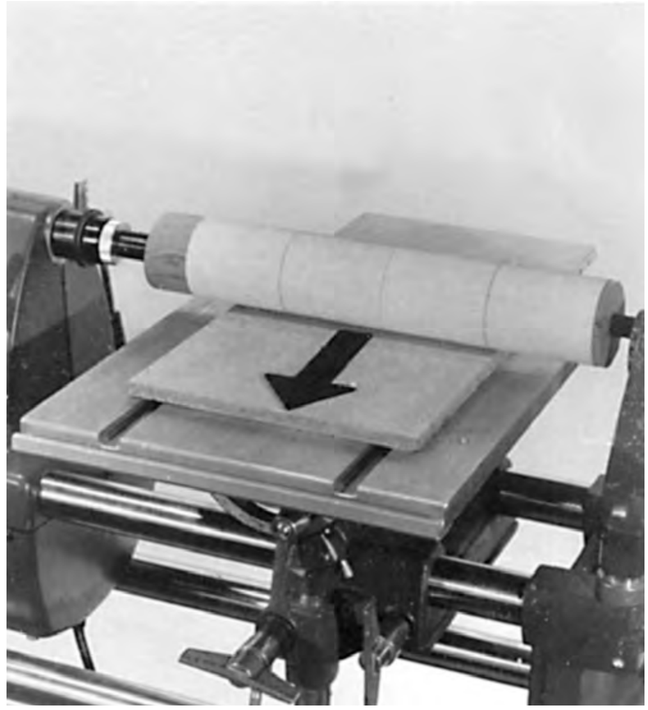


Figure 18-10. You can make a drum sander that can be mounted between the lathe centers and used, as shown here, for thickness sanding. Here, even more than on other operations, the pressure against the drum must be very light.

and the table's alignment is correct, the material will be sanded to a uniform thickness.

Use a hardwood like maple or birch. Construction details of the drum sander are shown in Figure 18-11.

Don't use excessive speeds, feed too fast, or try to take too deep a bite. Light passes will do a much better job than a single heavy one. ***Warning: If you try to remove more than 1/64" of material at once, you might cause the drum to be thrown from its mounting or the stock to be pulled from your hand and thrown.***

PATTERN DRUM SANDING

Pattern sanding is done by making a special insert with a guide disk having a diameter equal to the drum's diameter (Figure 18-12). It is important that the disk be centered exactly under the drum; therefore, when making the insert,

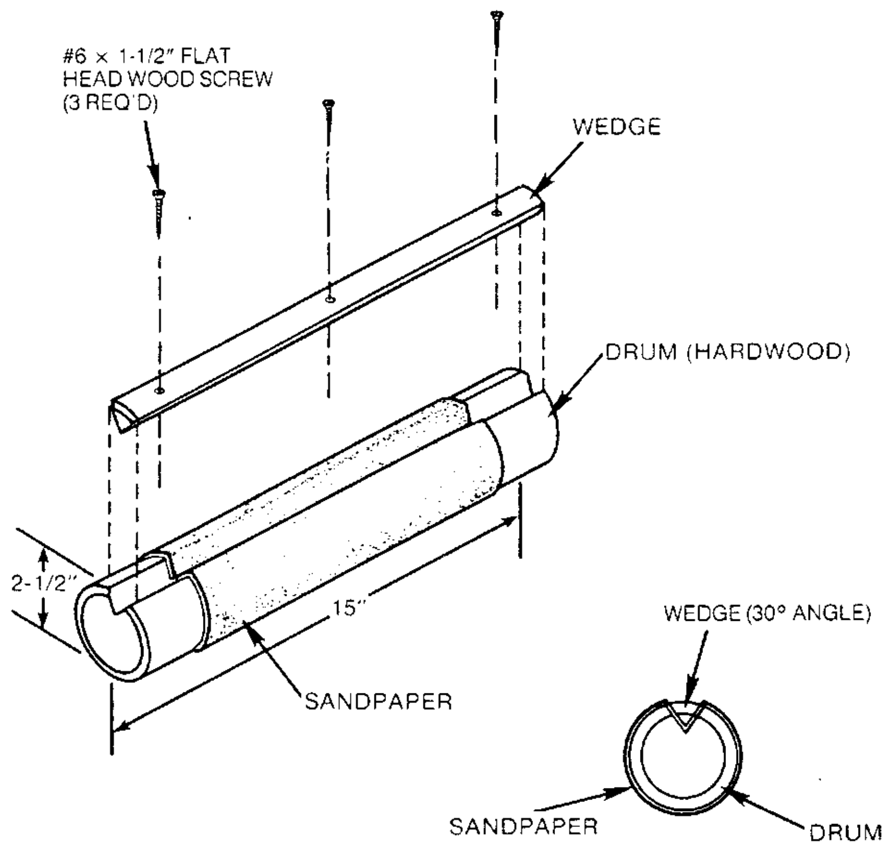


Figure 18-11. Construction details of a special drum sander.

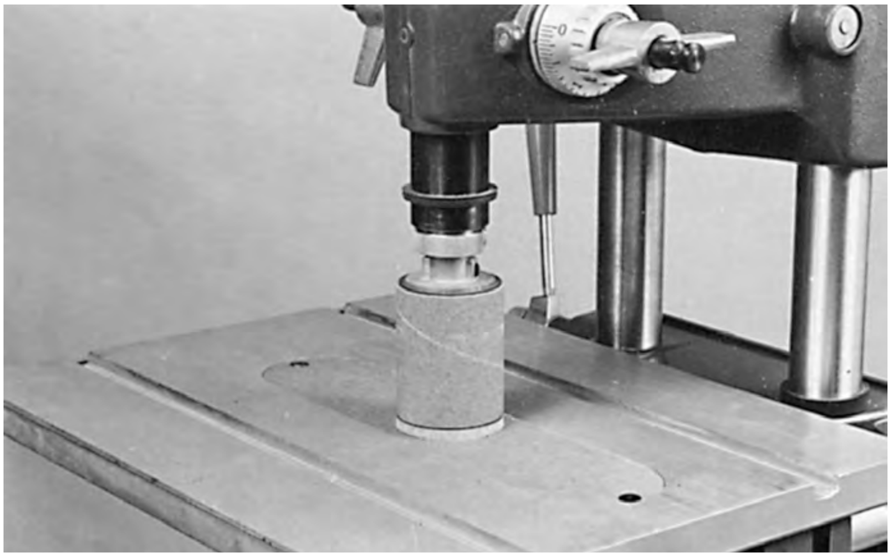


Figure 18-12. A special insert, with a disk that is centered perfectly under the drum, is needed when the drum sander is used for pattern sanding.

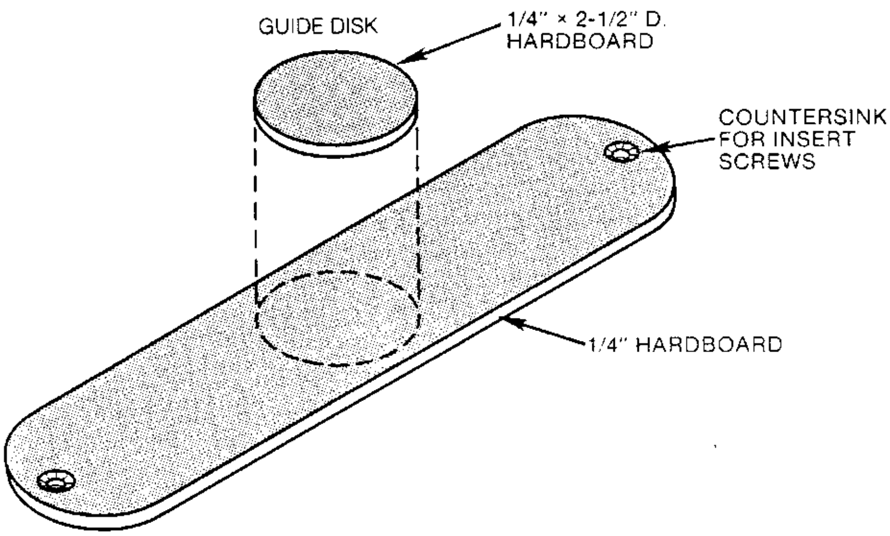


Figure 18-13. To make a special insert for pattern sanding, use a drum sander insert as a pattern. Locate the position of the guide disk with the drum sander mounted on the spindle. Attach the disk with glue and 1/2" brads.

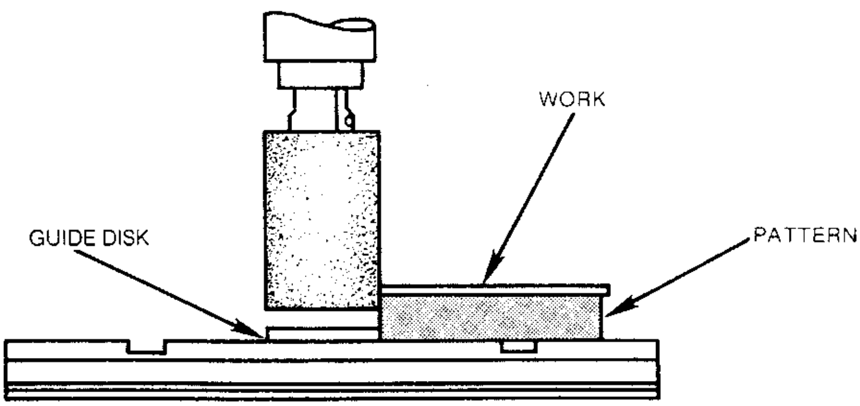


Figure 18-14. The pattern, with work attached, rides against the guide disk so the work is sanded to duplicate the shape of the pattern.

be sure to follow the instructions shown in Figure 18-13.

Figure 18-14 shows how the sanding is done. The pattern, which is the shape of the work you need, rides against the guide disk. The rough-cut work is held to the pattern with small brads or is impaled on brad points that project from the pattern. As you make the pass, keep the pattern in constant contact with the guide disk so that the work will be sanded to match the pattern.

Pattern sanding on the drum will work only if you accept it as a smoothing operation. When you rough-cut the workpieces, be sure they are not more than 1/16" or so oversize.

SANDING ODD SHAPES

Smoothing the surfaces of workpieces like the cabriole leg is typical of sanding operations best handled on a drum sander. Because of the project's elaborate contours, it is difficult to provide a support surface for the workpiece; so the operation is done freehand with the operator moving and guiding the workpiece (Figure 18-15).

Keep a firm grip on the workpiece and move it along steadily so the drum can't dig in at any point. Avoid excessive feed pressure. If

Figure 18-15. The drum sander is used to smooth surfaces of elaborately contoured projects like the cabriole leg.

necessary, go over an area several times. ***Warning: Always move the workpiece so you are feeding against the drum's rotation.***

Fitting a Leg to a Round Column

A furniture leg that must fit against a round column must have a radius formed on the edge that mates with the column. This can be accomplished by setting up the Mark V as shown in Figure 18-16. The table's height is set so the centerline of the workpiece is on the horizontal centerline of the drum. It may not be necessary, but the rip fence or a fixture can be used to keep the work square to the drum.

Move the workpiece forward so the edge to be sanded will be parallel to the surface of the drum. Don't force; let the abrasive work at its own speed. The cove that is formed in the workpiece will be determined by the diameter of the drum. If it isn't suitable for the connection you must make, you can modify it by hand with sandpaper or a file.

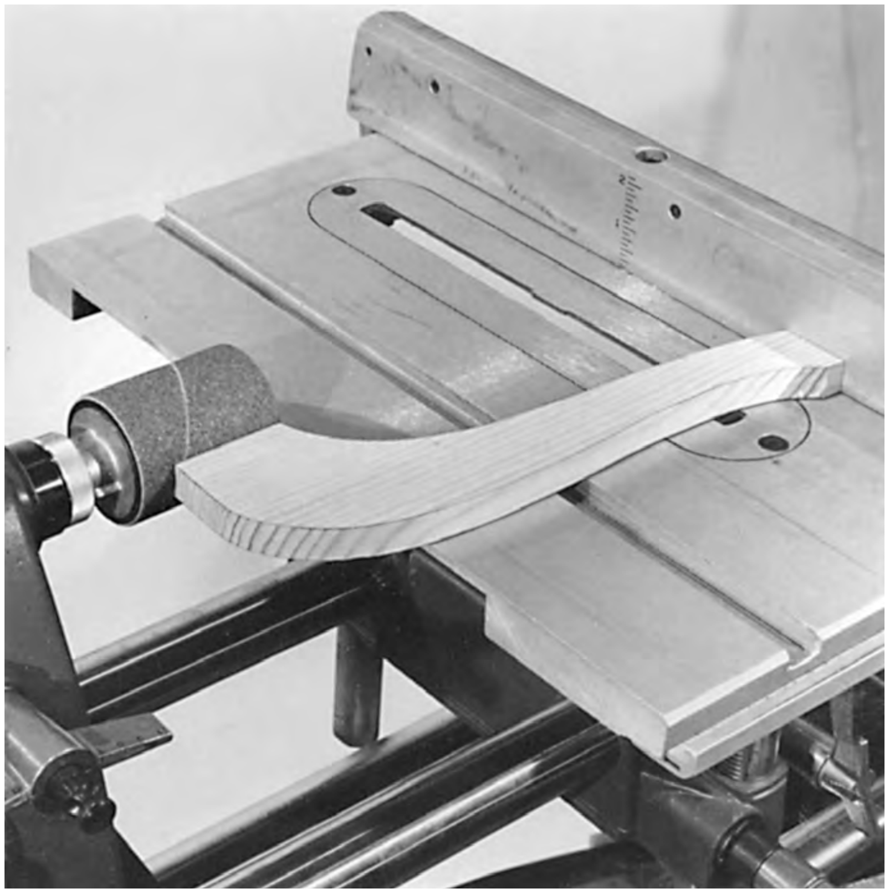


Figure 18-16. *How to form a cove so a leg can fit against a round column. Usually the cove won't be exactly the correct size, but you can make it right by doing some additional work by hand with sandpaper or a file.*

Chapter 19
Belt Sander

The belt sander is extremely useful for doing many different sanding jobs. It will produce a smooth surface on a board in less time and with less work than hand sanding.

The belt sander also offers an important advantage over disc sanders: The abrasive belt travels in one direction only, leaving no swirl marks. With a belt sander, you can sand parallel to the grain of the wood. This will produce a smooth finish free of scratches and tiny blemishes.

In addition, the belt sander has capabilities which permit you to sand end, miter, and bevel cuts quickly and accurately, sand convex and concave shapes, "round over" the edges and the ends of workpieces, and create compound curves in wood. You can also use the belt sander to sharpen tools. Information about using the belt sander to sharpen tools is found in Chapter 24.

The belt sander works by driving a continuous abrasive belt over two drums: a drive drum and an idler drum. The drive drum is covered by a nonslip rubber sleeve and drives the belt continuously in one direction. The idler drum is spring loaded to automatically tension the belt. The tension knob on the left side of this drum releases a torsion spring that presses the drum forward to tension the belt. The tracking knob (behind the tension knob on the left side of the belt sander) changes the angle of the idler drum in relation to the drive drum. This, in turn, centers the abrasive belt on the backup plate. Since the abrasive belt moves in a straight line, the machine is particularly suitable for sanding parallel to the wood grain. In some particular instances, especially when a lot of material must be removed, cross-grain or diagonal sanding techniques may be used.

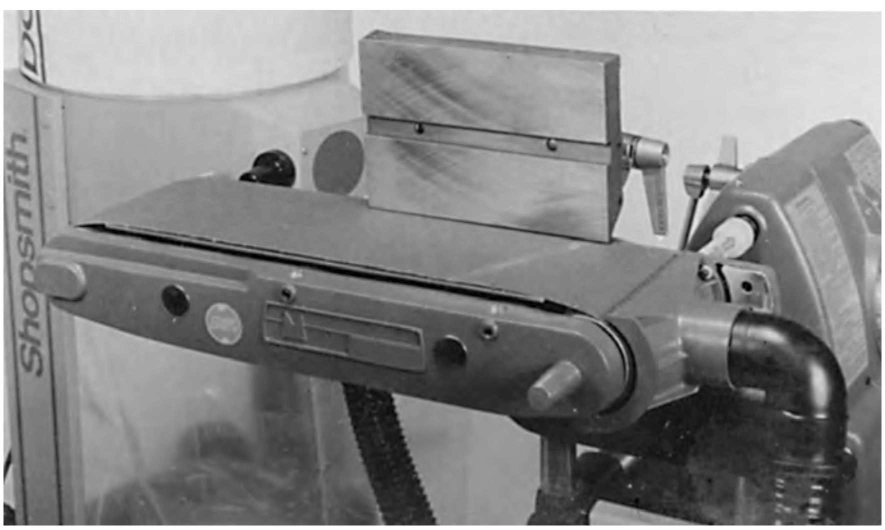
The belt width doesn't limit how wide stock must be in order to be sanded. Repeat passes and special procedures permit smoothing materials that are wider than the belt itself.

BELT SANDER—SETUP AND FEATURES

To set up your belt sander, follow the instructions in the Owners Manual that came with your machine.

As you work with the belt sander, you'll find that it has several special features:

• The belt sander mounts on the Mark V or on a Shopsmith Power Stand and is operated in either a vertical or horizontal position (Figure 19-1).



A

B

Figure 19-1. *The Belt Sander can be mounted on the Mark V or on a Shopsmith Power Stand and can be operated in (A) a horizontal position or (B) a vertical position.*

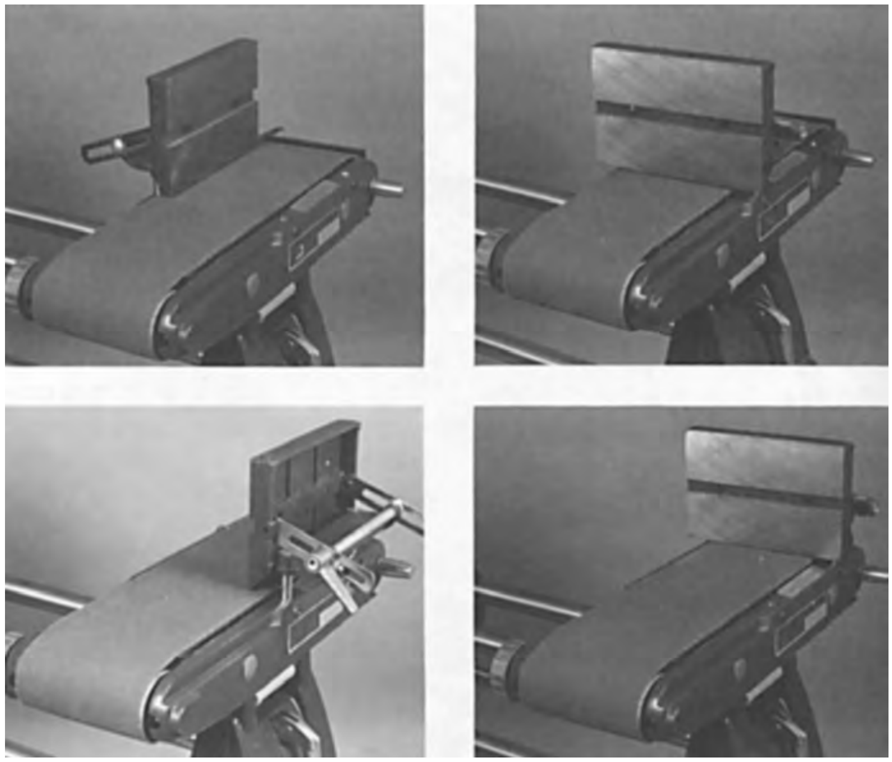


Figure 19-2. The worktable can be installed in four different positions.

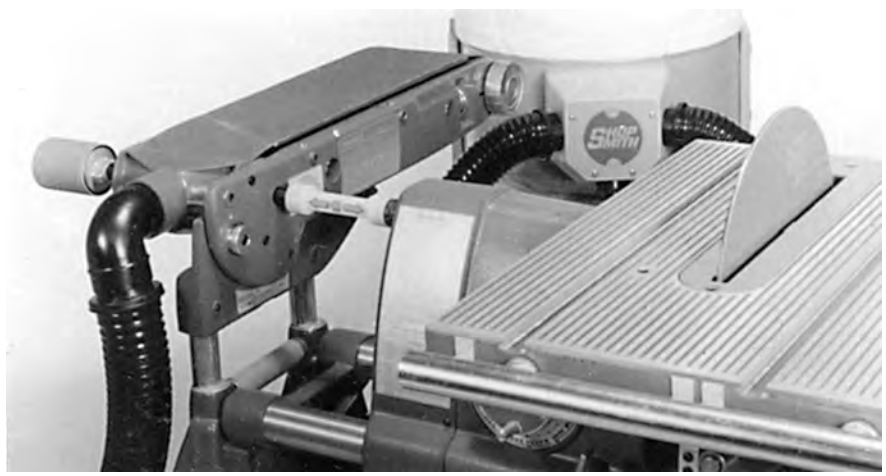


Figure 19-3. Combination setups allow greater versatility. Shown is a belt sander, disc sander and drum sander combination. The dust collection system is connected to the belt sander and the Mark V lower guard.

• The worktable is 6″ by 9″. It can be tilted from "0" to 20° into the belt, or from "0" to 45° away from the belt. The Shopsmith Miter Gauge fits in the slot on the worktable and can be locked in place. Also, the worktable has two holes cast into the table slot, making it easy to attach extensions and special fixtures.

• The worktable can be installed in four different positions on the hard side of the belt sander: parallel to the belt on either side of the machine or perpendicular to the belt in the center or at the back of the machine (Figure 19-2).

• The working surface on the 'hard side' of the belt sander (the side with the backup plate) is 6″ × 14″ when the worktable is used as a backstop, or 6″ × 16-1/2″ without the worktable. On the 'soft side' (the side without the backup plate), the working surface is 3″ × 16″. (When working on the 'soft side', use only the 3″ in the center of the belt to keep the belt tracking properly.)

• Often, woodworkers use a combination of abrasive tools to smooth and shape a workpiece. When mounted on the belt sander auxiliary spindle, the drum sander will sand a tighter radius (1-1/4″) than you can sand on the idler drum. You can also mount the drill chuck on the belt sander auxiliary spindle. The chuck will hold smaller drum sanders and flutter sheets.

When the Mark V is used to power the belt sander, you can mount the sanding disc on the Mark V's main spindle and use the two abrasive tools in combination. You can even use the dum sander (Figure 19-3). ***Warning: When tools are used in combination, never exceed the speed for the slowest tool. In this case that would be the disc sander.***

When you are not using the auxiliary spindle, be sure to install the spindle cap. Insert the lip of the cap in the belt sander casting and give it a tap with a mallet to secure it. Later on, if you wish to use the auxiliary spindle, the cap can be removed with a pair of pliers; simply turn the cap and pull out at the same time.

• The belt sander has a dust chute incorporated in its lower casting. This will direct waste material out of the machine and it will accept the hose from your dust collection system. Since most heavy-duty dust collection systems have fairly strong motors, it is good practice not to plug a dust collection system into the same circuit as the Mark V.

ABRASIVE BELTS

Abrasive belts are available in three grits: coarse, medium, and fine. The belt sander accepts abrasive belts 6″ wide by 48″ long. Often, there are slight inconsistencies from belt to belt; some are slightly longer than 48″, some shorter. The automatic belt tensioning feature compensates for this. There's no need for you to readjust the distance between the drums every time you change a belt, unless you use a non-standard belt.

The grit you choose depends on the work you have to do. Remember that for the smoothest surface possible, always work your way from coarse to fine grits.

Belts should be carefully stored by using one of the methods shown in Figure 19-4.

BELT SANDER SAFETY

Warning: Before using the belt sander, read and understand these important safety instructions:

Danger Zone—The belt sander danger zone is 3″ out from the abrasive belt in all directions. When you're working with the worktable parallel to the belt or without the worktable, the danger zone also extends 6′ in back of the belt sander; the moving belt can throw stock in this direction. Never stand in line with the rotation of the belt.

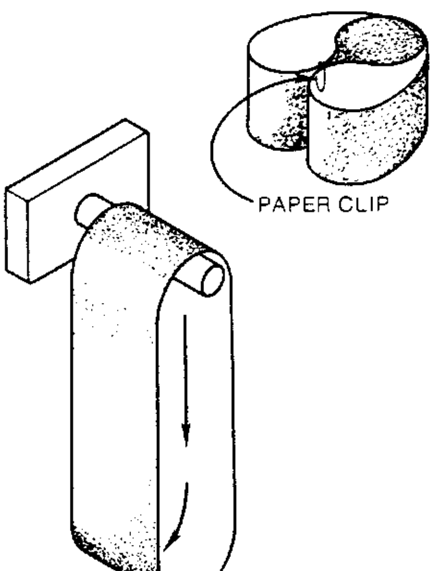


Figure 19-4. *Two ways to store sanding belts. Don't allow them to kink or become dirty.*

- **Wear proper eye and ear protection.**
- **Connect a hose from your dust collection system to the dust chute on the belt sander or wear a dust mask. When doing a lot of sanding, wear a respirator.**
- **If you're not using a dust collection system, always keep your hands away from the dust chute when the machine is running.**
- **Be sure the bottom edge of the worktable is not more than 1/16″ above the abrasive belt when you are working. Because of the direction of rotation of the belt, small pieces of stock—or a finger, for that matter—can be drawn down between the abrasive belt and the worktable. The smaller the clearance between the belt and the worktable, the easier it is to prevent accidents. However, never let the edge of the worktable touch the abrasive belt. This will grind away part of the worktable.**
- **Never tilt the table toward the belt. The rotation of the belt could wedge your hands between the table and belt.**
- **Use the belt sander in either the vertical or horizontal position. Avoid positions in between unless you install the extra bolt.**

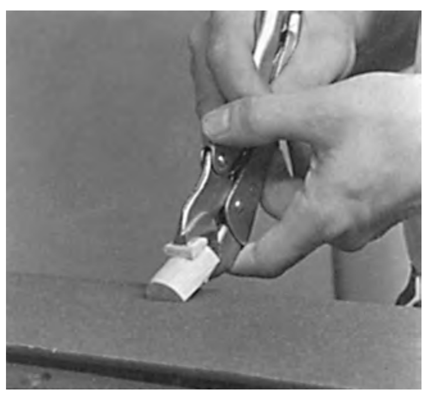


Figure 19-5. *To safely sand small workpieces, hold them with a pair of pliers, clamp them in a drill chuck, or use a special fixture you make yourself.*

- **Do not use worn belts.**
- **Let glued-up stock dry at least 24 hours prior to sanding.**
- **Never sand particle board or paint that contains lead.**
- **Don't attempt to sand pieces that are too small or too large to be safely controlled. To maneuver small workpieces on the belt sander, grip them in a pair of pliers (Figure 19-5), clamp them in a drill chuck, or make a special fixture to hold them. (Metal jaws should be covered with tape or leather so they don't leave marks on the stock.) This will give you better control and keep your fingers out of the danger zone.**
- **Always check the machine before you turn it on. Remove any adjusting wrenches or anything that may be resting on the belt.**
- **Be certain the abrasive belt is tracking properly and does not rub against any part of the belt sander.**
- **Whenever possible, support the workpiece by backing it up or guiding it with the worktable.**
- **Check that the worktable is locked securely in place.**
- **Always turn the belt sander on first; then put the workpiece in position. Never turn the machine on with a workpiece resting on the belt.**
- **Never spin the abrasive belt, drive shaft, pulley, or V-belt to start the belt sander. Keep your hands away from these parts when the machine is plugged in.**
- **The belt sander must be unplugged from its power source before performing any adjustments or repair procedures, with the exception of belt tracking and crowning. Do not rely solely on the power switch.**
- **If you use the belt sander to grind or sharpen tools, first clean the sawdust from inside and around the machine so sparks do not ignite the sawdust. Work with the cutting edge**

pointing away from you and in the same direction as the rotation of the belt. Never mount wire or grinding wheels on the auxiliary spindle. Never grind or sharpen tools freehand; use the table, a fixture or clamps to support and guide the tool.

- **If you're using a Shopsmith Power Stand, be sure that you're using the proper pulley and belt combination, and that the pulley and belt are properly guarded.**

BELT SANDER SPEEDS

Before you begin any belt sander operation, turn on the Mark V, set the speed according to Table 19-1 and let the belt sander get up to speed. Generally the speed is determined by the size of the workpiece. For instance, if you're sanding a large surface area, you'll want to set the speed dial toward the lower end of the speed range. Lower speeds provide more torque, and the machine won't "bog down" as easily.

Table 19-1: Belt Sander Speed Chart

Sanding Area	Hardwood	Softwood
Large	E (1150 RPM, 900 SFPM)	F (1300 RPM, 1020 SFPM)
Medium	G (1450 RPM, 1150 SFPM)	H (1600 RPM, 1250 SFPM)
Small	H (1600 RPM, 1250 SFPM)	J (1900 RPM, 1500 SFPM)
Grinding or Sharpening Metal Tools — Slow (700 RPM, 550 SFPM)		

NOTE: These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1.

SURFACE SANDING

Surface sanding is best done with the belt sander in the horizontal position (Figure 19-6). Install the worktable and lock it in place no farther than 1/16" above the abrasive belt.

Take a comfortable stance on either side of the belt sander. Your position is determined by whatever gives you the most control over the workpiece you're about to sand.

Check the sander to see that nothing is resting on the belt; then turn it on. Hold the stock against the abrasive belt and sand with the grain.

The drag on the machine increases with the pressure of the stock against the belt, causing the motor to labor. Excessive pressure will also heat up the abrasive belt and the backup plate. The belt will wear out faster, and the backup plate will warp slightly, making it difficult to sand a flat surface. So put just enough pressure on the stock to keep it firmly in position. Let the belt sander do the work.

If the workpiece is shorter than 14", use the worktable as a backstop. When sanding longer stock, secure the worktable parallel to the belt. Use the worktable as much as possible. The additional support adds safety and accuracy to your sanding operations. Even completely assembled projects can be sanded on all sides if you work as shown in Figure 19-7.

Hold the stock snugly against the worktable and flat against the belt. Move it slowly back and forth so that the entire surface is evenly sanded. If you don't keep the stock constantly moving, it may heat up and start to "burn." And be careful not to apply more pressure or dwell longer on one area of the workpiece than another; this will make the sanded surface uneven.

When you need to remove a lot of material or when the stock surface is very rough, start by sanding across the grain. Position the

Figure 19-6. *Use the belt sander in the horizontal position for general surface sanding.*

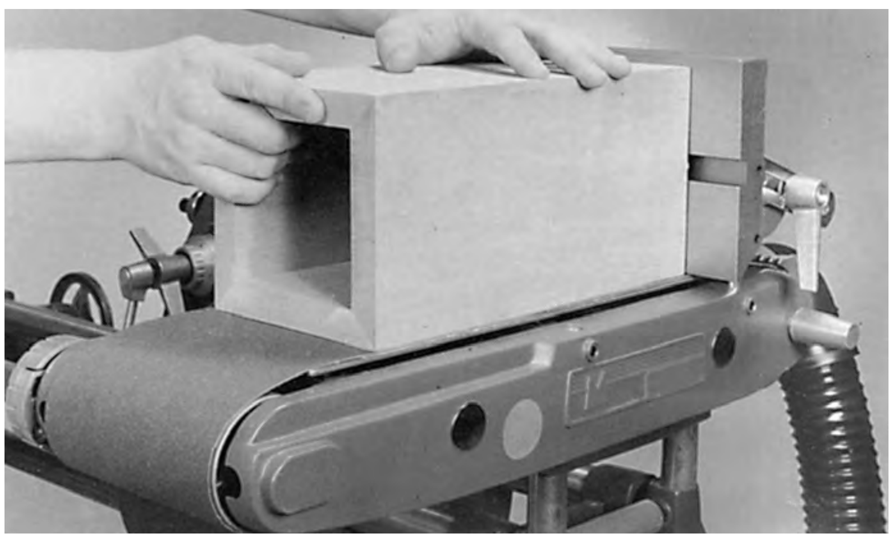


Figure 19-7. *Small, fully assembled projects can be sanded as shown. The worktable acts as a stop.*

worktable so that it straddles the belt; then pass the stock across the belt sander using the worktable as a backup (Figure 19-8). The wood grain should be perpendicular to the belt direction. When you've sanded away most of the stock you wish to remove, finish the operation by sanding with the grain. This will remove any blemishes caused by cross-grain sanding and leave a smooth surface on the workpiece.

The use of a diagonal feed with the belt sander in the horizontal position, as shown in Figure 19-9, permits the surfacing of a workpiece wider than the normal capacity of the belt. It gives a smoother finish than the method shown in Figure 19-8. A table extension is used to support the stock. Figure 19-25 shows how to make the extension. The angle of the fence should be kept as small as possible to minimize cross-grain sanding. A diagonal feed will always result in some cross-grain scratches on the workpiece surface. Therefore, this operation must always be followed by straight with-the-grain sanding until the scratches are removed and the surface is smooth.

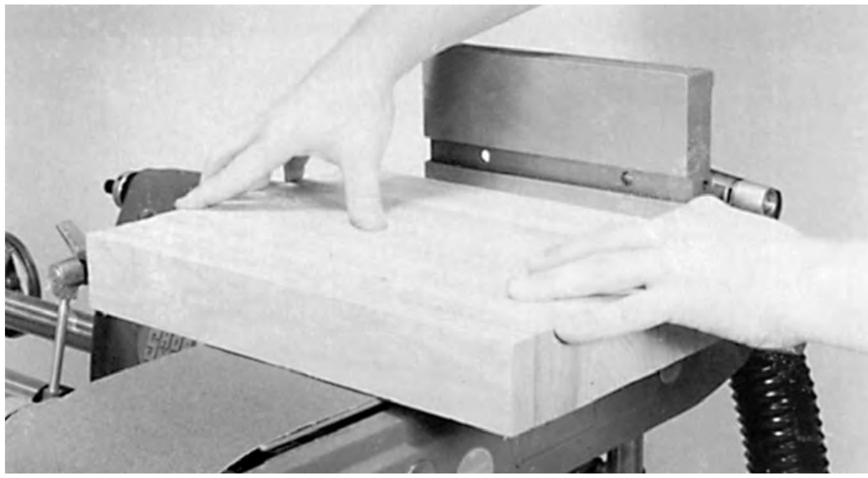


Figure 19-8. *To remove stock quickly, sand across the grain. Always finish up by sanding with the grain.*

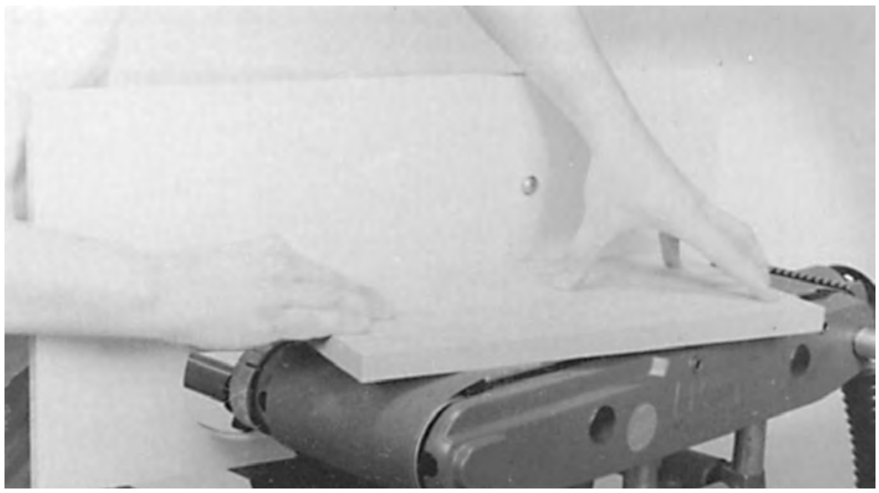


Figure 19-9. *Using a diagonal feed with the belt sander in the horizontal position.*

SANDING LARGE STOCK

If you are sanding large pieces of stock, you may need to remove the worktable from the belt sander (Figure 19-10). As we said before, the worktable contributes to the safety and accuracy of your sanding chores. But if you're careful, you can still get good results without it. ***Warning: Be careful of your fingers— do not hook them under the workpiece or you may accidentally rub them against the moving belt.***

Secure the belt sander in the horizontal position. Turn on the machine and let it come up to speed. Then hold the stock in place, flat against the belt. You may not have to press down at all; the weight of a large workpiece will usually supply ample pressure. As with smaller pieces, keep the stock moving so that the entire surface area is evenly sanded.

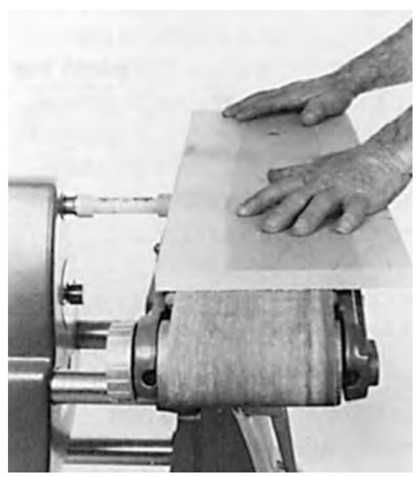


Figure 19-10. *To sand large workpieces, remove the worktable. Use extra care, as you have no additional support other than the belt sander itself.*

EDGE SANDING

To sand the edge of a workpiece, secure the belt sander in the horizontal position. Install the worktable parallel to and no farther than 1/16″ above the belt. Hold the surface of the stock firmly against the worktable, while moving the stock back and forth (Figure 19-11). Be careful to sand the entire edge evenly. If you sand too much stock off the middle of a workpiece, it will develop a bow.

END GRAIN SANDING

When you saw cross-grain, the saw blade leaves the ends of your boards rough. This rough surface is unsightly and can often make for a weak or ill-fitting joint unless you "true-up" and smooth cross-cut end grain with a sander.

To sand the end grain of short workpieces, you can work with the belt sander in either the horizontal or vertical position, with the worktable parallel to the belt. To sand the end grain of long pieces, secure the belt sander in the vertical position. Use the worktable to support one end of the workpiece and a roller stand to support the other.

Lock the miter gauge in the slot in the worktable by tightening the Allen screw in the miter gauge bar. The face of the miter gauge will provide another support surface and hold the workpiece square to the belt. With a square or drafting triangle, check that the surface of the worktable and the face of the miter gauge are 90° to the belt. Make adjustments, if necessary; then check that the worktable is no more than 1/16" above the surface of the belt.

Hold the workpiece firmly against the worktable and the miter gauge (Figure 19-12). Unlike surface sanding and edge sanding, do not move the stock back and forth. Instead, gently press the end of the stock against the moving belt. Be careful not to apply too much pressure or hold the stock against the belt for too long; the end grain may start to burn.

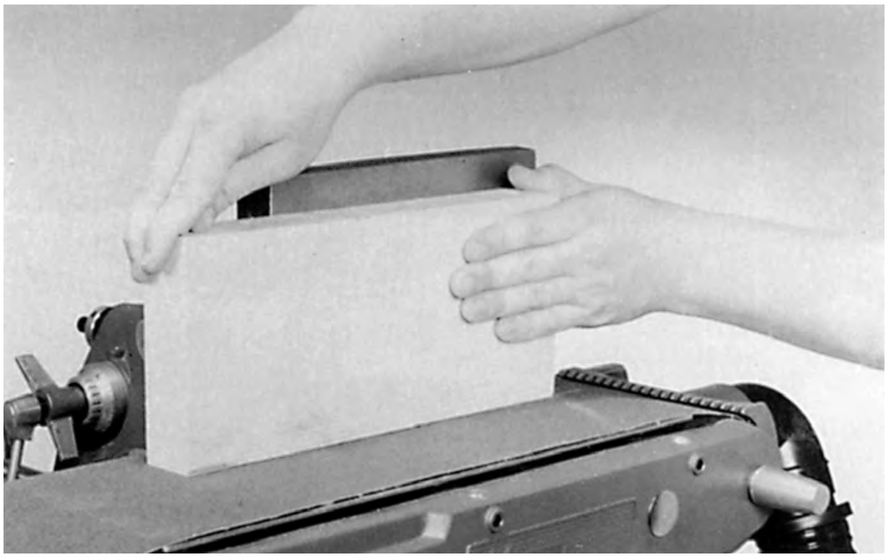


Figure 19-11. *Edge sanding is easily accomplished with an arrangement like this. The belt will try to move the workpiece back, so do not stand directly in-line with the belt.*

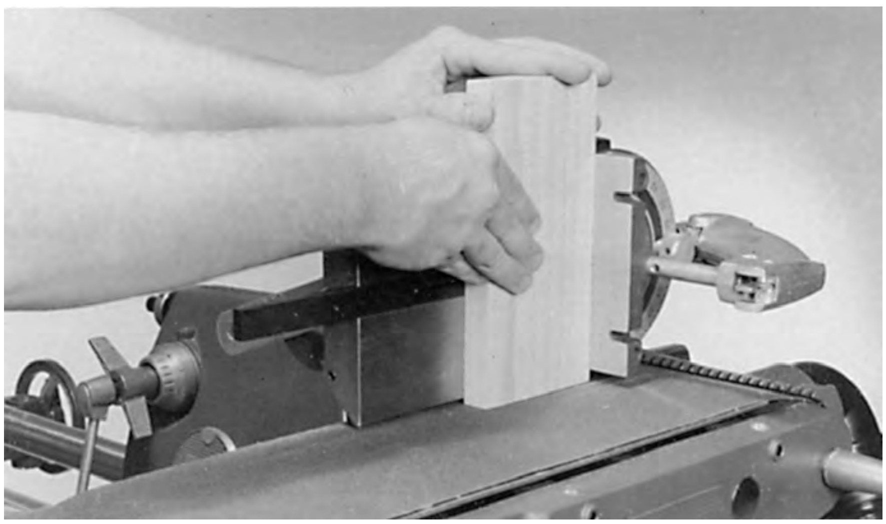


Figure 19-12. *To sand end grain, use the worktable and the miter gauge to support the workpiece. This helps keep the end of the workpiece square to the belt.*

VERTICAL BELT SANDING

Up to this point we have mainly concerned ourselves with the horizontal operation of the belt sander. Actually, the operation in both positions is basically the same. For instance, in both positions, excessive pressure against the belt is never necessary. Forcing the work can result in stalling the belt, clogging the abrasive, burning the stock, and even in tearing the belt. A slow, steady feed, with an occasional retraction of the workpiece to allow waste to move off, will always produce the best results.

When sanding square ends, move the workpiece directly forward against the belt and use the miter gauge, with an extension if needed, to keep the work in correct position (Figure 19-13).

To sand outside curves, hold the work flat on the table and then slowly, but steadily, sweep the workpiece across the belt while turning it to keep the curve tangent to the belt's surface (Figure 19-14).

You can accomplish some surface sanding by sweeping work across the belt as shown in Figure 19-15. This is not really the ideal way to smooth surfaces since, even when working with a fine-grit paper, the action will leave cross-grain marks. However, it's not a procedure to ignore, especially if you wish to remove a lot of material

Figure 19-13. To sand square ends, move the workpiece directly forward against the belt and use the miter gauge to keep the workpiece square. A light feed pressure is adequate.

Figure 19-14. Sand outside curves by sweeping them across the belt. Make a steady pass to avoid forming "flats" on the workpiece.

Figure 19-15. Surface sanding can also be done by sweeping the workpiece across the belt in this manner. However, this action will leave cross-grain marks.

quickly. Just be aware that the work will require some additional with-the-grain sanding.

SANDING MITERS AND BEVELS

Sanding a miter or a bevel is similar to end grain sanding. Once again, lock the miter gauge in the worktable and use both support surfaces to ensure the accuracy of the operation.

To sand a **miter** cut, adjust the angle of the miter gauge and leave the worktable square to the belt (Figure 19-16). To sand a **bevel** cut, adjust the tilt of the worktable and leave the miter gauge square to the belt (Figure 19-17). ***Warning: Do not tilt the worktable in toward the belt. When the worktable is tilted in, there is a danger that the rotation of the belt will wedge the stock—or your hands—under the worktable.*** You can also set both the miter gauge and the worktable to sand compound angles (Figure 19-18).

To set the angle of the miter gauge or tilt of the worktable at the same angle as the cut, copy the angle of the cut with a sliding T-bevel (Figure 19-19A). Lock the arm of the T-bevel in place.

Place the base of the T-bevel against the hard side of the belt sander. Rest the arm of the T-bevel against either the face of the miter gauge (if you're sanding a miter cut) or the worktable (if you're sanding a bevel cut). Adjust the angle or the tilt until the arm of the T-bevel rests flush against the working surface (Figure 19-19B).

If either the miter gauge or the worktable is to be left at 90° to the belt, check it with a square and make adjustments if necessary.

Figure 19-16. To sand miter cuts, adjust the angle of the miter gauge and leave the worktable square to the belt.

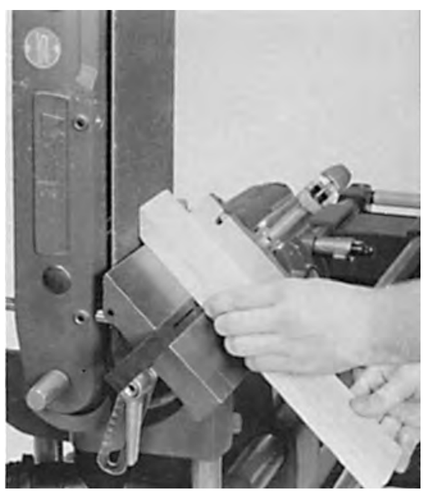


Figure 19-17 To sand bevel cuts, just tilt the table to the angle you need. Move the workpiece directly forward into the belt.

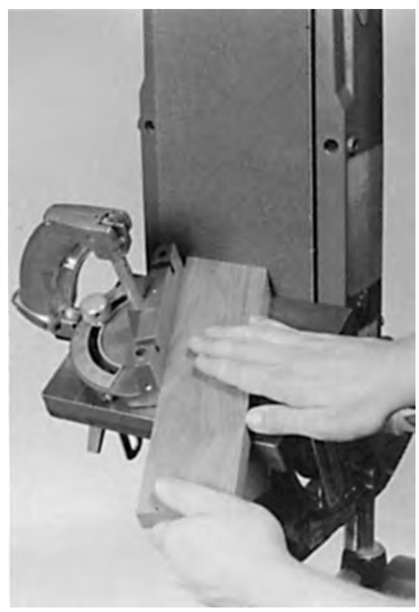
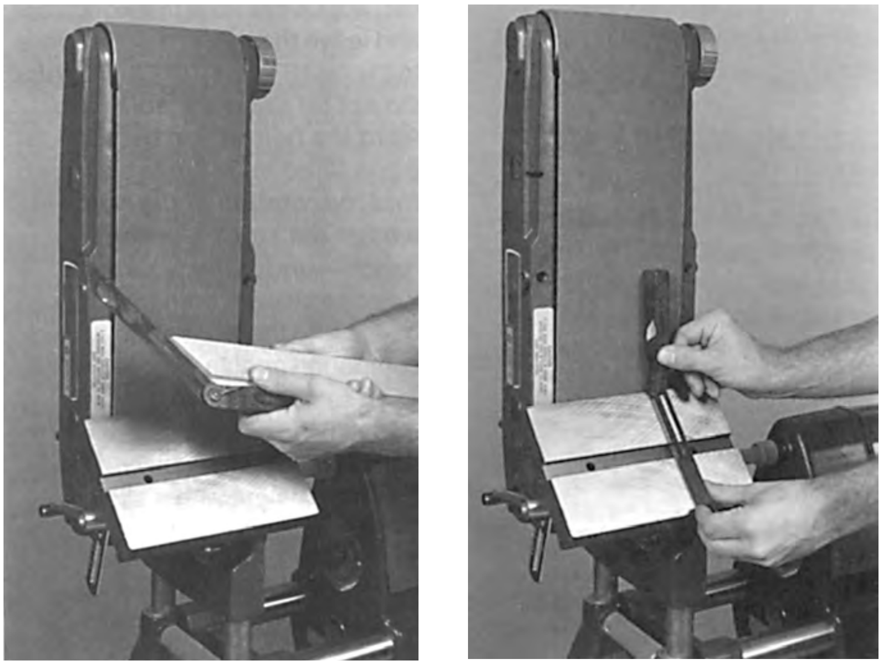


Figure 19-18. To sand compound angles, set the miter gauge and the table tilt to the same angles used when the workpiece was cut.



A B

Figure 19-19. (A) To set the angle of the miter gauge or the tilt of the worktable, first copy the angle of the cut with a sliding T-bevel. (B) Once you have copied the angle with a bevel, transfer that angle to the miter gauge or worktable.

Figure 19-20. Sand perfect chamfers on the ends of stock by using the miter gauge to set the angle; the stop block allows the stock to move just so far against the belt.

When you have completed all the angle and tilt adjustments, be sure that the worktable is no more than 1/16" away from the belt.

Hold the stock firmly against the worktable and the miter gauge. Don't move the stock back and forth; just press it gently against the moving belt.

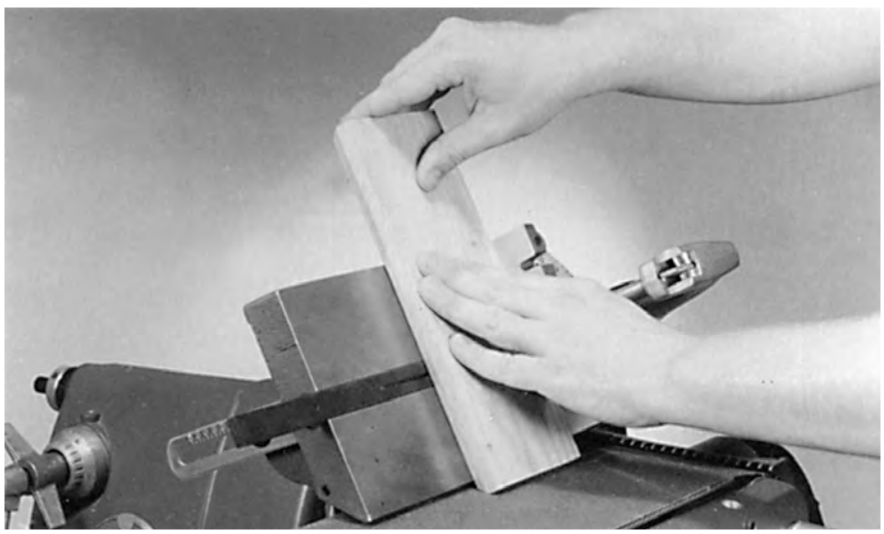


Figure 19-21. To sand a chamfer on the edge of a workpiece, secure the belt sander in the horizontal position. Install the worktable parallel to the belt and mount the miter gauge. Hold the workpiece flat against the worktable while moving it back and forth.

SANDING CHAMFERS

You can form chamfers on the end of a workpiece by using the miter gauge and a stop block as shown in Figure 19-20. Set the miter gauge to the angle you need and clamp the stop block in position so the workpiece can be advanced just so far against the belt. With the miter gauge's position locked, it's just a matter of holding the work against the miter gauge face and then moving it forward until it hits the stop block.

If the cross section of the work is rectangular, the stop block must be adjusted to accommodate wide and narrow surfaces of the work. If the workpiece is square, then one stop block setting will do. If there are many chamfers to sand, change the position of the stop block to avoid working against just one area of the belt.

Chamfers can also be formed on the edges of a workpiece with the belt sander in the horizontal position. Position the worktable parallel to the belt and adjust the tilt. Hold the workpiece absolutely flat against the worktable and move it back and forth parallel to the rotation of the belt. Check it frequently to be sure that you're sanding the chamfer evenly all along the edge of the workpiece (Figure 19-21).

SANDING CONVEX AND CONCAVE CURVES

As mentioned in the beginning of this chapter, you aren't limited to sanding just flat, straight surfaces; the belt sander will also sand curves.

The belt sander will quickly remove millmarks from curved workpieces. Or, when the shape of a curve is critical to the design or fit of a workpiece, many woodworkers cut wide of the mark and use the belt sander to sand the stock to its final shape. This technique gives you better control and accuracy when making odd-shaped workpieces.

To sand both convex and concave curves, secure the belt sander in the horizontal position. Install the worktable parallel to and no farther than 1/16″ above the belt. If you haven't already done so, make the worktable extension shown in Figure 19-25; then bolt it to the worktable. This extension is essential when sanding both concave (Figure 19-22) and convex curves.

To sand convex curves, hold the workpiece firmly against the worktable and rock it against the direction of rotation on the hard side of the belt sander. Sand the curved edge evenly until all millmarks are removed and you achieve the desired shape.

To sand concave curves, hold the workpiece firmly against the worktable and roll it against the direction of rotation on the idler drum. Once again, sand the curved edges evenly until all millmarks are removed and you achieve the desired shape.

When sanding with the idler drum, use very light pressure. If you press too hard, you'll put an unnecessary strain on the sleeve bearings in the idler drum. You may also ruin the crown of the abrasive belt. Once the crown is destroyed, the belt will not track properly.

SANDING COMPOUND CURVES AND ODD SHAPES

You can sand three-dimensional or "compound" curves on the soft side of the belt sander. There is no backup plate on this side, and the belt will conform to almost any shape that's pressed against it. This is especially useful when rounding off lathe turnings or softening sharp corners and edges.

Secure the belt sander in the vertical position, without the worktable. Hold the workpiece and touch it to the abrasive belt (Figure 19-23). Use very light pressure. Hold the workpiece with the end you're sanding pointing up. If you feel the belt sander dragging the workpiece up and out of your grasp, back off immediately. Rock the workpiece from side to side and back and forth until you achieve the desired shape.

When you use the soft side of the belt sander, always work in the center 3″ of the abrasive belt. If you press against the sides, the belt will creep off center.

HELPFUL WOOD SANDING HINTS

Getting a smooth, clean surface begins by making sure you hold the stock flat against the abrasive belt, keep the stock moving, and sand all areas evenly. Here are a few additional tips to help you get the best results:

Working in the Center of the Belt—Work in the center of the abrasive belt, especially if you're sanding small workpieces. If you sand on the edges, the belt will drift off center, rub up against the belt sander frame, and begin to fray.

Cleaning Abrasive Belts—As you work with your belt sander, sawdust and other materials will accumulate on the belt, making the abrasive surface smooth and useless. You can extend the life of your abrasive belts by cleaning them occasionally with an abrasive cleaning stick. Simply hold the cleaning stick against the abrasive belt while the machine is running.

Sanding Glue—The belt sander is especially useful in "truing up" glue joints, sanding off high or uneven surfaces and excess glue. But glue will quickly accumulate on the belt, even more quickly than sawdust. And if the glue dries on the belt or melts into the fabric, it will be impossible to remove. To minimize the glue that accumulates on the belt and to safely sand glued-up stock, let all glue joints dry at least 24 hours. Then knock off the largest glue beads with a scraper or chisel before sanding the workpiece. ***Warning: Let glued-up stock dry at least 24 hours prior to sanding.*** Sand the workpieces slowly, apply very light pressure, and don't allow the fric-

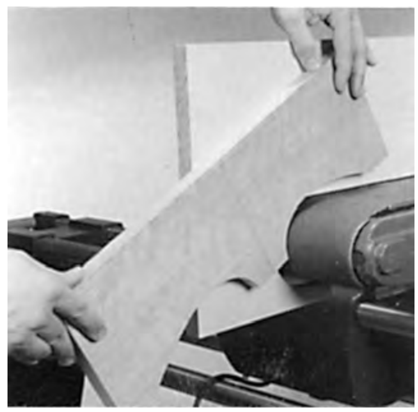


Figure 19-22. *Use the worktable extension when sanding a concave curve.*

Figure 19-23. *Using the belt sander to sand an odd-shaped object.*

tion of the belt to melt the glue. Clean the belt with an abrasive cleaning stick immediately after sanding.

Removing Paints and Other Finishes—The belt sander can also be used to clean up second-hand wood, especially wood that has been painted or finished. But like glue, these substances will quickly accumulate on your abrasive belt and stay there. Remove the majority of the old finish from the wood with a chemical paint remover and/or scraper. If you use a water-based remover, allow the workpiece to dry 24 hours before sanding it. Once the majority of the old finish has been stripped from the wood, sand the surface clean on the belt sander. ***Warning: Be sure to wear a dust mask and never sand surfaces painted with lead paint.*** When you've finished, clean the belt with an abrasive cleaning stick.

Using Additional Support—Extremely long or odd-shaped workpieces may require additional support in order to sand them safely and accurately. A roller stand and/or a worktable extension provide additional support during sanding operations (Figure 19-24). Construction details for building the extension are shown in Figure 19-25.

As shown in Figure 19-26, the worktable extension can also be used when a drum sander is mounted on the belt sander auxiliary spindle. Position the worktable on the right side of the machine, parallel to but facing away from the belt. ***Warning: Tape or tie up the table tilt lock so it doesn't contact the belt.***

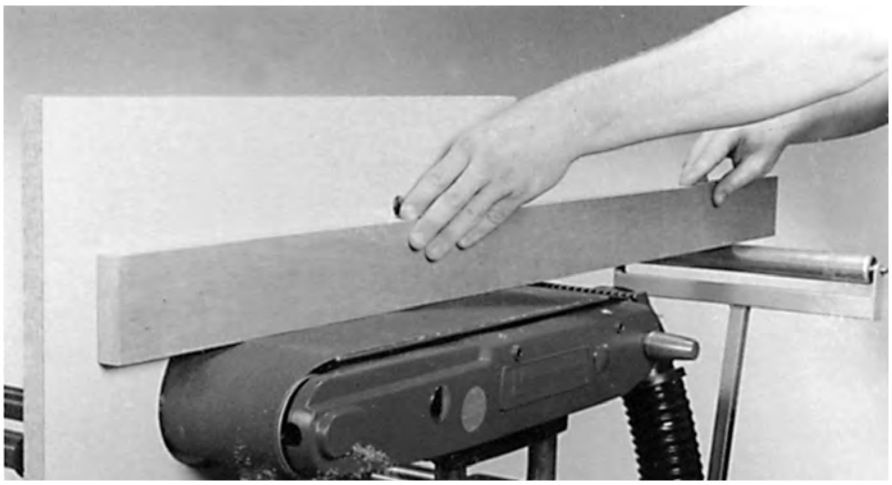


Figure 19-24. *A roller stand and/or a worktable extension provide additional support.*

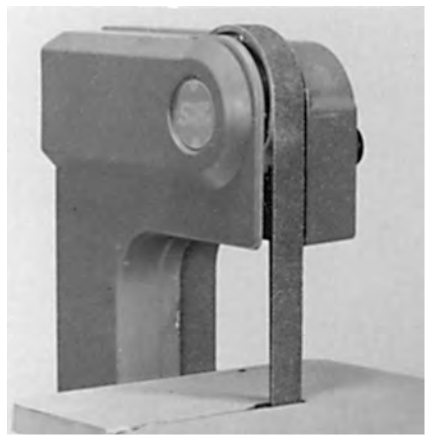


Figure 19-26. *To save wear and tear on your abrasive belts and idler drum when sanding a lot of concave curves, mount a drum sander on the belt sander auxiliary spindle. The worktable and worktable extension provide support.*

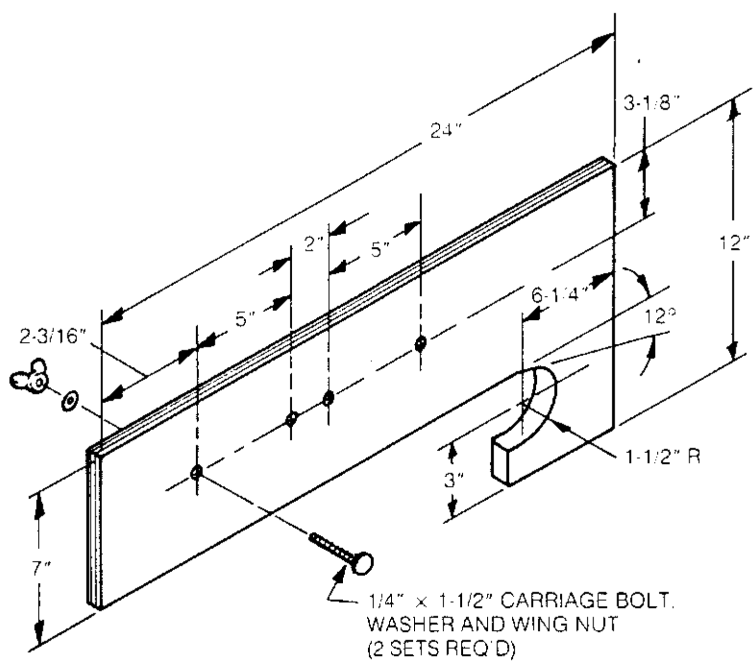


Figure 19-25. *Construction details of the worktable extension.*

Chapter 20
Strip Sander

The strip sander is designed to do intricate detail sanding. It will sand the straight, angled, curved, convex or concave edges and ends of workpieces quickly and accurately. A unique feature of the strip sander is its ability to sand the internal edges of round and oval picture frames, decorative shelf supports and other projects that have been cut out using the piercing cut method on a scroll saw or jigsaw. You can also use the strip sander to polish metal and grind tools. Information about using the strip sander to sharpen tools is found in Chapter 24.

STRIP SANDER — SETUP AND FEATURES

To set up your strip sander, follow the instructions in the Owners Manual that came with your strip sander.

As you work with the strip sander, you'll find that it has several special features:

• The strip sander mounts on the Shopsmith Mark V (Figure 20-1).

• The dust chute in the bottom of the cover will allow you to connect the hose from your dust collection system during wood sanding operations.

• The strip sander can accommodate stock of any size and shape within these limits: 6" in front of the platen (contact with the table), 3-1/4" thick between the table and the upper part of the housing, and 6-1/4" wide in the throat (back of the platen housing).

• There are three platens — 1" flat, 1/2" flat and 1/2" radius curved — that back up the belt.

• The table can be tilted from "0" to 45° forward. Its surface is 11" × 11". A table stop automatically positions the table at 90°.

• A tensioning spring automatically keeps the belt at the proper tension.

STRIP SANDER SAFETY

Warning: Before using the strip sander, read and understand these important safety instructions:

• Wear proper eye and ear protection, and a dust mask.

• Keep your hands and fingers out of the danger zone. The danger zone is 3" out in all directions from the belt.

• Keep the belt tracking properly during all operations.

• Never reach close to the belt or underneath the table while the machine is running.

• Always use the table to support the stock. The only exception to this is when you are sanding against the tracking wheel. Then hold the stock securely in your hands and keep your hands and fingers 3" away from the moving belt.

• Sand on the downward motion side of the belt only. The downward motion keeps the belt

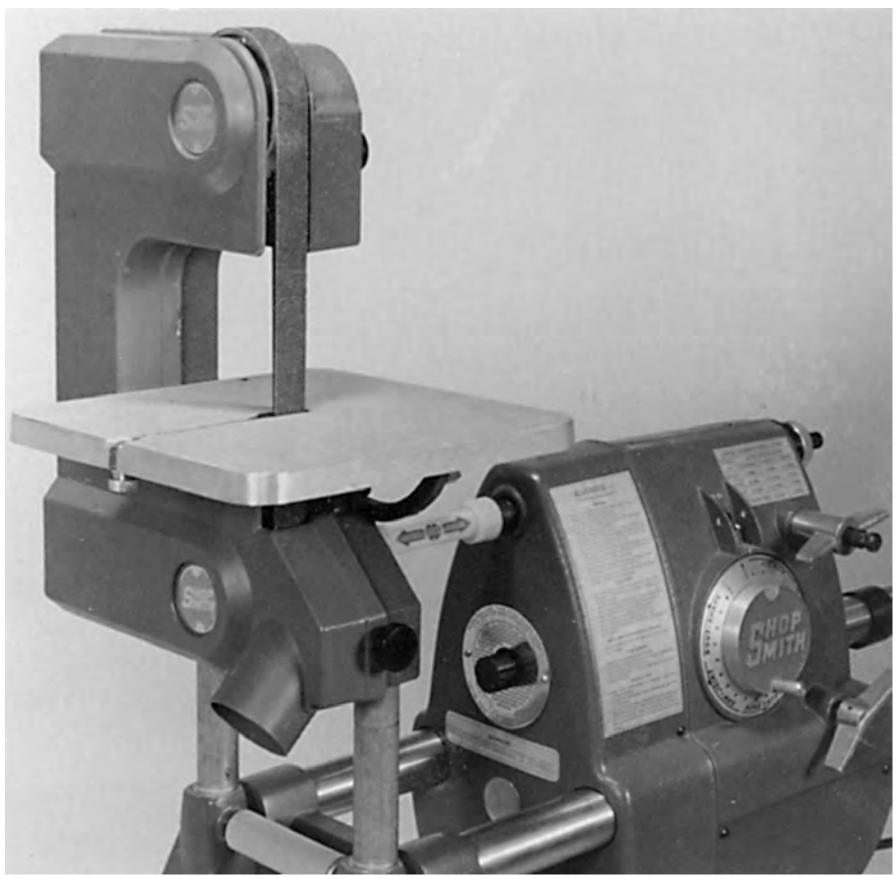


Figure 20-1. *The Strip Sander mounts on the Shopsmith Mark V.*

tracking properly and helps hold the stock down against the table.

- **Never attempt to sand an internal area smaller than the belt will allow. This will pull the belt off the tracking wheel causing the belt to cut into the frame or cover, and can cause the belt to break.**
- **Support long stock with a roller stand.**
- **Use pliers to hold small pieces of stock against the moving belt. Never use your hands.**
- **If the belt breaks, turn off the machine and stand away until the machine comes to a complete stop.**
- **Secure the Mark V accessory mount lock and power plant lock, and the strip sander eccentric mounting tubes.**
- **Never exceed speed setting K (2050 RPM) on the Mark V speed dial.**
- **Never turn on the machine with anything laying on the table or stock held against the belt.**
- **If you hear a ticking sound or other unusual noise, stop the strip sander immediately. A ticking sound often indicates a damaged belt.**
- **Never leave the cover open while the strip sander is in operation.**
- **Never attach a dust collection system to the strip sander during grinding operations. Sparks and/or hot pieces of metal could ignite the sawdust or debris in the collection bag.**

STRIP SANDER SPEEDS

Before you begin any strip sander operation, turn on the Mark V, set the speed dial to the proper speed and let the machine get up to speed.

The speed setting is determined by the material being sanded, the type of abrasive belt and the size of the platen. Use Table 20-1 to determine the proper setting.

STRIP SANDER BELTS AND PLATENS

The strip sander uses aluminum oxide, garnet and silicon-carbide belts of various grits in 1/2″ × 42″ and 1″ × 42″ sizes. Use aluminum oxide belts for sanding wood, metal and plastic; garnet for wood and plastic; and silicon-carbide for metal. A felt polishing belt and buffing compounds are also available for polishing metal and plastic.

The platens provide a firm backup for the belts and keep them tracking properly during sanding operations. There are three sizes of platens: 1″ flat, 1/2″ flat, and 1/2″ radius curved.

Table 20-1 contains information about the belts and platens that are available for the strip sander.

STRIP SANDER OPERATIONS

To perform sanding operations, turn on the Mark V, set the speed dial to the proper speed and let the machine get up to speed.

Work with the stock against the downward motion side of the belt only. The downward motion keeps the belt tracking properly and helps hold the stock down against the table. Work slowly and use light pressure against the belt.

Table 20-1: Belts, Platens and Speeds

GRIT	ABRASIVE		BELT		SPEEDS*			PLATEN				MATERIALS WORKED				
SIZE	GARNET	ALUMINUM OXIDE	1″	1/2″	SPEED DIAL SETTING	RPM	SF/MIN	1″	1/2″	CURVED 1/2″ R.	NONE	HARD WOODS	SOFT WOODS	FERROUS METALS	NON-FERROUS METALS	PLASTICS**
80	✓		✓		SLOW-E	700-1150	550-903	✓		✓	✓	✓	✓			✓
100	✓		✓		B-G	850-1450	668-1139	✓		✓	✓	✓	✓			✓
150	✓		✓		D-I	1050-1750	825-1374	✓		✓	✓	✓	✓			✓
220	✓		✓		F-K	1300-2050	1022-1610	✓		✓	✓	✓	✓			✓
80	✓			✓	SLOW-E	700-1150	550-903		✓		✓	✓	✓			✓
100	✓			✓	B-G	850-1450	668-1139		✓		✓	✓	✓			✓
150	✓			✓	D-I	1050-1750	825-1374		✓		✓	✓	✓			✓
220	✓			✓	F-K	1300-2050	1021-1210		✓		✓	✓	✓			✓
60		✓	✓		SLOW-G	700-1450	550-1139	✓		✓	✓	✓	✓	✓	✓	✓
80		✓	✓		B-H	850-1600	668-1257	✓		✓	✓	✓	✓	✓	✓	✓
150		✓	✓		D-I	1050-1750	825-1374	✓		✓	✓	✓	✓	✓	✓	✓
220		✓	✓		F-J	1300-1900	1021-1492	✓		✓	✓	✓	✓	✓	✓	✓
320		✓	✓		H-K	1600-2050	1257-1610	✓		✓	✓	✓		✓	✓	
400		✓	✓		E-I	1150-1750	903-1374	✓		✓	✓	✓		✓	✓	
600	SILCON-CARBIDE		✓		C-G	950-1450	746-1139	✓		✓	✓			✓	✓	
POLISH**			✓		SLOW-E	700-1150	550-903				✓			✓	✓	✓

* These speeds are for 60 hz. operations. For 50 hz. operations, refer to Table 1-1. Plastics are always worked at "Slow" speed.
** Use the appropriate polishing compound for the material being worked.

Whenever possible, sand with a platen installed. You can sand without a platen when sanding concave curves and internal edges. However, use a slower speed and very light pressure so the belt tracks properly and is not pulled off the tracking wheel. *Caution: If the belt is pulled off the tracking wheel, parts of the strip sander could be damaged.*

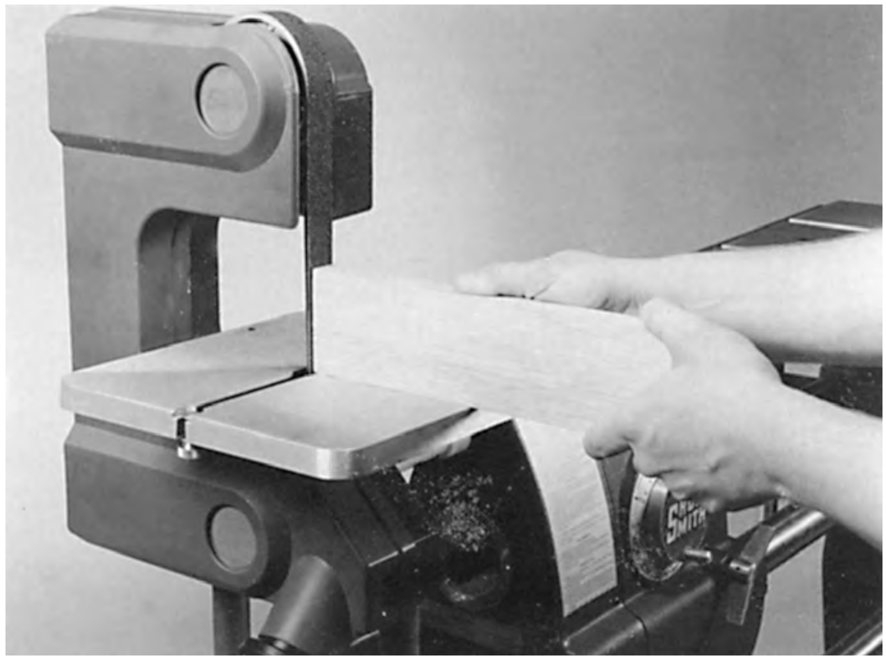


Figure 20-2. *Hold the end of the stock against the belt and platen.*

End Sanding

Hold the edge of the stock down against the table and the end you want to sand against the belt and platen (Figure 20-2). Apply enough pressure to sand without gouging the stock.

Sanding Angles

Loosen the table lock knob, tilt the table to the desired angle and tighten the knob. Hold the edge of the stock down against the table and the sawn angle against the belt and platen (Figure 20-3). Apply light, even pressure.

Sanding Convex Curves

Hold the stock firmly against the table and follow the line of the curve in a slow, steady motion. Apply light pressure against the belt and platen (Figure 20-4).

Sanding Concave Curves

To sand concave curves, use the curved platen or sand without a platen.

Follow the cut in a slow, steady motion while keeping the stock flat against the table. Apply light, even pressure against the belt (Figure 20-5). Be careful not to hook the stock on the belt. You could pull the belt off the tracking wheel.

When sanding without a platen apply less pressure, use a slower speed and watch belt tracking constantly. Be careful not to pull the belt off the tracking wheel.

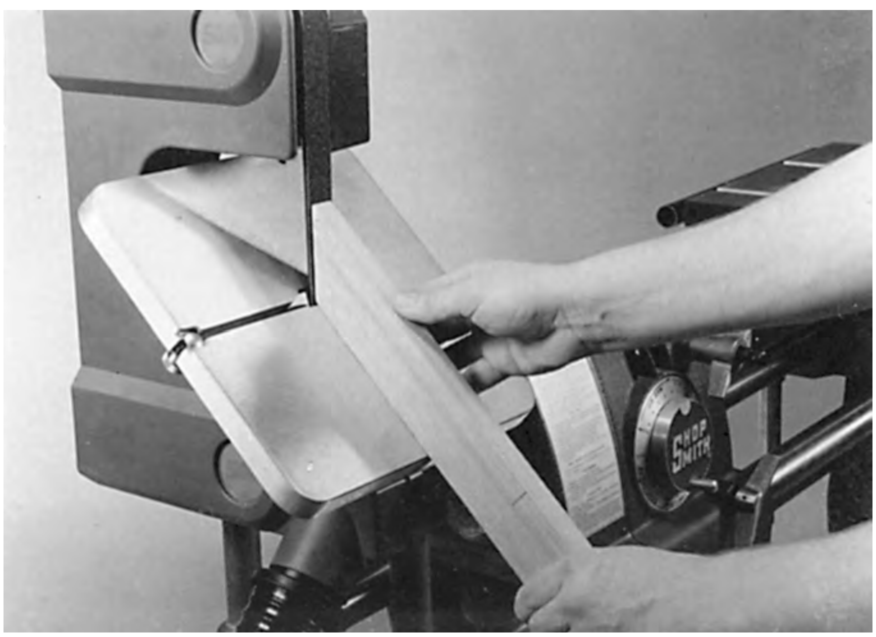


Figure 20-3. *Tilt the table to the desired angle and then sand the sawn angle.*

Internal Sanding

To perform internal sanding operations, you must change the location of the left idler wheel assembly and install the belt up through the table. Refer to the Strip Sander Owners Manual for instructions on relocating the left idler wheel assembly and installing the belt.

Internal sanding is done basically like sanding concave and convex curves. Sanding the internal edges of a shelf support is shown in Figure 20-6.

Warning: Sand on the downward motion side of the belt. The downward motion keeps the belt tracking properly and helps hold the stock down against the table.

You can internal sand with or without a platen installed. When sanding without a platen, work at a slow speed and be careful not to pull the belt off the tracking wheel.

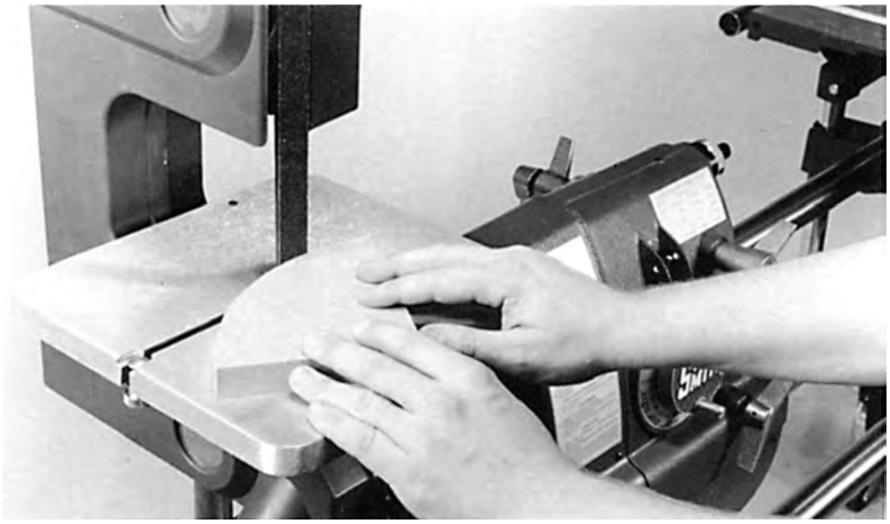


Figure 20-4. Apply light pressure against the belt and platen, and follow the line of the convex curve.

Sanding Against the Tracking Wheel

Sand odd-shaped or concave workpieces against the tracking wheel (Figure 20-7). Hold the workpiece securely in your hands and sand the workpiece in the center of the wheel. Work carefully so you don't pull the belt off the tracking wheel.

Sanding Other Materials

You can sand plastics and metals, and perform buffing operations with the strip sander. Refer to Table 20-1 to determine which belts, platens and speeds to use for these materials.

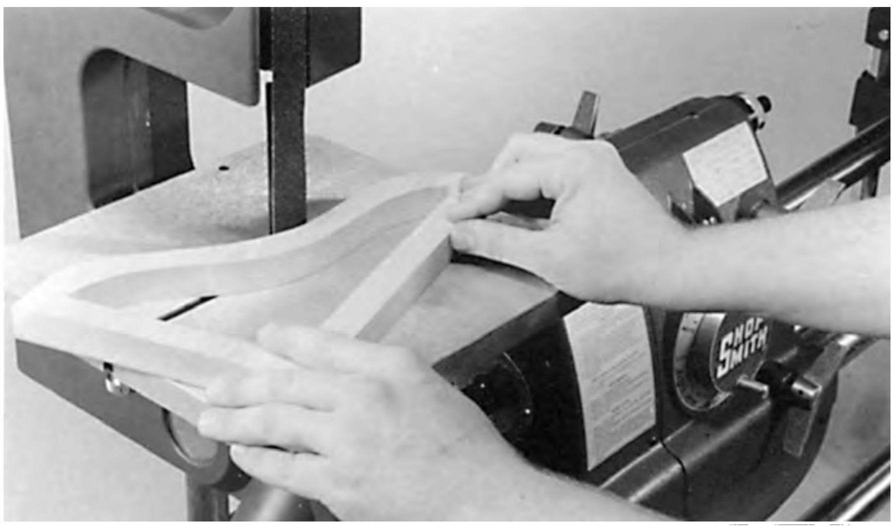


Figure 20-5. Sand concave curves by working with or without a platen.

Figure 20-6. Internal sanding is done with the left idler wheel relocated, with the belt installed up through the table, and with or without a platen.

Figure 20-7. Sand odd-shaped or concave workpieces on the tracking wheel. Work in the center of the wheel.

Chapter 21
Planers

Shopsmith has two models of planers: the Thickness Planer and the Professional Planer. The Thickness Planer mounts on the Mark V (Figure 21-1) or a Shopsmith Power Stand. The Professional Planer has its own stand and motor (Figure 21-2).

In terms of what it does, the planer might be the simplest power tool in a home woodworking shop. Yet, simple as it is, when teamed with other power tools, the planer gives you everything you need to transform all kinds of lumber into useful, beautiful and fun projects. It gives you greater freedom to work with hardwood, softwood, even trees from your backyard or logs from your wood pile. Adding a planer is a great step toward achieving a totally self-sufficient home woodworking shop.

Don't confuse the planer with the jointer. The planer is not the best tool to use for straightening cupped or warped stock. These defects should be removed with the jointer before you plane the stock.

A planer performs only two basic tasks, but it does these very, very well:

One: It planes the surface of a workpiece so that it's smooth and flat. Sometimes this means it will remove a large amount of stock in several passes (such as when you're planing a really rough piece of lumber). At other times it can be set to take off just a small amount (when you want to get an extremely smooth, final surface).

Two: The planer will plane any number of boards to the exact same thickness.

PLANERS—SETUP AND FEATURES

To set up your planer, follow the instructions in the Owners Manual that came with your planer.

As you work with the planer, you'll find that it has several special features:

- The planer will plane stock from 4″ down to 3/32″ thick. It can handle boards from 1″ up to 12″ wide. The length of stock is limited only to what you can safely control.
- The cutterhead revolves on two sealed ball bearings and holds three precision-ground steel knives. Each knife is 12-1/4″ long and rests on three knife leveling screws so that you don't have to match grind the knives. With the knives installed, the cutterhead is 2-1/4″ in diameter.

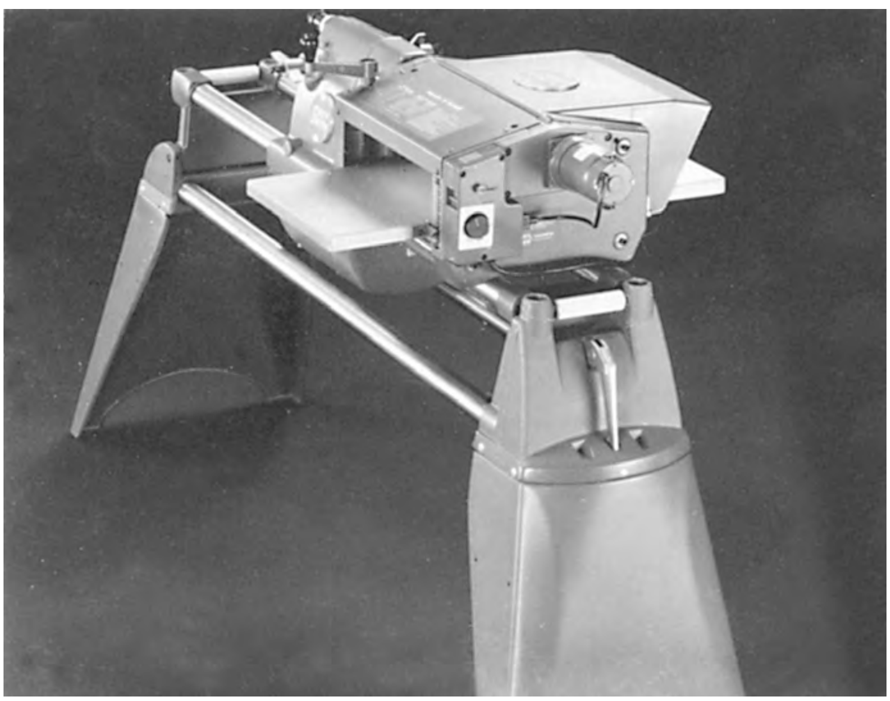


Figure 21-1. *The Thickness Planer can be mounted on the Mark V, as shown, or on a Shopsmith Power Stand.*

Figure 21-2. *The Professional Planer has its own stand with its own motor.*

• The table surface is 28″ long and 12-1/2″ wide. The table is held parallel to the cutterhead by four threaded posts. The vertical position can be adjusted from 3/32″ to 4″ away from the cutting edge of the knives.

• The 1/20 horsepower variable-speed feed motor feeds stock through the planer. The actual feed rate at any given feed control setting will vary depending on the depth of cut, sharpness of the knives and width of the stock.

KNIFE MOUNTING SYSTEM

The cutterhead holds three knives. Each knife is held in the cutterhead by two metal wedges with four locking screws through each wedge. In all, eight locking screws hold each knife in place.

In addition, the knives themselves are wedge-shaped. Each knife is slightly thicker at the bottom than it is at the top. When properly seated, the wedges and the knives interlock. ***Warning: Use only Shopsmith Planer Knives in your planer. Other brands of knives are not wedge-shaped and will not seat properly in the cutterhead. Using off-brands of knives is extremely dangerous. Check the wedge locking screws immediately if an unusual noise, vibration, or uneven cuts develop and after every 10 hours of use.***

There are also three knife leveling screws under each end and under the middle of each knife. These screws allow you to adjust all three knives to precisely the same height without the need for costly and time consuming match grinding.

PLANER SAFETY

Warning: Before using the planer, read and understand these important safety instructions:

Danger Zone—The planer danger zone is separated physically by the infeed and outfeed shields. It is extremely dangerous to place your hands inside or under the shields. This rule applies not only when the planer is running, but whenever the planer is plugged in. The danger zone also extends 6′ directly in front and to the rear of the stock being planed because the planer can kick stock and chips in both directions.

Always stand to the right side (the switch side gives you maximum control) of the planer and keep your hands from under the infeed and outfeed shields whenever the planer is plugged in. There is one exception to this rule: You must put your hands in front of or behind the openings to feed and receive stock. But don't put your hands into the openings or stand so that your body is in line with these openings.

• **Wear proper eye and ear protection, and a dust mask.**

• **Keep the infeed and outfeed shields in place and locked down. Never operate the planer without the protective shields in place and properly secured.**

• **Don't let your fingers be pinched between the stock and the table. Release the stock as soon as the infeed roller grabs it.**

• **Never reach under the infeed or outfeed shield to adjust a workpiece or brush away wood chips while the planer is running. Turn off and unplug the machine, let the cutterhead come to a complete stop, then reach in with a push stick or similar wooden or plastic tool. Never reach under the infeed or outfeed shield with a metal tool. You could nick the knives.**

If you need to reach under the infeed or outfeed shield with your hands, turn off and unplug the machine and let the cutterhead come to a complete stop before doing so.

• **When planing glued-up stock, make sure glue joints are strong. Glue the stock and leave it clamped for at least 24 hours before planing.**

• **Plane dry, properly cured wood only. Wet sawdust and shavings will adhere to the knives, causing the machine to cut poorly. The moisture will also rust the knives and other ferrous metal parts of the planer.**

• **Never plane 'secondhand' lumber. Hitting a nail or screw will ruin the planer knives and possibly cause injury.**

• **Don't plane wood that has large, loose knots and other imperfections which might cause the board to split or fly loose.**

• **Never plane painted or varnished wood, plywood, or particle board—these materials will ruin your planer knives.**

• **Always plane with the grain direction of the wood.**

• **Don't plane stock less than 1″ wide or over 12″ wide. If the stock is too narrow, the anti-kickback fingers will not catch it. If it's too wide, it may jam between the sides of the planer.**

• **Don't plane stock less than 12″ long. If the stock is too short, it will not feed properly and you will have to reach into the danger zone in order to plane it.**

• **Don't plane stock that's higher than it is wide as it sits on the table. (This is sometimes called *edge planing.*) Edge planing is dangerous because the board can easily tip over and be kicked back.**

• **The stock should remain parallel to the sides of the planer table as it's fed through the machine. If a board begins to drift to one side, very carefully shift it back into position by pushing against one side or the other with a push stick.**

• **Don't push or pull a board through the planer. Let the machine do the work.**

• **If the stock stops feeding, immediately turn off and unplug**

the planer and wait until it stops. Lower the table and remove the stock. See what caused the jam; then correct the problem. Never force a jammed board.

- **If a strange noise or vibration develops, immediately turn off and unplug the planer. Do not operate the machine again until you have found and corrected the problem.**
- **When removing large amounts of stock, the best and safest way is to make several passes. The maximum depth of cut on the thickness planer is 3/32″ for most operations. The maximum depth of cut for the professional planer is 1/8″. Most operations require that you take a shallower depth of cut.**
- **Don't plane boards of different thicknesses in the same pass. Because the planer must be adjusted for the thicker board, the rollers would not hold the thinner board securely and it might be kicked back.**
- **Feed just one board into the planer at a time. Never plane two or more boards side by side—one board may interfere with the others.**
- **When working with long or heavy boards, support the work with one or two roller stands placed 1′ to 4′ out from the machine.**
- **Never leave the thickness planer running unattended. When you're finished planing, turn off and unplug the planer.**
- **Don't lean on the planer, whether it's running or not. And never stand on the planer or use it as a step stool. You could harm yourself and your planer.**
- **Never use your planer as a storage shelf. Small tools, screws, and nails could roll under the shields. When the planer is turned on, these objects could be thrown out, severely damaging the machine—or injuring you.**
- **Make sure the machine rests firmly on the floor—not up on its retractable casters.**
- **Use only Shopsmith Planer Knives; other brands of knives are not wedge-shaped and will not seat properly in the cutterhead.**
- **Do not attempt to disassemble or repair the control box.**

SETTING THE THICKNESS

Turn the thickness adjustment crank counterclockwise to lower the table and accommodate thicker stock. Turn the crank clockwise to raise the table and decrease the final thickness of the planed lumber (Figure 21-3).

Always make this adjustment from a greater to a lesser thickness. For instance, if you want to plane a board 3/4″ thick, first lower the table so that it goes down past the 3/4″ mark on the thickness scale at least one full turn of the crank. Then raise the table up to the mark. This maneuver takes up any slack in the thickness adjusting mechanism. If you don't set the thickness from greater to lesser, there's a chance the planer table may "drift" down slightly during the pass and you'll get a tapered board.

By adjusting the thickness, you also adjust the depth of cut—how much stock the planer removes from a board in a single pass. To remove 1/16″ of stock from a 3/4″ board, turn the thickness adjustment mechanism clockwise one full revolution. ***Warning: Never turn the thickness adjustment mechanism while you are planing stock.***

THICKNESS PLANER SPEEDS AND FEED RATES

Before you begin any thickness planer operation, set the Mark V to run at the correct cutterhead speed and the feed motor to feed stock at the proper rate (Figure 21-4). For the most part, the right speed and feed rate depend on:

- the hardness of the wood
- the width of the board
- the depth of cut
- the sharpness of the knives.

The harder the wood, the wider the board, the deeper the cut, the duller the knives, the slower you want to set the cutterhead speed and feed rate. As you plane softer woods, narrower boards, or take

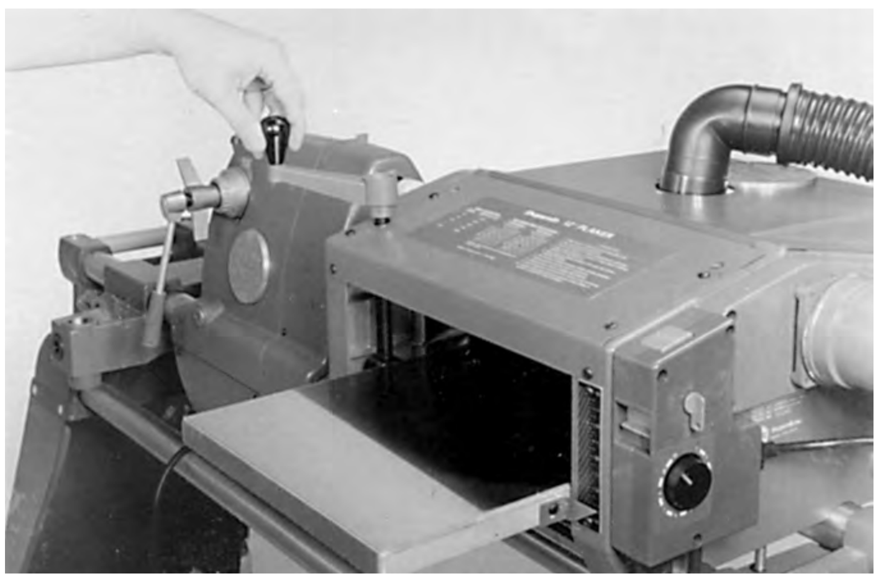


Figure 21-3. *Always make thickness adjustments from a greater to a lesser thickness, turning the thickness adjustment crank clockwise and raising the table.*

shallower cuts with sharp knives, you can use faster speeds and feed rates. To determine the correct speed and feed rate for an operation, first look up the hardness of the wood you're planing in Table 21-1. Measure the width of the widest board and decide the amount of stock you want to remove in each pass. Then look up the recommended feed rates in Table 21-2.

To a lesser extent, speed and feed rates also depend on the grain pattern of the stock. As the grain becomes more figured or "wild," or the more knots there are in the grain, the slower the speed and feed rates should be. If the planer "bogs down" during a cut, even though the cutterhead speed and the feed rate are set properly, immediately lower the feed rate to let the planer catch up. On the next pass, try a slower feed rate. If that doesn't work, try a shallower depth of cut, then a slower cutterhead speed—in that order. Do not continue to run the planer at a speed or feed rate that causes the machine to labor or stop during a cut. *Caution: If you operate the planer at too high of a speed, the motor that powers the cutterhead will overheat, blow fuses, and may burn out.*

***Figure 21-4.** To increase the power feed rate, turn the feed control clockwise. To decrease the feed, turn the feed control counterclockwise.*

Table 21-1: Wood Planing Guide

*This guide contains information on a variety of common and exotic woods that will help take the guesswork out of your planing operations. To use it, first look up the wood you're about to plane in the **Wood Characteristics Chart.*** Pay particular attention to the hardness rating—whether the wood is rated as hard, medium, or soft. Once you know the hardness of the wood, measure the width of the widest board you have to plane and decide the amount of stock you want to remove on each pass. Use the ***Speed and Feed Chart** to determine the Mark V speed dial setting (Speed) and the planer feed control setting (Feed).*

Wood Characteristics Chart

Wood	Characteristics	Planing Tips
Ash (White)	Hardness: Hard Grain: Distinct Workability: Difficult	Tends to chip when fed too fast or against the grain.
Basswood	Hardness: Soft Grain: Faint Workability: Fair	Pay attention to grain direction. Becomes fuzzy if you cut against grain.
Birch (Yellow)	Hardness: Hard Grain: Faint Workability: Difficult	Very difficult to plane because of curly grain pattern. Take very shallow cuts.
Butternut	Hardness: Soft Grain: Distinct Workability: Fair	Fuzzy, tough grain. Becomes fuzzier if you cut against grain. The grain direction may be inconsistent.
Cedar (Aromatic Red or Western Brown)	Hardness: Soft Grain: Distinct Workability: Fair	Feed slowly to avoid chipping out knots. If you work with western brown cedar, wear a dust mask—sawdust may cause an allergic reaction.
Cherry (Wild)	Hardness: Hard Grain: Distinct Workability: Difficult	Tends to burn when planed at a high speed or slow feed rate.
Chestnut (Wormy)	Hardness: Soft Grain: Distinct Workability: Easy	Stock tends to be brittle. Chips out easily around knots.
Cocobolo	Hardness: Hard Grain: Distinct Workability: Difficult	Stock is very hard and brittle. Pay attention to grain direction to avoid chipping. Wear dust mask—sawdust is toxic!

Table 21-1: Wood Planing Guide (Continued)

Wood Characteristics Chart

Wood	Characteristics	Planing Tips
Ebony	Hardness: Hard Grain: Faint Workability: Difficult	Stock is very hard. Limit depth of cut to 1/32". Difficult to tell grain direction. Stock is sometimes coated with wax to avoid checking. Remove wax with scraper before planing to avoid gumming up table and rollers. Wear dust mask—sawdust is toxic!
Elm (Rock)	Hardness: Hard Grain: Distinct Workability: Fair	Tough grain. Pay attention to grain direction. Chips badly if you cut against grain.
Fir (Douglas)	Hardness: Medium Grain: Distinct Workability: Difficult	Stock alternates between hard and soft. Pay attention to grain directions. Chips or feathers if you cut against grain.
Fruitwood (Apple, Pear, etc.)	Hardness: Hard Grain: Distinct Workability: Difficult	Tends to burn when fed too slowly. Tends to chip when fed too fast.
Hickory	Hardness: Hard Grain: Faint Workability: Difficult	Extremely hard, tough wood. Limit depth of cut to 1/32". Tends to burn when planed at high speed or slow feed rate.
Mahogany (Honduras)	Hardness: Medium Grain: Faint Workability: Easy	Grain direction may be inconsistent. Wear dust mask—sawdust may cause an allergic reaction.
Maple (Rock)	Hardness: Hard Grain: Distinct Workability: Fair	Watch for curly grain pattern and bird's eyes. Planes easily when grain is straight.
Oak (Red)	Hardness: Hard Grain: Distinct Workability: Fair	Pay attention to grain direction. Chips badly if cut against grain.
Oak (White)	Hardness: Hard Grain: Distinct Workability: Difficult	Has same characteristics as red oak.
Padouk	Hardness: Hard Grain: Distinct Workability: Difficult	Extremely hard wood. Limit depth of cut to 1/32" and feed rate to SLOW. Orange sawdust stains hands and clothing.
Pine (White)	Hardness: Soft Grain: Faint Workability: Easy	Tends to chip out around knots.
Pine (Yellow)	Hardness: Medium Grain: Faint Workability: Fair	Stock alternates between hard and soft. Knives must be sharp to avoid chipping.
Poplar (Yellow)	Hardness: Soft Grain: Faint Workability: Easy	Tends to fuzz slightly if you cut against grain. Planes very easily.
Purpleheart	Hardness: Hard Grain: Distinct Workability: Difficult	Extremely hard and brittle. Pay attention to grain direction. Chips if cut against grain. Purple dust stains hands and clothing.

Table 21-1: Wood Planing Guide (Continued)

Wood Characteristics Chart

Wood	Characteristics	Planing Tips
Redwood	Hardness: Soft Grain: Faint Workability: Easy	Clear boards plane easily.
Rosewood (Indian)	Hardness: Hard Grain: Distinct Workability: Difficult	Extremely hard, dense wood with curly grain. Limit depth of cut to 1/32" and feed rate to SLOW. Wear dust mask—sawdust is toxic!
Spruce	Hardness: Soft Grain: Distinct Workability: Easy	Clear wood planes easily.
Teak	Hardness: Hard Grain: Distinct Workability: Difficult	Extremely hard, dense wood. Limit depth of cut to1/32". Wear dust mask—sawdust can cause an allergic reaction.
Walnut	Hardness: Hard Grain: Faint Workability: Fair	Watch for burls and knots. Tends to chip. Wear dust mask—sawdust can cause an allergic reaction. Dust stains hands and clothing.
Zebrawood	Hardness: Hard Grain: Distinct Workability: Difficult	Extremely hard, dense wood. Limit depth of cut to 1/32". Pay attention to grain direction. Chips badly if cut against grain.

Table 21-2: Planer Feed Rate Chart

12" Thickness Planer*				Professional Planer			
Depth of Cut	Board Width	Feed Rate*** Hardwood	Feed Rate*** Softwood	Depth of Cut	Board Width	Feed Rate*** Hardwood	Feed Rate*** Softwood
1/64"	0-4"	10	10	1/32"	0-4"	10	10
	4"-8"	10	10		4"-8"	10	10
	8"-12"	10	10		8"-12"	10	10
1/32"	0-4"	10	10	1/16"	0-4"	10	10
	4"-8"	10	10		4"-8"	3	6
	8"-12"	9	7		8"-12"	**	**
1/16"	0-4"	10	10	3/32"	0-4"	9	10
	4"-8"	5	5		4"-8"	**	**
	8"-12"	**	**		8"-12"	**	**
3/32"	0-4"	6	9	1/8"	0-4"	4	10
	4"-8"	**	1		4"-8"	**	**
	8"-12"	**	**		8"-12"	**	**

NOTE: These are maximum recommended feed settings for clear, straight-grained woods. If your stock contains knots, figured grain, or is unusually dense and hard, you will have to adjust these settings downward.

* If the Thickness Planer is mounted on the Mark V set the speed dial to "T" (4100 RPM).
** Not recommended.
*** Feed Rate: Feet per minute.

GETTING THE SMOOTHEST POSSIBLE CUT

The cutterhead speed and feed rate combine to give you a certain number of cuts per inch (cuts/inch). Generally, as the cuts per inch increase, the planed stock becomes smoother. To raise the number of cuts per inch, increase the cutterhead speed and decrease the feed rate. To calculate the exact cuts/inch, use this equation:

$$\frac{\text{RPM} \times 3}{\text{SFPM} \times 12} = \text{Cuts/Inch}$$

You'll also find your planed stock gets smoother as you take shallower cuts. A shallow depth of cut does not lift the wood grain as badly, and it reduces the risk of chipping or tearing out hunks of wood.

To get the smoothest possible surface on your planed stock, reduce the depth of cut to 1/64″ or less on the last pass through the planer. Increase the cutterhead speed one to two letters and decrease the feed rate to SLOW. If the planer slows or stops during a pass when the feed rate has already been adjusted to SLOW, turn off the machine immediately. Lower the table and remove the stock. Try the pass again with a shallower depth of cut. If that doesn't help, try a slower cutterhead speed (Mark V mounted thickness planer only).

GENERAL THICKNESS PLANING

Measure the thickness of the board you're about to plane at its thickest point. Then adjust the table so that the depth of cut pointer is exactly indicating the thickness of the thickest part of the board. Always make your first pass at "0" depth of cut. This will even out any inconsistencies in the thickness of the stock.

If you're planing long or heavy lumber, have a helper ready to feed or receive the stock. If you can't find a helper, place one or two roller stands out 1′ to 4′ from the infeed and/or outfeed tables. Make sure these stands are adjusted to precisely the same height as the table; then remember to readjust them each time you raise or lower the table.

Turn on the planer and set the cutterhead speed and feed rate; then turn the machine off again.

Take a comfortable stance to either side of the infeed opening, as near to the planer power switch as possible. Turn the planer on and let it come up to speed. Hold the board parallel to the sides of the table; then feed it forward until the infeed roller grabs it (Figure 21-5). Continue to support the board as it feeds into the planer, but do not push or pull it through the machine. Let the rollers do the work.

Always turn on the planer and let it come up to speed; then feed the stock into the machine. ***Warning: Never turn on the planer with stock already under the cutterhead or feed stock into the planer before it's running at full speed.*** As the stock is feeding through the planer, watch and listen carefully for several problems:

- Watch that the stock doesn't drift toward one side of the table, but always remains centered under the cutterhead.
- Watch that the stock continues to feed at a steady rate.
- Listen that the planer doesn't begin to slow or stop in the middle of a cut.
- Watch and listen that the stock doesn't chip, splinter, or tear out.

If the stock begins to drift toward one side of the table or the other, gently press against the infeed or outfeed end of the stock to straighten it as the stock is being cut. ***Warning: Never put your hands under the infeed or outfeed shield! If you can't straighten the stock or if the stock jams in the planer, turn off and unplug the machine and let it come to a complete stop.*** Lower the table and remove the stock. Remove any wood chips or sawdust that might be blocking the path. Then repeat the pass.

If the cutterhead slows or the wood chips and splinters, quickly adjust the feed rate to SLOW, if this doesn't correct the problem, immediately turn off and unplug the machine. Let the planer come to a complete stop; then lower the table, remove the stock, and inspect both the planer and the stock to see what could be causing the problem. It might be any one or a combination of several different causes:

- The depth of cut may be set too deep.

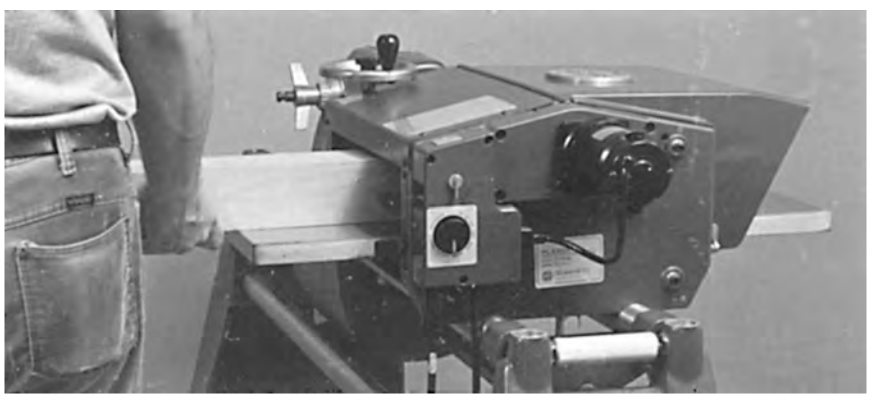


Figure 21-5. *To feed a board into the planer, hold the board parallel to the sides of the table; then push it forward until the infeed roller grabs it. Continue to support the board as needed, but do not push or pull the board once the rollers are feeding it through the planer.*

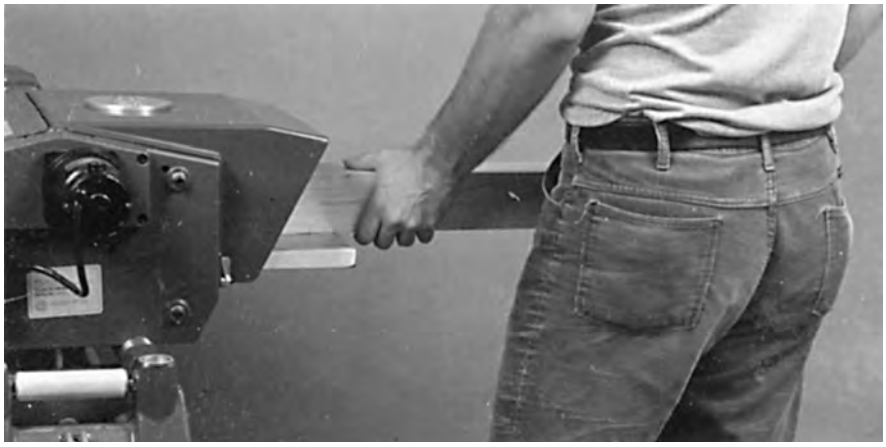


Figure 21-6. Support the stock as it comes off the outfeed table. Don't pull the stock any faster than the rollers want to feed it.

- The planer may be cutting against the wood grain.
- The stock may have wild, figured grain or dense, hard knots.
- The knives may be worn and dull.

If the problem is that the cutterhead slows, reduce the depth of cut or decrease the cutterhead speed. If the wood is chipping, reduce the depth of cut or increase the cutterhead speed. Also try turning the board end-for-end if the wood seems to be tearing along the grain. If the cause of the problem is figured wood grain or knots, you may have to take very light cuts at a very slow feed rate.

If the wood seems to hesitate or stick as you feed it, but neither the cutterhead nor the feed motor slows down, the rollers need to be cleaned or the table needs to be waxed—or both. Clean the rollers with a damp cloth and apply paste wax to the table. Dry off the rollers and buff the table carefully. Locate the cause of the problem and correct it; then repeat the pass, watching and listening carefully to see that the problem does not reappear. If an unusual vibration develops or if you hear excessive chipping and splintering, immediately turn off the planer. Do not operate the machine until you have located and corrected the problem.

As the stock emerges from the planer, move to the outfeed side of the machine, keeping your body to the right of the outfeed opening. Support the stock as it is fed out, but don't pull it any faster than the rollers want to feed it (Figure 21-6). Once the outfeed roller lets go of the stock, remove it from the planer.

Inspect the board for any chipped or torn spots. If there are no problems, readjust the depth of cut and feed the board into the planer for another pass. Make repeat passes until you have reduced the board to the desired thickness.

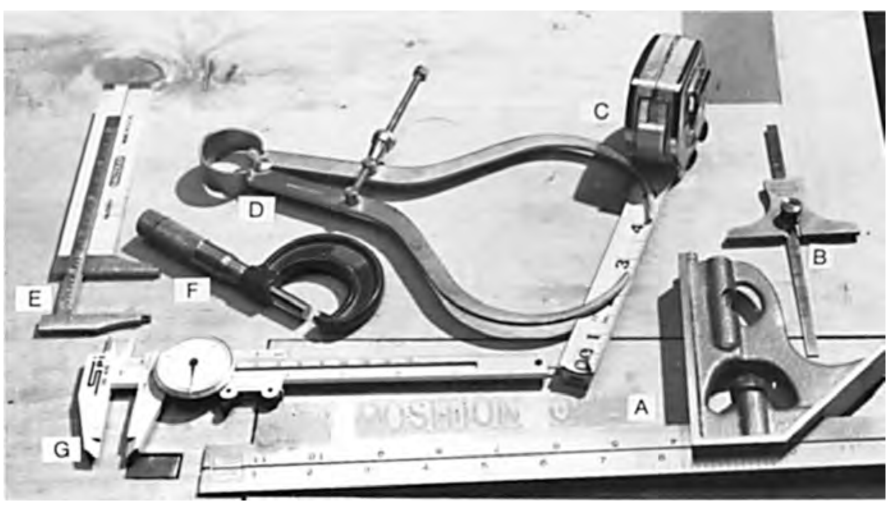


Figure 21-7. When you're planing stock to a desired thickness, you need a tool to measure the thickness. Shown here are a combination square (A), depth gauge (B), tape measure (C), outside calipers (D), vernier calipers (E), micrometer (F), and dial calipers (G). All of them will work well when measuring thickness, but dial calipers are perhaps the handiest.

HELPFUL PLANING TIPS

Getting a good, smooth surface begins by making sure the knives are sharp and properly adjusted, the depth of cut isn't too deep, and that the machine is running at the proper speed and feed rate. Here are a few additional tips to help you get the best results:

Accuracy—When you're planing stock to a desired thickness, you'll probably want to measure the thickness many times as the stock approaches the final dimension. Several measuring tools will work well—a combination square, depth gauge, tape measure, outside calipers, vernier calipers, micrometer, or dial calipers (Figure 21-7). If you want a tool that is easy to use and accurate, choose the dial calipers.

Wood Grain Direction—Always feed the stock so that the knives are cutting in the same direction as the wood grain (Figure 21-8). If you cut against the grain, the wood may chip out or even be torn apart in the planer (Figure 21-9).

The grain direction is usually easy to determine by the look and feel of the workpiece. Looks can be deceiving, though, especially with close-grained woods. If the stock starts to knock or kick back against the infeed roller or you hear wood chipping out, quickly turn the feed rate down to SLOW. If this doesn't help, immediately turn off the planer. When the machine comes to a complete stop, lower the table and remove the stock from the planer. Turn the board end-for-end and try the pass again.

Knots and Trouble Spots— Wood with knots, wild grain, or extensive figuring is always difficult to surface and requires extra care. Check that any knots in a board are solid. ***Warning: Never plane stock with loose or cracked knots. Feed the work very slowly and take light cuts (1/128" to 1/64"). Be especially cautious of kickbacks and stop cutting immediately if the stock will not feed smoothly.***

Sniping—If you let the stock droop when it's being fed into or coming out of the planer, the knives may cut a large snipe at the beginning or the end of the board (Figure 21-10). A small snipe (less than 0.005" deep) is normal. But if the snipes are deep, be more careful as to how you support the stock. Keep it parallel to and flat on the table at all times.

Less often sniping may be caused by weak roller pressure. If the planer continues to cut a pronounced snipe no matter how you feed the stock, check the roller springs, following the procedure in the Planer Owners Manual.

Ridges—Damaged or nicked knives leave long ridges on the surface of the planed stock, running the entire length of the board (Figure 21-11). These ridges detract from the finished surface of the wood and may interfere with the accuracy of your woodworking. The only way to restore the knives

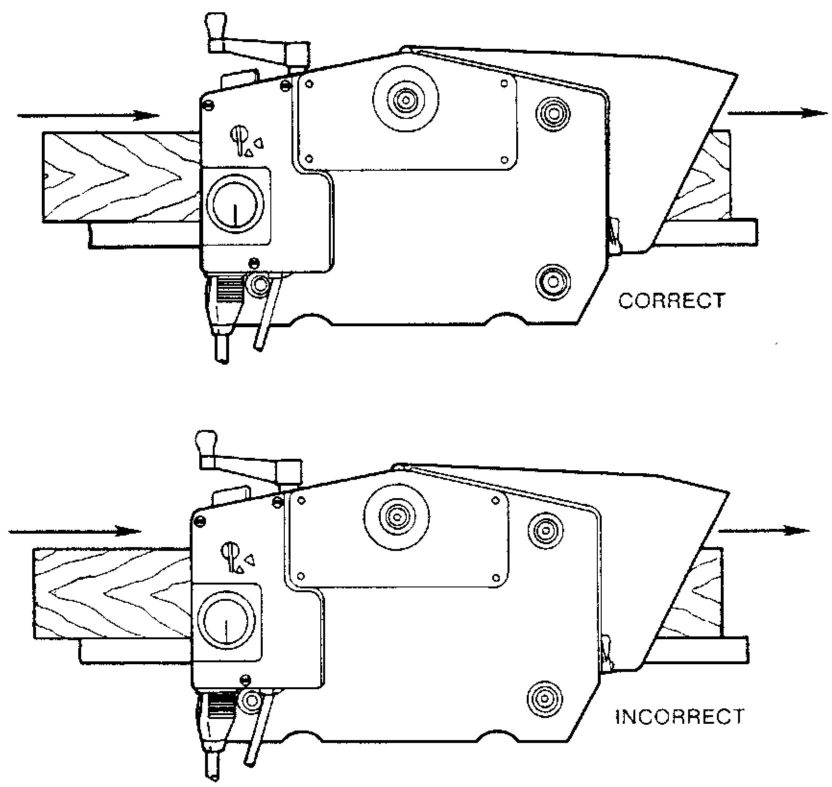


Figure 21-8. Check your stock before you feed it into the planer. The knives should cut with the grain direction.

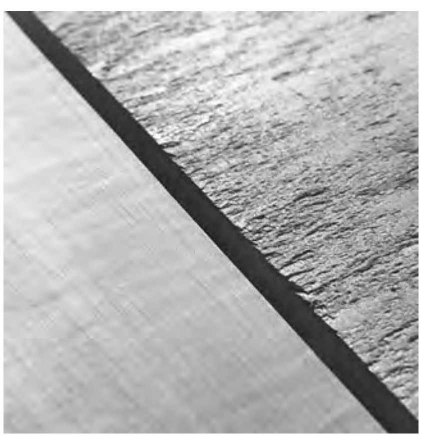


Figure 21-9. If you feed the wood against the grain, you may get a rough, chipped out surface as shown on the right. Feed the wood with the grain to insure a smooth surface as shown on the left.

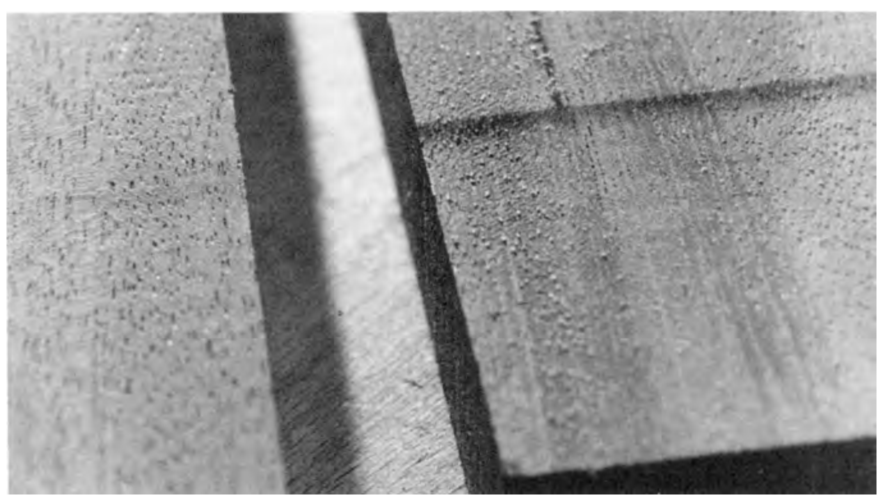


Figure 21-10. It's normal for the planer to cut a small snipe (less than 0.005" deep) in the end of a board as shown on the right. But if you let a board droop when it's fed into or coming out of the planer, the knives may cut a pronounced snipe in one end as shown on the left. Keep the board parallel to and flat on the table at all times.

so they won't leave these long ridges is to have them reground.

To avoid damaging the planer knives, inspect each board before you plane it. Be sure there are no nails, staples, tacks, dirt, paint, or similar materials on or in the wood. If you must surface glued-up stock, follow the procedure described later in this chapter. *Caution: If you attempt to surface old lumber with rusted off nails below the surface, painted wood, plywood, hardboard, wood with glue beads, or any material other than solid wood, you will damage the planer knives. Even a bit of dirt on the wood can nick the planer knives badly.*

Mill Marks—If the planer makes too few cuts per inch or the height of the knives is inconsistent, the machine will leave unsightly mill marks on the stock. Mill marks are small, parallel ripples that run across a board from edge-to-edge. To eliminate mill marks, try increasing the cutterhead speed (Mark V mounted planer only) or decreasing the feed rate. If the mill marks persist, check the knife positions.

SURFACING ROUGH LUMBER

Buying rough-cut lumber and doing your own custom surfacing is essentially no different than general planing, but there are a few tricks you should know.

Be sure the wood is properly dried. Wet or green lumber clogs the machine as you plane it. Sap builds up on the knives, interfering with the cutting action. And as the wood dries, the planed stock becomes uneven and requires resurfacing.

Air-dried wood should stand for at least one year per inch of thickness of the rough-cut stock. The moisture content of air-dried wood should be about 12% to 19%. You needn't worry about how long kiln-dried wood stands, but it should have a moisture content of about 10%. If the wood is to be used for fine furniture or cabinets, some woodworkers prefer a moisture content of about 7% to 8%.

To determine the amount of moisture in wood, cut a sample block from a board. (Don't simply cut off an end—ends dry quicker and this will give you a false reading. Instead, cut 6″ off the board and discard the end; then cut off a second 6″ for your sample.) Weigh the sample on a postal scale; then bake it in an oven for one to two hours at 200°F to remove all the moisture. When the sample is completely dry, weigh it again. Use this equation to calculate the moisture content of wood:

$$\left(1 - \frac{\text{Weight after baking}}{\text{Weight before baking}}\right) \times 100$$

$$= \%\ \text{Moisture content}$$

Joint one edge before surfacing a board. It's almost impossible to determine the grain direction in a rough-cut board. By jointing one edge before you plane a board, you can determine which way the grain is running and feed the board into the planer so that the knives cut with the grain.

Measure to find the thickest part of the board. As wood dries, its dimensions become inconsistent—including its thickness. Measure the thickness of a rough-cut board at several places and set the depth of cut for the first pass according to the thickest spot.

Take very shallow cuts at first. Just as it's difficult to tell the grain direction in a rough-cut board, it's also difficult to tell how the grain is figured. To avoid ruining the wood, take shallow cuts (1/64″ to 1/32″) until you can tell whether there are any burls, bird's eyes, or other unusual grain patterns.

Remember to surface both sides. Plane one side until you have removed all the saw marks; then turn the board over and plane it to the desired thickness.

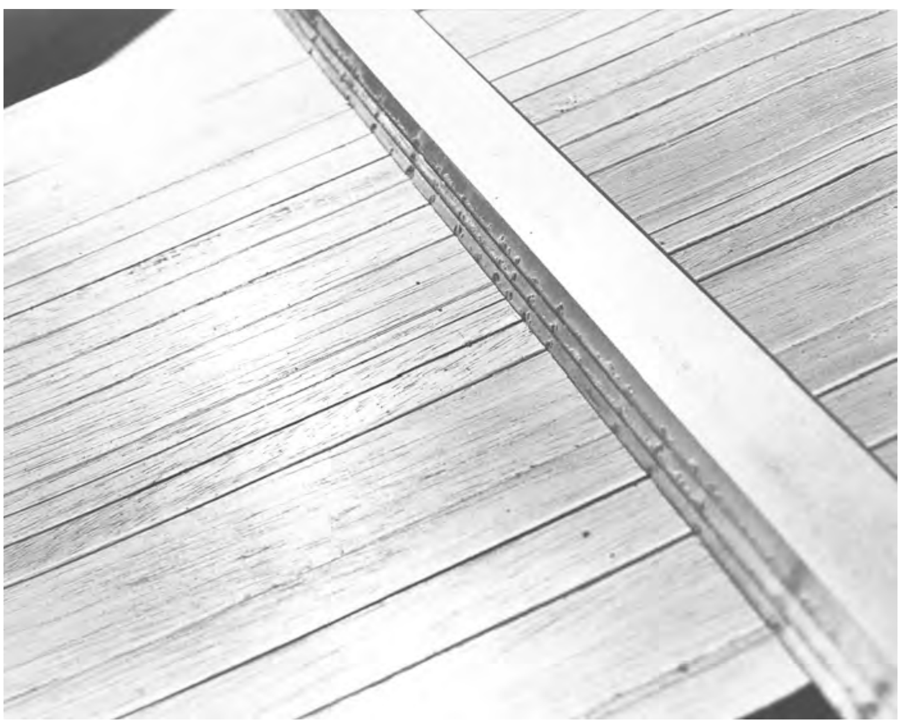


Figure 21-11. *Damaged or nicked knives will leave long ridges on the planed stock. Inspect each board before you plane it to insure there are no staples, tacks, paint, dirt, glue beads, or similar materials that will damage the knives. Never plane plywood, hardboard, or any material other than solid wood.*

PLANING BOARDS TO IDENTICAL THICKNESSES

When thicknessing, you often need to plane two or more boards to identical thicknesses. To do this, start by planing the thickest board. Plane it down to the thickness of the next thickest boards; then begin to plane both boards at the same depth-of-cut settings. Cut these two boards down to the thickness of the third thickest board; then plane all three. Continue in this manner until you are planing all of the boards. Never feed two or more boards side-by-side through the planer. The boards may interfere with each other as they pass through the machine, causing them to jam or kick back.

A simple way to tell if one board has been planed down to approximately the same thickness as another is to place both boards on a flat surface, side-by-side. With your hand, feel the step from the edge of one board to the next (Figure 21-12). If the step seems higher than 1/64", continue planing the thicker board. If it's smaller than 1/64"—or there is no step—you can begin planing both boards at the same depth-of-cut settings.

Finish up by planing all of the boards at the same depth-of-cut setting at least once. This will insure that all boards are cut to identical thicknesses.

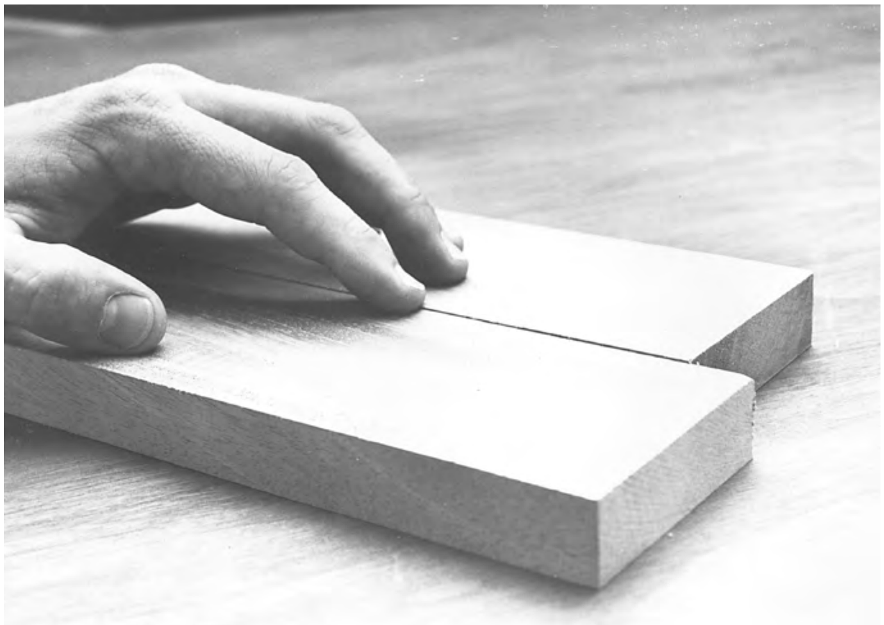


Figure 21-12. *To tell if one board has been planed down to approximately the same thickness as another, place the two boards side-by-side on a flat surface. Then simply feel the step between the edges of the boards with your hand.*

SQUARING STOCK

The planer can also be used to square turning stock, furniture legs, and posts.

Start by rough-cutting your stock square, leaving at least 1/8" extra stock for planing. Square one corner of the stock on a jointer, jointing two adjacent sides so that they are exactly 90° apart (Figure 21-13).

Figure 21-13. *To square stock, start by squaring one corner on a jointer. Joint two adjacent sides so that they are exactly 90° apart.*

On the end grain of the stock, mark the sides opposite the joined sides S1 and S2. Set the depth of cut on the planer; then plane the stock with side S1 up. Without changing the depth of cut, make a second pass with side S2 (Figure 21-14). Continue in this manner until you have planed the stock to the desired dimensions. If you wish to square two or more boards, you can combine this procedure with the procedure for "Planing Boards to Identical Thicknesses," described earlier in this chapter.

PLANING GLUED-UP STOCK

Your planer is designed for planing wood. Other materials, including glue, will dull or damage the knives. However, on those occa-

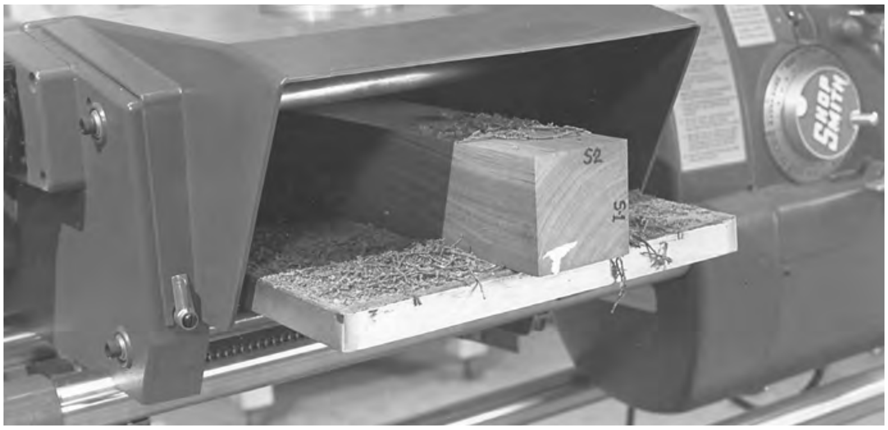


Figure 21-14. On the end grain, mark the sides opposite the joined sides S1 and S2. Plane the board with side S1 up; then without changing the depth of cut, repeat the pass with side S2 up.

Figure 21-15. If you wish to plane glued-up stock, scrub the wood with a wet rag while the glue is still wet. Be sure to remove all the glue on the surface of the stock. If any surface glue remains after the glue dries, remove it with a scraper or a belt sander. ***Warning: Allow the glued-up stock to dry at least 24 hours before planing it.***

sions when you need to true up glued-together stock, follow this procedure to minimize the damage to the knives:

After you glue up the stock, scrub all the glue off the surface with a wet rag (Figure 21-15). This will prevent glue beads from forming on the surface of the wood. Allow the glue to dry at least 24 hours; then check the stock for any surface glue you might have missed. If you find any, remove it with a scraper or a belt sander. ***Warning: Glued-up stock must dry for 24 hours prior to planing. If it doesn't, the stock may come apart in the planer.***

When you plane glued-up stock, take a shallow depth of cut (1/32" or less) and use a slower feed rate than normal. When you're finished, check the planer knives for built-up pitch and signs of wear.

Chapter 22
Routing System

The Shopsmith Routing System is a home or small shop version of a commercial machine that was originally developed for high-speed mass duplication of furniture parts and components.

In the **overarm mode** of operation, a rigid arm holds a router motor securely in a fixed position over the table surface. The arm itself has a built-in quill-feed lever that controls the depth-of-cut.

During the duplication process, the routing system suspends a router motor and bit above a precisely aligned pin which protrudes up from the table surface and rides in a pre-cut groove in the underside of a guiding fixture. By guiding the fixture over the pin, the operator can cut the identical design or shape in a workpiece attached to the top (or opposite) side of the fixture.

In the **under-table mode**, the base of your router is attached to the underside of the table. When the router is installed in this manner, the router bit will protrude up through the table surface.

Besides the obvious time-saving benefits of high-speed duplication, the routing system also offers certain safety advantages by providing improved visibility and control of the work, as well as the ability to perform operations on smaller workpieces that would be almost impossible to grip firmly while using a hand-held router.

The routing system will cut-out, shape, mold, mortise, duplicate and form intricate, professional-looking joinery for a wide variety of projects.

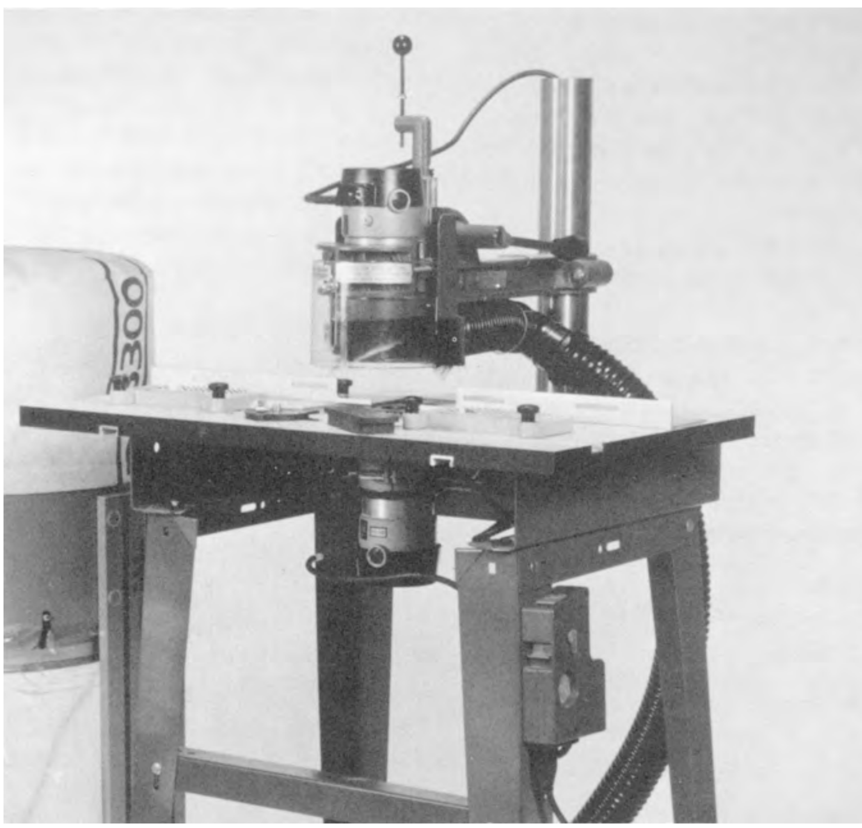


Figure 22-1. The Shopsmith Routing System.

ROUTING SYSTEM—SETUP AND FEATURES

To set up your routing system, follow the instructions in the Owners Manual that came with your Routing System.

The Shopsmith Routing System (Figure 22-1) offers a number of unique features:

- In the overarm mode, the throat capacity of the routing system ranges from 13-5/8″ to 15-1/8″ (depending upon the diameter of the router motor being used).
- By moving the arm to the top of the steel column, projects up to 12″ thick can be worked in either the overarm or under-table mode with ease.
- In the overarm mode, the arm holds any router motor from 2-1/2″ to 4″ in diameter firmly in position.
- For under-table routing, a universal table plate will accept virtually any router base for quick, simple mounting.
- The routing system's precision rack-and-pinion vertical feed mechanism offers up to 3-1/2″ of vertical travel to provide easy depth-of-cut control during overarm operations.
- A large see-through guard keeps your hands and fingers out of the danger zone, protects your eyes, and directs debris to a dust collection system.
- The worktable is 30″ wide by 18″ deep and offers over 7″ of

front-to-back adjustment. It can be locked into position at any location. Its smooth, laminated surface offers a large number of threaded holes to enable the convenient attachment of optional feather boards, fences and other devices to improve workpiece control and safety during operations.

- The built-in miter rail allows the use of the Shopsmith Miter Gauge as a guide or safety device during operations.
- Interchangeable table inserts provide adequate workpiece support when using a variety of different sized router bits.
- Screw-in guide pins allow precision pin routing with a variety of bit sizes.
- The optional two-piece adjustable fence is used to guide workpieces during straight-line routing and for mounting fence extensions and stop blocks.

ROUTER BITS

Router bits come in a large variety of shapes and sizes, each designed to preform a specific operation. Generally speaking, most router bits have three main components. These are the shank, the flute and the pilot (Figure 22-2).

The **shank** is the part of the bit that is gripped firmly by the collet (or chuck) of the router motor. The **pilot** is the portion that rides against the edge of the workpiece and controls the depth-of-cut of the bit during operations. The **flutes** are the cutting edges of the bit.

Piloted Versus Un-Piloted Bits

When buying router bits, you have the option of selecting either piloted or un-piloted bits (Figure 22-3).

Piloted bits are used when cutting a decorative profile on a straight or curved workpiece where the entire edge of the workpiece is **not** to be removed. When choosing piloted bits, you can select from bits with solid pilots or bearing pilots. Solid pilot bits are less expensive, but create friction that could burn your workpiece edge during cutting. Although bearing pilot bits are slightly more expensive, they will eliminate this friction and burning of the workpiece edge.

Un-piloted bits offer no edge guide and will cut all the way to the tip. They are therefore designed for use on projects where the entire edge of the workpiece is to be removed or a decorative cut is desired somewhere within the perimeter of the stock. As a result, they should always be used with a fixture, guide pin or fence.

Router Bit Materials

Router bits are available in a variety of different materials, based upon the amount of use they are expected to receive and the types of materials they are intended to cut.

High-speed steel bits are the most commonly available type and are intended for occasional use only, or for working with soft woods such as pine or redwood. These are the least expensive of all bits and offer limited use before sharpening is required.

Carbide-tipped bits generally offer high-speed steel shanks and bearing pilots with carbide cutting flutes welded-on to provide for more extended use before sharpening is required. Carbide-tipped bits should be used for working with hardwoods such as oak or maple, plastic laminates or composite materials like particleboard.

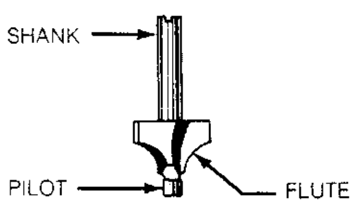


***Figure 22-2.** Components of a typical router bit.*

These bits are slightly more expensive than high-speed steel bits.

Solid carbide bits are usually only available in simple, straight profiles and offer the same benefits of durability as carbide-tipped bits.

Router Bit Types

Router bits are available in many different shapes for a variety of specialized jobs. Figure 22-4 shows examples of the types that are available.

Mounting Router Bits

Always insert the bit all the way into the router's collet and then back it out about 1/8″ before tightening to prevent the transfer of heat and vibration from the bit to the router motor armature.

Router Bit Storage

When storing router bits, never throw them carelessly into a drawer with other tools. This could result in nicking of the edges and necessitate costly, professional sharpening.

In addition, avoid storing them in a damp location, as this will cause rusting (and dulling) of the edges. One suggestion is to store them in an enclosed area with camphor tablets (which coat the bit with a thin, rust-inhibiting film).

Cleaning Router Bits

Occasionally, router bits will collect pitch that should be removed to prevent burning of the workpiece edges. This cleaning can be easily performed with household

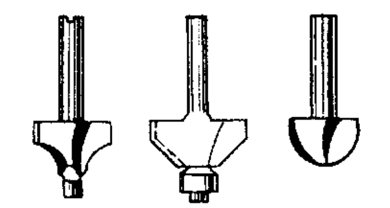


***Figure 22-3.** Router bits are available in piloted or un-piloted styles.*

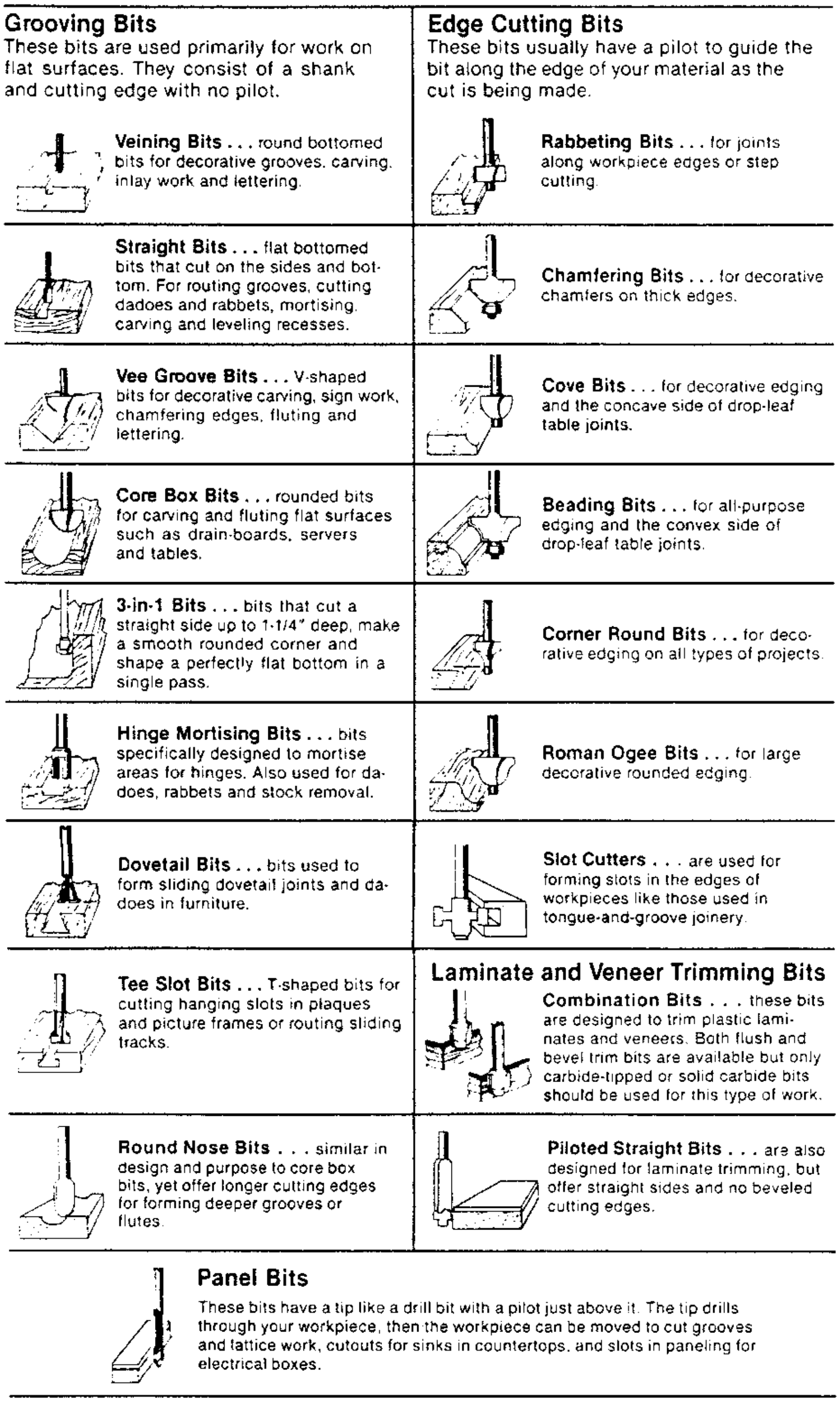


Figure 22-4. Just a few of the wide variety of router bits that are available.

oven cleaner. However, always remove bearing pilots from bits to avoid getting solvents or oven cleaner in the bearings. These materials will destroy the bearing lubricant and cause premature bearing failure.

Sharpening Router Bits

As with all cutting tools, router bits require occasional sharpening for optimum performance. High-speed steel and carbide-tipped bits can be easily honed in the shop (see Chapter 24 for sharpening techniques). However, if carbide-tipped or high-speed steel bits become extremely dull or nicked, they should either be replaced or taken to a professional sharpening service.

ROUTING SYSTEM SAFETY

Warning: Before using the routing system, read and understand these important safety instructions:

Danger Zone—The danger zone on the routing system includes any location within 3" of the rotating bit. Always keep hands clear of this area when working with the machine.

Protective Guard—Keep the see-through guard in place and set at no more than 1/4" above the surface of the workpiece during overarm or under-table routing.

- **Always wear proper eye and ear protection.**
- **Never attempt to clamp the overarm assembly onto any column less than 2-3/4" in diameter by using bushings or adapters.**
- **Follow your router manufacturer's recommendations as to replacement parts for your router.**
- **Before beginning any operation or turning on your router motor, always check to be sure the router, overarm assembly, depth stop rod, depth control handle, worktable, table plate, accessories, safety devices, fences and fixtures are secured.**
- **Whenever possible, use a push stick, push block, feather board, miter gauge with safety grip, fixture or other safety device to maneuver a workpiece into the rotating bit. This is especially true of small or narrow stock.**
- **Always keep a firm grip on your workpiece and never hold it with your hand in line with the bit.**

• When cross-grain routing stock up to 10″ wide, use your miter gauge with safety grip to control the workpiece (which must extend 5-1/2″ away from the router bit).

• To prevent the router from grabbing and throwing the workpiece, always feed the stock *against* the rotation of the bit and *never with it.* During overarm routing, stock being worked in front of the bit should be moved from left to right. During under-table routing, stock being worked in front of the bit should be moved from right to left.

• Always cut with the grain of the wood and not against it for a smoother, safer cut.

• To avoid being hit by a thrown workpiece, never stand in-line with the workpiece being fed.

• Never rout second-hand lumber. It may contain nails or screws that could damage your bit and cause serious injury.

• Use extra care when working stock that contains highly figured grains or knots to avoid kickbacks.

• Do not rout boards that are warped, bowed or cupped.

• When working long boards or sheet materials, always support them adequately with roller stand(s) placed from 1′ to 4′ from the table.

• Never freehand rout stock less than 12″ × 12″ in size or equivalent.

• With the exception of single-pass dovetail cuts, limit your depths-of-cut to 1/4″ for each pass when using bits up to 1/2″ in diameter to cut hardwoods.

• Never exceed depths-of-cut of 3/8″ when using bits up to 1/2″ in diameter to cut soft woods.

• When using bits over 1/2″ in diameter, limit your depths-of-cut to half the recommended depths for bits up to 1/2″ diameter.

• NEVER feed your workpiece between the rotating router bit and a fence, as this could cause a kickback.

• When stop routing, always use stop block(s) to control the length of cut. Failure to use stop block(s) could cause a kickback.

• NEVER install a router bit without first un-plugging the router motor.

• Make sure the router bit is secured firmly in the collet. Loose bits could work free and cause serious injury.

• Insert bits all the way into the collet and retract them about 1/8″ to avoid transferring vibrations and heat to the motor armature.

• Listen carefully for sounds of chattering or looseness at start-up. If you hear, see, or suspect problems, turn off the tool immediately, unplug it and check it out thoroughly. Correct the problem before proceeding.

• NEVER try to make your own collet adaptor to hold different sized bits. Balance is very important at high speeds, so always use purchased adapters.

• Keep router bits clean and sharp at all times.

• Attach the routing system to a dust collection system . . . or wear a close-fitting dust mask.

SPECIAL CAUTIONS AND CONSIDERATIONS ON MATERIALS AND TECHNIQUES

Because routers are powerful, high-speed tools with unique performance characteristics, you must pay particular attention to the materials and techniques you are using to avoid mistakes and safety hazards.

• All hardwoods should be worked in light, multiple passes without pausing or dwelling to avoid burning the workpiece. Open grained hardwoods such as oak and similar species will splinter very easily when you reach the end of a cross-grain cut. For this reason, it's always a good idea to either make very light passes, leave extra stock on the width of the workpiece so the splintered area can be cut away or back-up your workpiece with a scrap block at the exit point of the bit. Another good technique to avoid splintering is to make all cross-grain cuts first, then make your cuts with the grain.

• Softer woods such as lauan, basswood, pine and willow can be worked in slightly heavier passes but "tear" or "fuzz" easily and will require more finish sanding.

• Highly figured woods such as birdseyes, crotchwoods and burls have an inconsistency of grain that requires cautious, light passes to produce a clean cut.

• Particleboard and similar composite materials contain high concentrations of glue that can quickly dull high-speed steel bits. Therefore, it is recommended that you always use carbide-tipped or solid carbide bits when working these materials.

• Plastic laminates are very hard materials that can also dull high-speed steel bits quickly. Again, always use carbide-tipped or solid carbide bits when working laminates.

• Avoid pressing hard against the bearing pilots on certain bits during cuts. Since they rotate at such high speeds, excessive friction could cause a heat build-up that will destroy the bearings.

• Again, it's important the stock always be fed **into** the rotating bit and **not with** it to avoid kickbacks.

ROUTING SYSTEM OPERATIONS

You can perform both **overarm** and **under-table** operations with

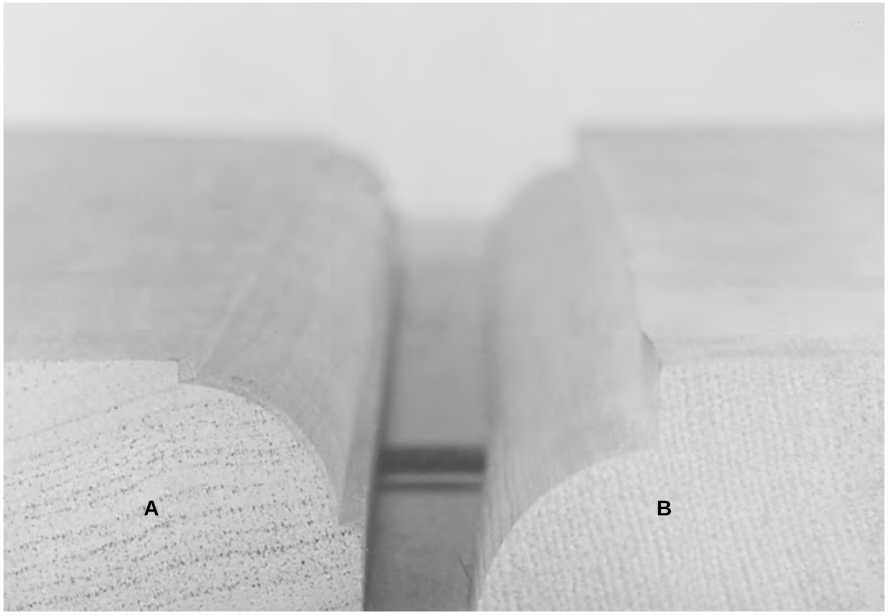


Figure 22-5. Notice that workpiece (A) has only a portion of its edge removed, while workpiece (B) has the entire edge removed.

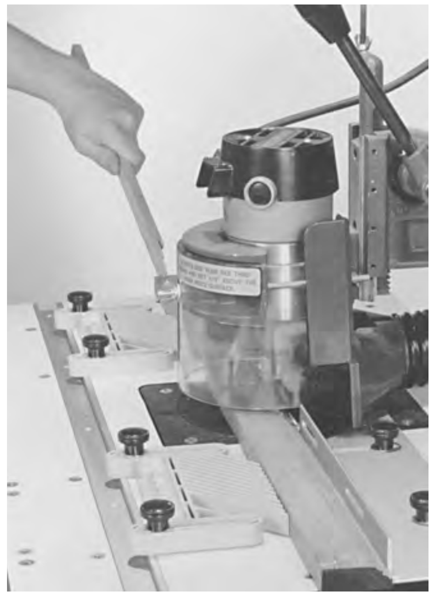


Figure 22-6. When removing the entire edge of a straight workpiece, use a fence to control the depth-of-cut.

your routing system. Overarm operations will be explained first, followed by under-table operations.

EDGING

This process is used most frequently in the construction of furniture and cabinetry. And although the shaper is an excellent tool to use for the job, the high operating speed of the routing system can often produce cuts so smooth that they will seldom require sanding.

To begin, there are two types of edging operations (Figure 22-5).

Full Edge Removal—First, there's the type where the entire edge of the workpiece is removed.

This operation is performed with un-piloted bits and requires the use of a fence (Figure 22-6) or guide pin to limit the depth-of-cut and keep it consistent along the entire edge.

When working projects with straight edges, it's best to use a two-piece fence or a guide strip to control your depth-of-cut.

Remember that if you're using a two-piece fence for this operation, the infeed side of the fence is adjusted to control the depth-of-cut while the outfeed side is adjusted to provide support for the stock after the cut has been made (Figure 22-7).

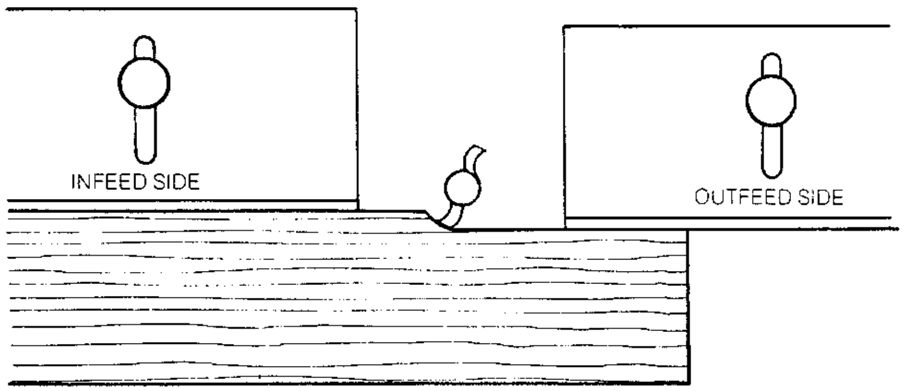


Figure 22-7. Note that during full edge removal, the outfeed side of the two-piece fence is set forward of the infeed side to provide support after the edge has been removed. Note: Offset is exaggerated for clarity.

Keep in mind that in order to remove the entire edge of a workpiece, the bottom cutting edge of the bit will have to protrude below the workpiece.

To perform this operation without routing into the top surface of the table, be sure to position the table so the bit protrudes down through the hole in the table plate or the table insert during operations.

When working against a fence, always make the cross-grain cuts first, followed by the with-the-grain cuts to cut away any tear-outs or splintering. Don't try to make your cuts in a single pass. Always take multiple passes to achieve the cleanest cuts.

When removing an entire edge on a round project such as a plaque or wheel, you can control the depth-of-cut by drilling a shallow hole in the center of your circular workpiece (on the back side) that can be dropped over an offset guide pin or the starter pin and used as a pivot to rotate the stock through the cut (Figure 22-8).

The final way to control the depth-of-cut when removing the entire edge of a workpiece is with a fixture. This process will be explained later in the chapter.

Partial Edge Removal—This is the simplest of all edging operations since it is usually performed with piloted bits that control the depth-of-cut during operations on straight or irregular-shaped workpieces.

If you're using a piloted bit, fences and fixtures are not necessary. Just ease your workpiece into the cut by resting it against the 1/4" starting pin, then guide it against the bearing or solid pilot of the bit (Figure 22-9).

If you want to remove only part of the workpiece edge and have no piloted bits, you will have to use fences to control your depth-of-cut on straight-edged projects.

In those cases where you're using un-piloted bits on circular or irregular-shaped stock, simply use an undersized guide pin to control your depth-of-cut. The guide pin should be centered under your bit during this operation. Then, merely press your stock firmly against the pin as you rotate it through the cut. The depth-of-cut can be changed by altering the size of the guide pin (Figure 22-10).

DECORATIVE SURFACE CUTS

Decorative surface cuts are best described as grooves or patterns formed on the surfaces of workpieces. Some examples might be "carved" house number signs, fancy kitchen trivets and accent cuts on cabinet doors (Figure 22-11).

Usually, decorative cuts are made with un-piloted roundnose, core box, veining or straight bits. As a result, you will need some way to guide your workpiece

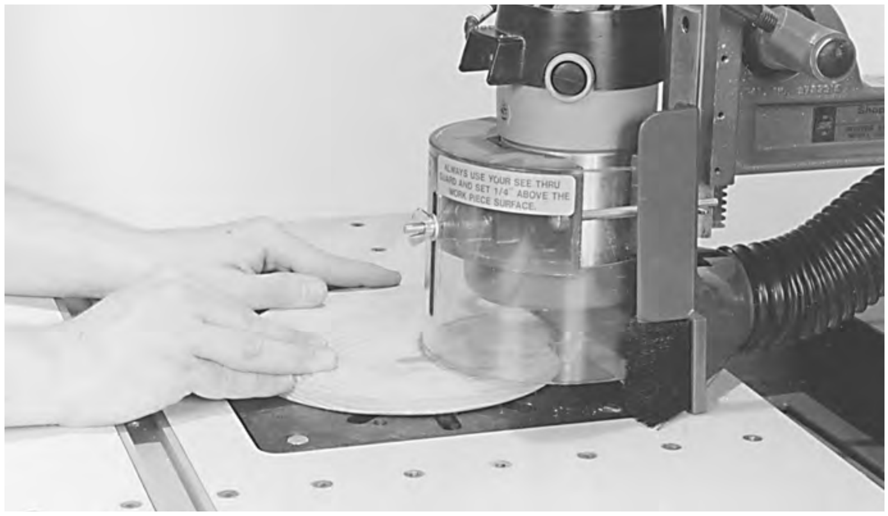


Figure 22-8. *Removing the entire edge on a round project is easiest by using the guide pin or starter pin as a central pivot point and rotating your workpiece through the cut.*

Figure 22-9. *When removing the partial edge with a piloted bit, rest the workpiece against the 1/4" starting pin and ease the stock into the rotating bit.*

Figure 22-10. *When decorating the partial edge of an irregular-shaped workpiece with an un-piloted bit, simply guide your stock against a guide pin that's been aligned with the router bit.*

through the cuts. If your designs are straight and parallel with the edges of the workpiece, use the two-piece routing system fence. If they're angled across the surface like those on the trivet shown in Figure 22-11, you will have to use a scrap piece of stock as a guiding fixture to "carry" your workpiece through the cuts. Simply attach your workpiece to this piece of stock with double-stick tape or nails. Then, guide this fixture (with your workpiece attached) against the fence to make your cuts (Figure 22-12). ***Warning: If you use nails to attach your stock to the guiding fixture, be sure they are not in the path of the bit.***

You can also use un-piloted edging bits such as an ogee or corner rounding bit to form fancy grooves in workpiece surfaces with shaped cuts on both the left and right of the bit (Figure 22-13). This technique can be used quite effectively to produce raised panel-looking cabinet doors from a solid piece of stock.

If you're cutting grooves on the surfaces of round workpieces, you can use V-shaped fence faces (Figure 22-14) to guide the stock or use the pivoting pin technique described earlier under "Full Edge Removal".

When making free-hand decorative cuts on irregular-shaped workpieces, it's important that you take multiple light passes to avoid grabbing and provide improved control.

The most accurate method of forming irregular-shaped decorative cuts is with a guiding fixture. Specific information about making and using fixtures can be found later in this chapter.

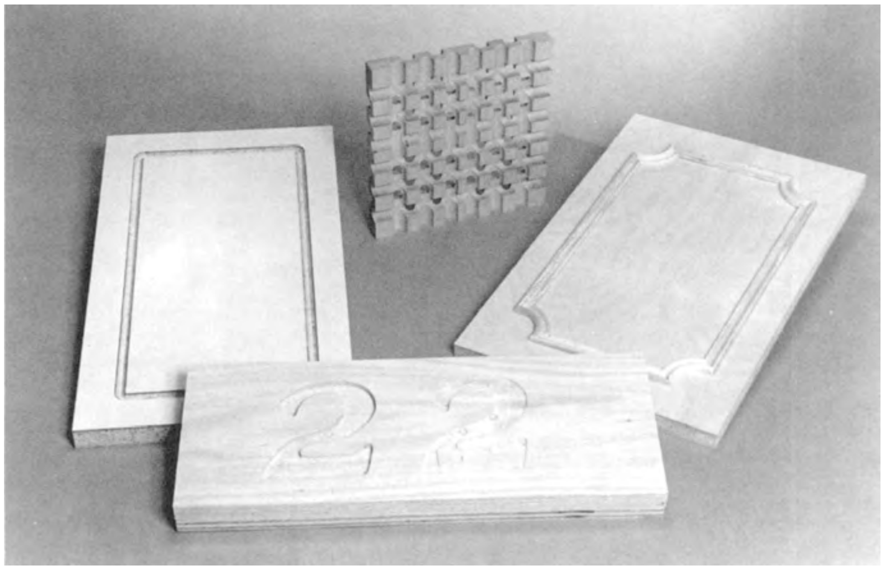


Figure 22-11. *Decorative surface cuts like these are made with the routing system.*

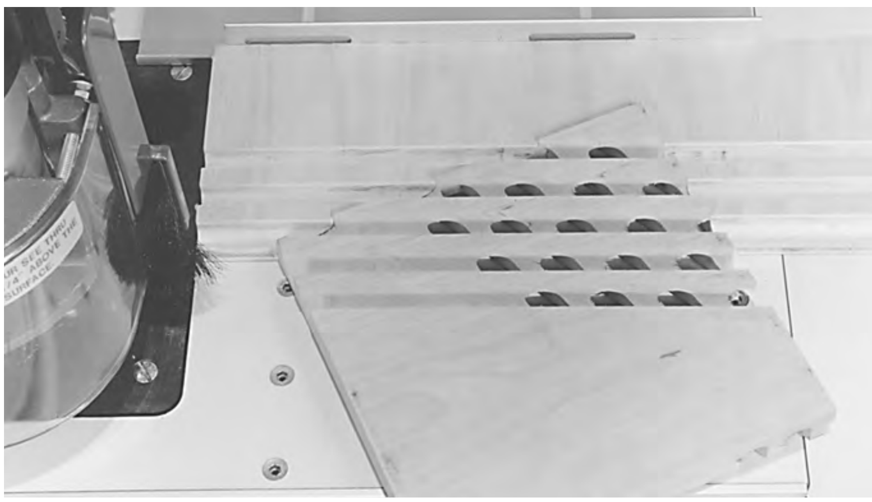


Figure 22-12. *To make straight, diagonal cuts across the surfaces of projects, attach your workpiece to a fixture at an angle and guide it against the fence.*

MOLDINGS

The process of making moldings on the routing system is very similar to the way it is done with the shaper. These finished moldings can be used in many different ways to accent all types of projects (Figure 22-15).

Begin with a piece of stock that is large enough to handle safely. If your finished piece of molding will be straight, simply guide your stock against the pilot of the bit or a fence to form the edge, as you would for edging as explained earlier in this chapter. Shop-made hold-down fences (Figure 22-16) will allow the use of feather boards in providing improved workpiece control during operations (Figure 22-17).

If your finished molding will be curved, first cut out the curved shape on a wide piece of stock (Figure 22-18). Then shape this curved edge on the routing system (Figure 22-19). Remember that if

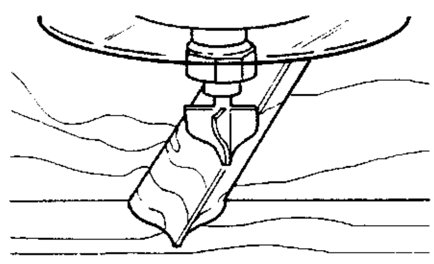
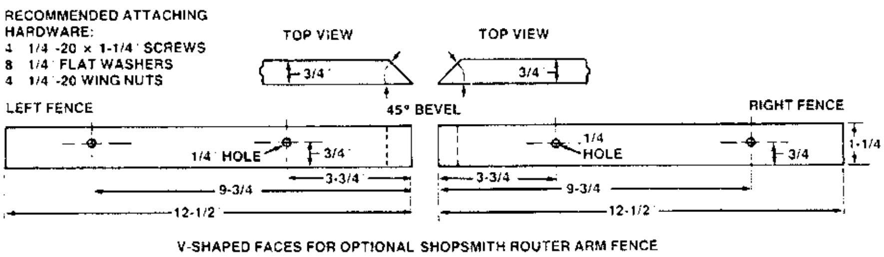


Figure 22-13. *Un-piloted bits like this ogee bit can be used to shape both sides of the groove when making raised panel-looking doors.*

A



B

Figure 22-14. *(A) V-shaped fence faces can be attached to the routing system fence and used to control your cuts when using un-piloted bits to rout round workpieces. (B) Construction details of V-shaped fence faces.*

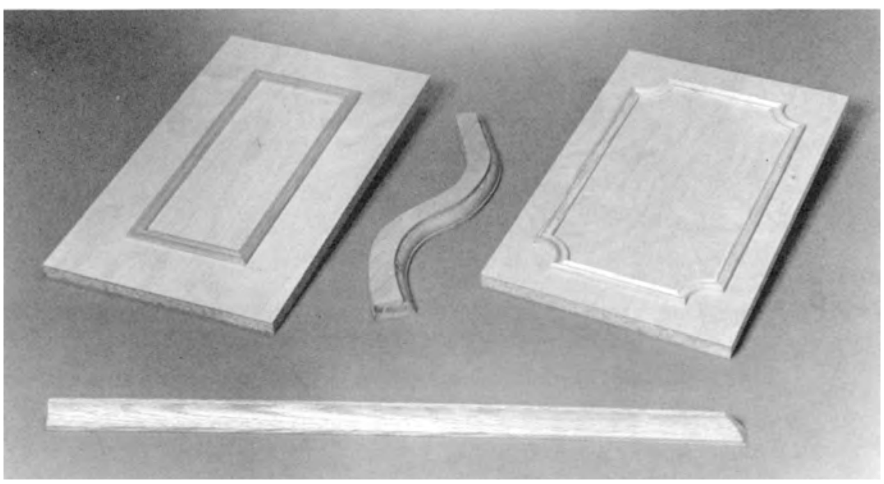


Figure 22-15. *Moldings made with the routing system can be used to accent all types of projects like these.*

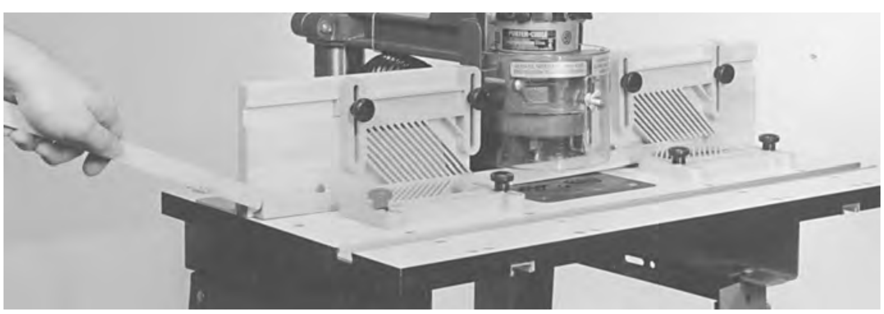


Figure 22-17. *Using the hold-down fences and feather boards to control the workpiece.*

you're using a piloted bit, no fixtures or fences will be required, since the pilot of the bit will control your depth-of-cut during operations. If you're using an un-piloted bit, you will need to use the fence when cutting straight moldings—a fixture (details provided later in this chapter) or an undersized guide pin (as explained under edging earlier in this chapter) when cutting curved moldings.

Once you've formed the shaped edge (curved or straight), simply cut it away from your workpiece using a bandsaw or scroll saw (Figure 22-20) and complete the operation by sanding the edges.

MORTISING

Mortises are most commonly used for joinery in cabinet projects. However, there are other applications such as hinge mortises, inlay

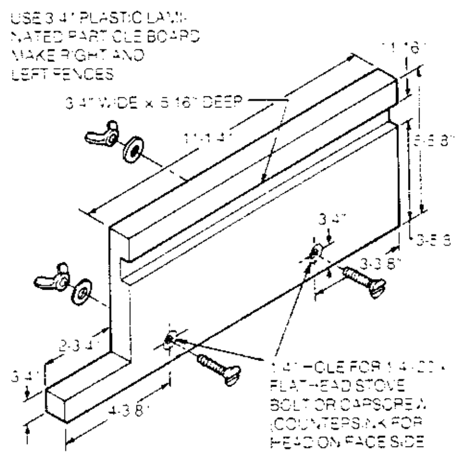


Figure 22-16. *Construction details of the hold-down fences.*

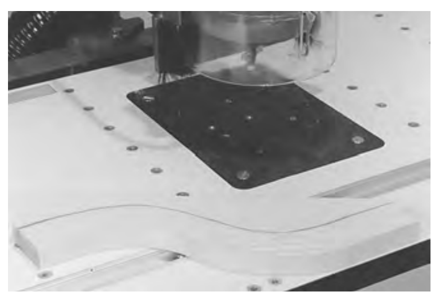


Figure 22-18. *When making curved moldings, first cut out your desired shape on a piece of stock with a bandsaw or scroll saw.*

Figure 22-19. Guide the stock against the piloted bit to shape the curved edge.

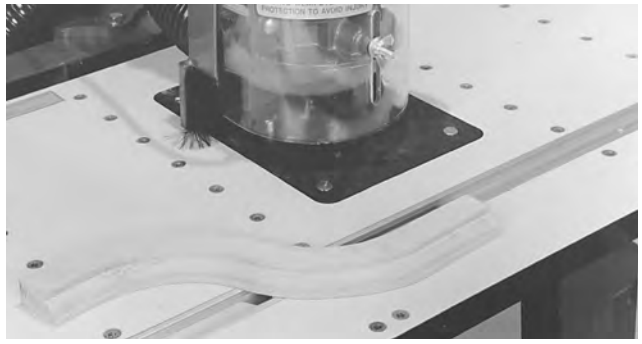


Figure 22-20. Use a bandsaw or scroll saw to cut the shaped edge away from the workpiece.

work and hollowed-out boxes of all types.

Hinge Mortises

As a rule, most hinge mortising is performed with a chisel. And, if you're mortising for hinges on the edges of wide or large doors, this is still the best method because workpieces that are wider (or thicker) than 12″ will not fit between the table surface and the router bit. However, if you have a lot of mortises to cut in the surfaces of cabinet doors or similar projects, the routing system can make them quickly and accurately.

First, locate the positions of the hinges on the door surfaces and mark them very carefully. If you're working with small doors or box lids, simple shop-made fence extensions and stops can be attached to the routing system fence to limit your cuts in both directions. Make the fence extensions and stops as shown in Figure 22-21. When working with larger doors or lids that extend beyond the edges of the table, simply clamp the stops to the door or lid itself (Figure 22-22).

Measure the thickness of the hinge very carefully. Make your initial cuts with the smallest diameter straight bit you have so the corners will be as close to square as possible. Set the depth-of-cut of your bit to match the thickness of your hinge and make a test pass

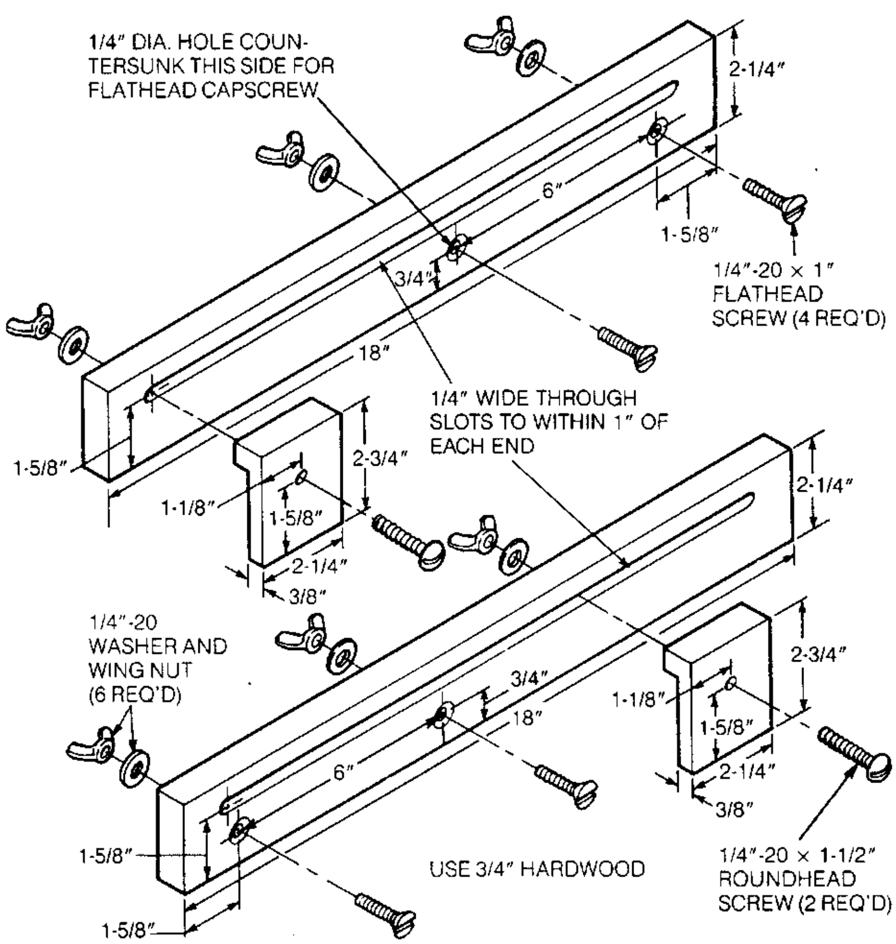


Figure 22-21. Construction details of special fence extensions and stops that can be attached to the routing system fence to help limit and control stopped cuts.

on a piece of scrap to verify the proper depth-of-cut.

Make all the cuts around the outer edges of your mortise (full depth) with the small bit (Figure 22-23). Then, remove the remainder of the stock from your mortise by changing to a larger diameter bit or by rocking your workpiece back and forth against the small diameter bit, using the stops and the fence extensions to limit your cuts. When you've finished, square all corners with a chisel and insert your hinges.

If you're cutting mortises for odd-shaped hinges or hardware, it's often best to do this free hand.

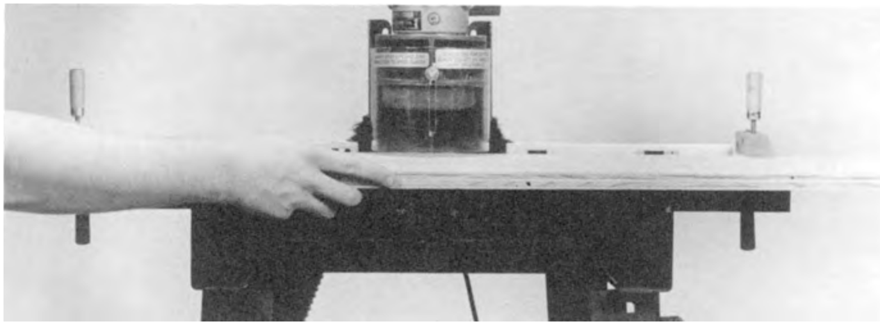


Figure 22-22. *When working large doors or box lids, clamp the stops directly to the door or lid to limit your cuts.*

Figure 22-23. *First, cut around the edges of your mortise with a small diameter straight bit. Then remove the remainder of the stock with a larger diameter straight bit.*

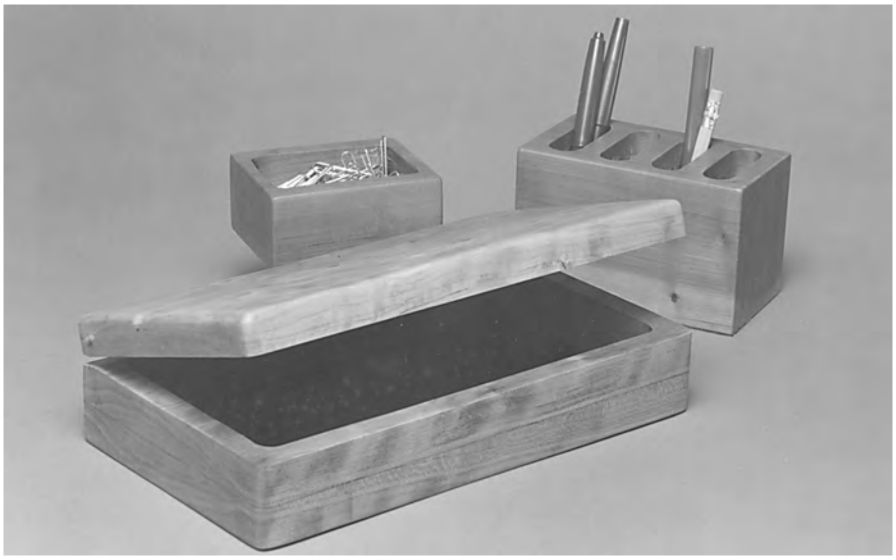


Figure 22-24. *Mortised-out boxes like these are easy to make with the routing system.*

Figure 22-25. *When a great deal of stock must be removed from a mortise, begin by drilling over-lapping holes on the drill press.*

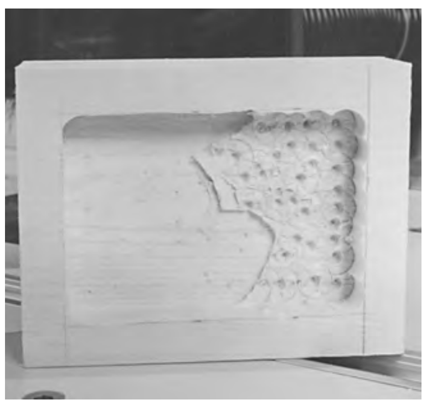


Figure 22-26. *Once the stock has been removed from the center of the box, clean-up the edges with a router bit.*

First, trace the outline of the hinge onto your workpiece. Then, carefully rout away the stock in the center of your mortise, being sure to stay about 1/16″ to 1/8″ away from the outer cutline. Finally, rout away the remainder of the stock to complete your mortise. *Note:* Trace the profile of the mortise onto your workpiece with a razor knife. Then, darken the line with a pencil. As you make your final cuts to the profiled edge of the mortise, the router bit will turn up a fuzzy wood burr at the edge of the cut that will fall off as the bit reaches the line.

Making Mortised Boxes

The routing system is perfect for making all types of mortised-out boxes for jewelry, pencils, etc. (Figure 22-24).

The techniques used here are very similar to those used for mortising hinges. However, since boxes usually require that a lot of stock be removed, it is suggested that you start by doing this with brad-point bits or forstner bits on the drill press (Figure 22-25).

When you have finished this process, cut out the scrap with a bench chisel and clean-up the edges and bottom with a router bit (Figure 22-26).

For this job, you can use either a straight bit or a special 3-in-1 bit, which forms a flat bottom, straight sides and a coved edge where the bottom and sides meet.

To control the cuts, use the fence extensions and stops, much as you would with hinge mortises.

JOINERY

The overarm mode of the routing system is an excellent way to make a wide variety of structural joints for cabinets and furniture projects of all types (Figure 22-27).

The router bit's high operating speed allows it to make cuts that are cleaner than those produced by a table saw. And in some cases (like the mortise for a mortise and tenon), it will perform operations that simply cannot be done on the table saw.

Generally, most joints are formed by using un-piloted straight bits with the workpiece being guided by a fence, miter gauge and/or stops to control and limit the depths-of-cut. This capability provides the advantage of repetition, ensuring that every cut will be identical to the last.

As with other routing system operations, it's often best to back up the exit sides of through cross-grain cuts with scrap blocks (or to allow sufficient extra stock so that some can be removed after the initial cuts are made) to prevent unsightly tear-outs.

In some cases (such as square-cornered mortise and tenons), the corners of the joints will require squaring with a chisel after they've been cut. However, if you're producing a rounded mortise (which is perfectly acceptable in most cases), you'll have to round the ends of the matching tenon with a file or pocketknife to match the mortise. Another option is to cut the tenon shorter so its square corners will slip inside the rounded ends of the mortise.

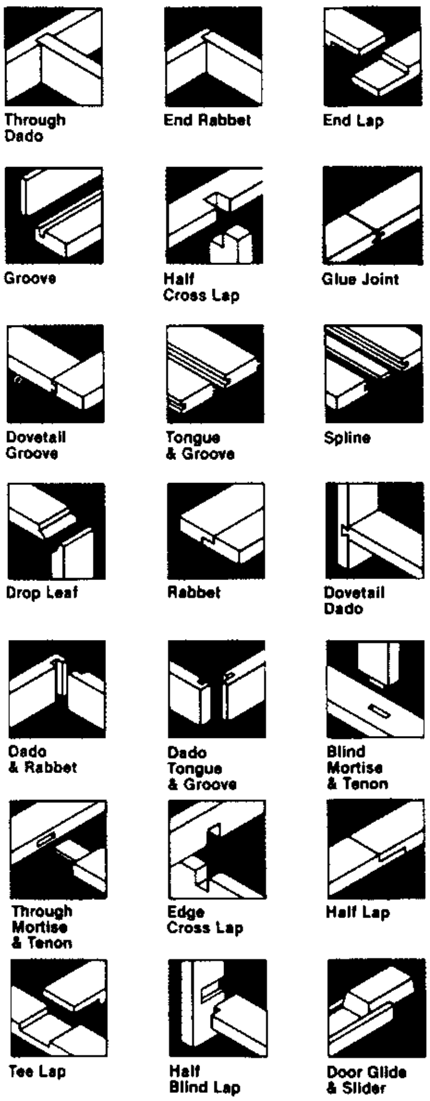


Figure 22-27. Some of the structural joints that can be formed with the routing system.

DUPLICATING

Of all the unique capabilities provided by the overarm mode of the routing system, high-speed duplication of complete projects or project components is the most interesting and challenging.

Through the use of shop-made guiding fixtures, you will be able to make an unlimited number of identical pieces, quickly and accurately.

As we explained briefly in the beginning of this chapter, the process works by guiding a precut fixture over a pin which protrudes up from the routing system table surface. When a bit is installed directly above the pin (and in perfect alignment with it), a matching pattern is cut into a workpiece attached to the opposite side of the fixture (Figure 22-28).

Types and Styles of Fixtures

There are two **types of fixtures** that can be used with the routing system: permanent and temporary.

Permanent Fixtures are more complicated in their design and allow for rapid attachment and removal of workpieces in a repetitive fashion. They are generally used when making five or more of the same project or component.

Temporary Fixtures are usually nothing more than a wooden template of a simple design that is merely screwed to your workpiece. Temporary fixtures often require more time to attach and remove the workpieces than permanent fixtures. This is perfectly acceptable since it makes little sense to spend a lot of time building a complicated fixture that will be used to produce less than five identical projects or components.

When making fixtures, it's important to think about how many

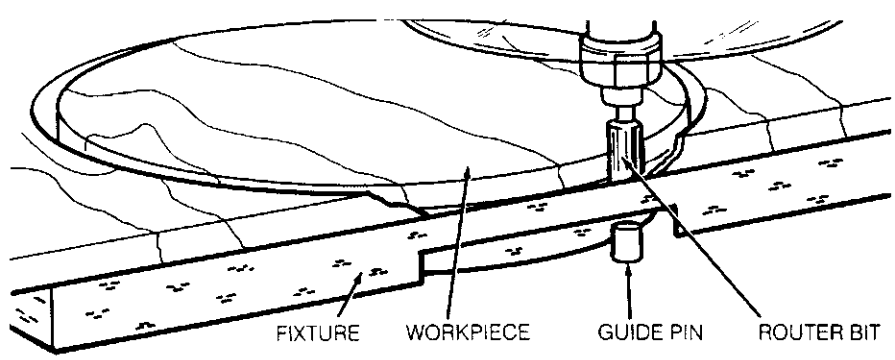


Figure 22-28. Notice how the guide pin rides in a groove on the underside of the fixture to control the cutting of a matching profile in the workpiece attached to the top of the fixture.

times they will be used before deciding how the workpiece will be held in position. If you're planning to make a large number of the same piece, you will want a fixture that allows the rapid attachment and removal of stock. If you're only making one or a few of the same piece, this is less important.

There are a number of different **styles of fixtures**, determined by the way the stock is held in position and whether you are cutting on the outside, inside or both edges of your workpiece:

Screw-on Fixtures (Figure 22-29) are among the simplest in design. With this style, screws are driven up from the underside of the fixture and into the workpiece to hold it firmly in position during operations. If you have a power screwdriver or variable-speed reversible drill with screwdriver bits, this attachment style works equally well for both temporary and permanent fixtures and is a "must" if you are removing the outside edge of your workpiece.

Drive-on Fixtures (Figure 22-30) feature screws driven up through the bottom of the fixture so they protrude 1/8" to 1/4" above the top surface. The workpiece is positioned on top of the fixture and struck with a hammer or your hand to temporarily "impale" it on the protruding screw points. This attachment style is also ideal for either permanent or temporary fixtures and is a good option when removing the outside edge of your workpiece. Always use sheet metal screws for these fixtures, since they have threads all the way down the shank. Once you've driven the screws through the fixture, sharpen the protruding points with a file.

Clamp-in Fixtures (Figure 22-31) are the most complicated style, yet offer the distinct advantage of quick workpiece attachment and removal. Since they require more time to build than any of the other types, they are usually reserved for situations where you will be cutting-out large numbers of the same item. With these fixtures, the stock is clamped firmly in position during operations by a "floating" bar or cam clamp. Since the workpiece is gripped by the edge, this style of fixture will not allow full-depth cuts around the outside perimeter of the stock.

Drop-in Fixtures (Figure 22-32) are made the same way as clamp-in fixtures, but have no bar or clamps to hold the workpiece in position. Instead, the stock is merely dropped into the frame and cut as it would be with a clamp-in fixture. ***Warning: A tight fit of the workpiece is critical to keep it from moving during operations.***

Again, these fixtures are recommended for high-volume situations and **not** for projects where full-depth cuts around the perimeter of the stock are required.

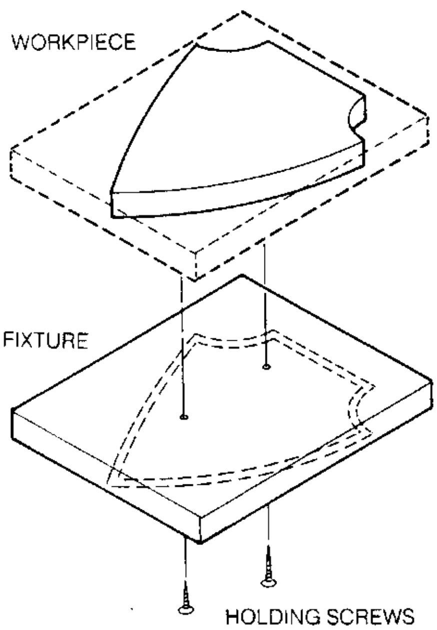


Figure 22-29. *A typical screw-on fixture.*

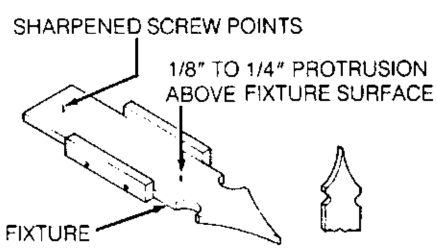


Figure 22-30. *A typical drive-on fixture.*

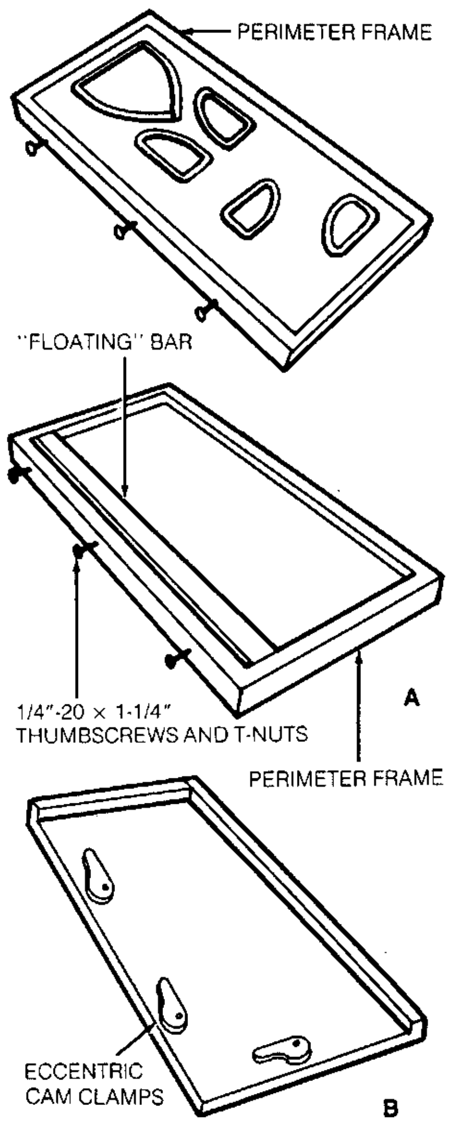


Figure 22-31. *Two typical clamp-in fixtures: (A) floating bar and (B) cam clamp.*

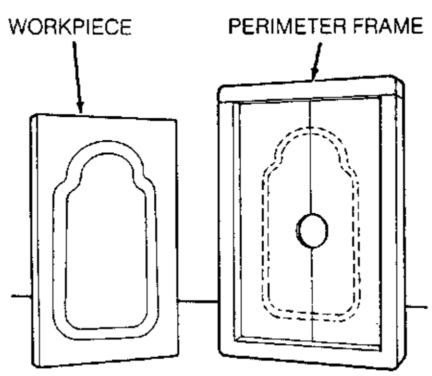


Figure 22-32. *A typical drop-in fixture.*

Profile Fixtures are usually a combination of drive-on and drop-in styles (Figure 22-33). The most common application for these is the making of fence post tops and similar projects. They usually contain sides to help position the workpiece and protruding screw points to keep it from moving during operations. However, they can also be made with floating clamp bars or eccentric clamps, if you like. If the profile is identical on both sides of the workpiece, the fixture can be profiled on one side only and the stock flipped over to cut the second side.

Double-Stick Tape Fixtures (Figure 22-34) are very simple to make and work very well when the workpiece must be cut around the perimeter and is too thin to grip from below with screws. They can be made with readily available double-stick tape and should only be used when the stock is large enough to hold firmly in position with your hands a safe distance from the rotating bit. They are intended primarily for low-volume production jobs. ***Warning: Change tape frequently, since wood dust and repeated use will cause its adhesive qualities to fail after a few uses.***

BUILDING FIXTURES

For reasons of durability, most fixtures are made from particleboard or other similar materials that are covered with plastic laminate. These materials will withstand long periods of continuous use without wearing down and changing the profile of your pattern. This type of material is readily available from cabinet shops and hardware stores as cut-outs for sinks from countertops and is usually very inexpensive.

If laminate covered particleboard is not available in your area, it is suggested that you use hardwoods such as oak, maple or cherry . . . or a high-quality ply-

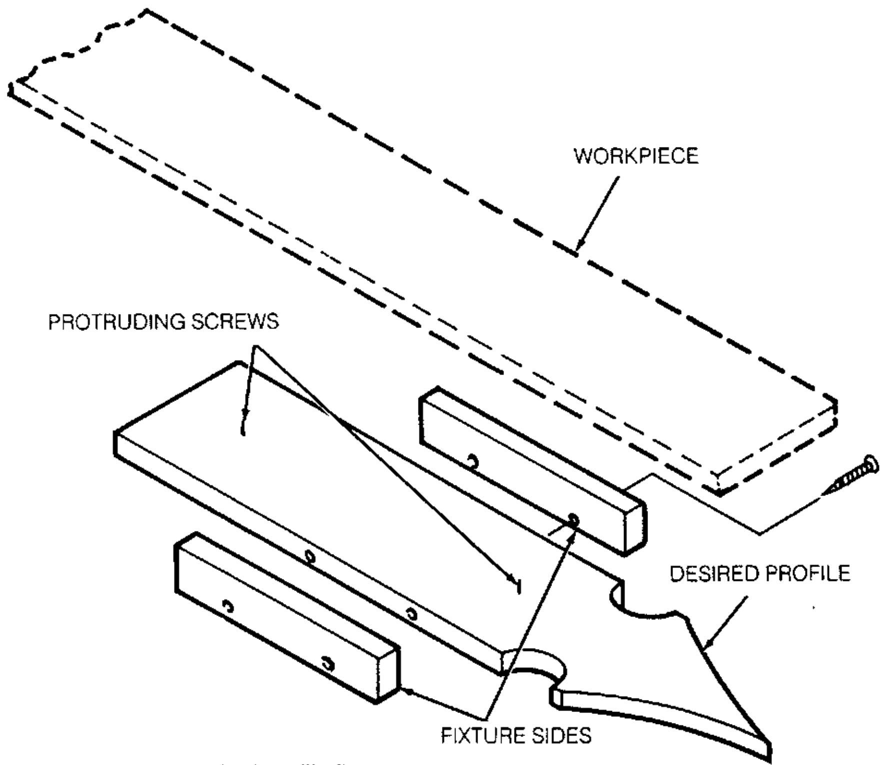


***Figure 22-33.** A typical profile fixture.*

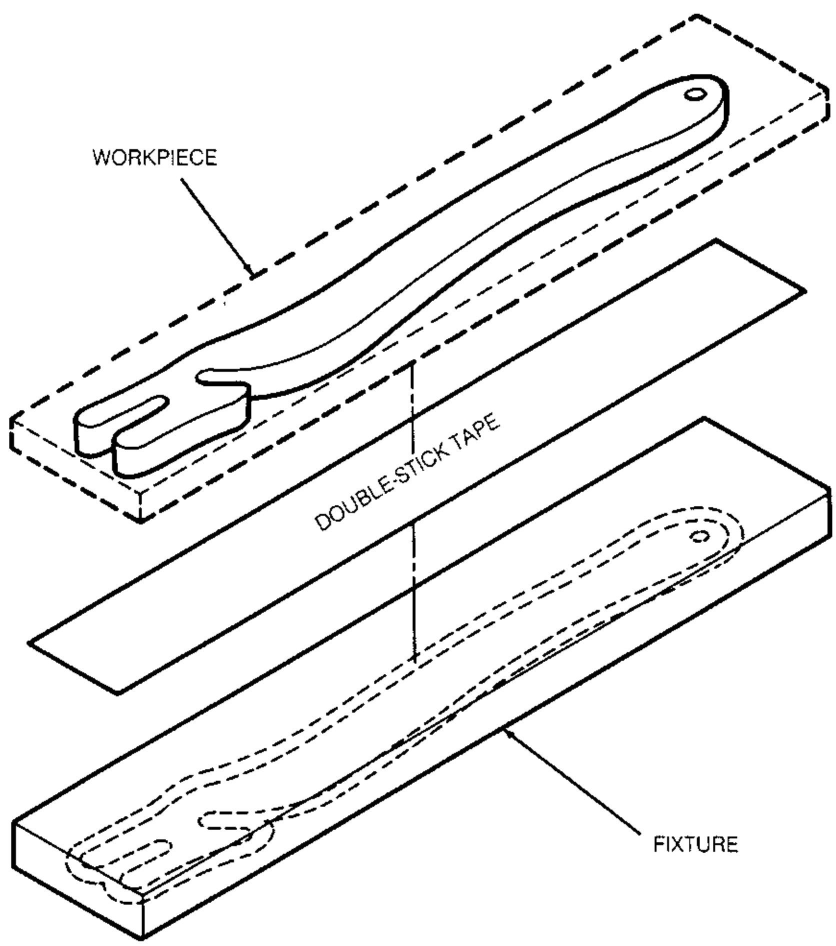


***Figure 22-34.** A typical double-stick tape fixture.*

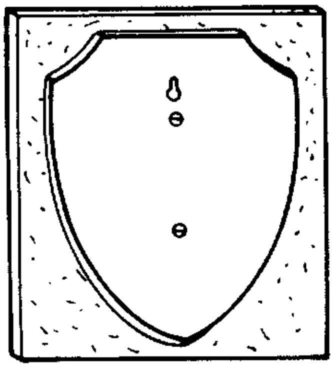


Figure 22-35. Use screws or nails to attach the item to be duplicated to the particleboard side of your fixture blank.

wood without any "voids" or holes in the edge grain. Remember, the key to building a long-lasting fixture is to make it with durable materials that will withstand long periods of continuous use without wearing and altering your desired profile.

There are two basic ways to build routing system fixtures: using an existing product or using a template.

Using An Existing Product— The first and easiest way to do this is to start with an existing product and use it as a template to guide your bit through the process of cutting the grooves in your fixture blank.

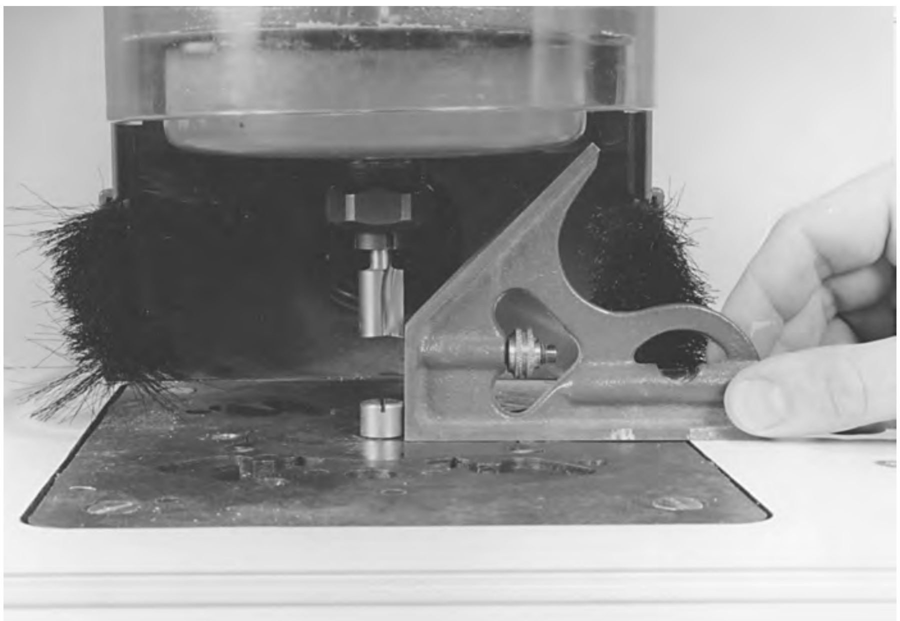


Figure 22-36. Use the base of a combination square to check bit-to-pin alignment at three points 90° apart.

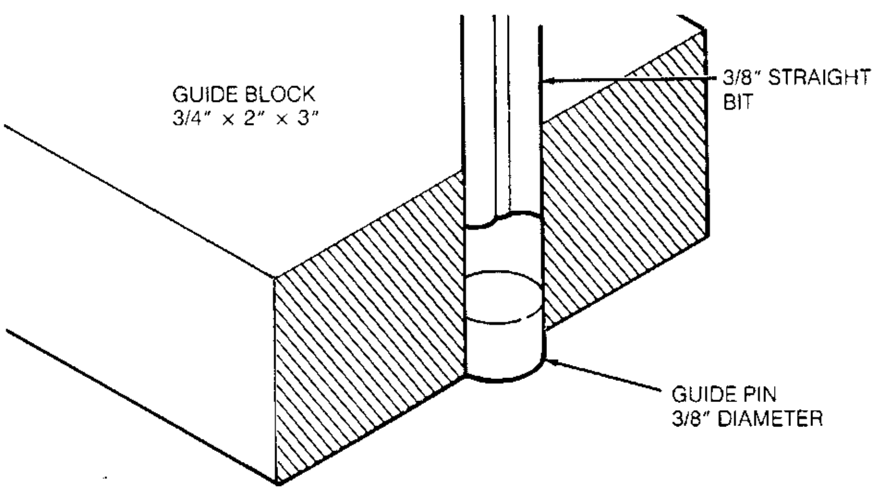


Figure 22-37. Make a 3/4" thick guide block with a through hole of the same diameter as the bit and pin you will be using. Use this block to align the bit and pin.

To begin, cut out a fixture blank that is 1" to 2" larger than the dimensions of your item. Start by drilling countersunk pilot holes for the holding screws in the existing item. Then, attach the item to be duplicated to the particleboard side of your fixture blank with screws or nails (Figure 22-35). Be sure to position the attaching screws or nails in a location where they will not be seen or be in the path of the router bit when you make your cuts.

Next, select the size straight bit you will be using to make your profile cuts (usually a 3/8" straight carbide bit) and thread the matching pin into the center hole of the pin insert in the table. Align the pin and bit **perfectly** by using the base of a combination square (Figure 22-36) or a guide block with a same size (3/8" in this case) through-hole (Figure 22-37).

Once the machine is aligned properly, set the depth-stop rod to make a cut about 3/8" deep in the surface of the fixture.

Turn the fixture over with the product to be duplicated on the bottom and start your router motor. Slide the fixture forward until the guide pin touches the edge of the product and lower the rotating bit into the laminate material about 1/8". Twist the quill feed handle to lock it into position.

Guide the product around its profile (against the rotation of the bit), being sure to always maintain contact with the guide pin during operations (Figure 22-38). Repeat this process two more times until you have cut your groove in the laminate surface of your fixture to a depth of about 7/16" to 1/2". Remove the existing product from the fixture. To make duplicates of this product, simply screw a blank workpiece to the

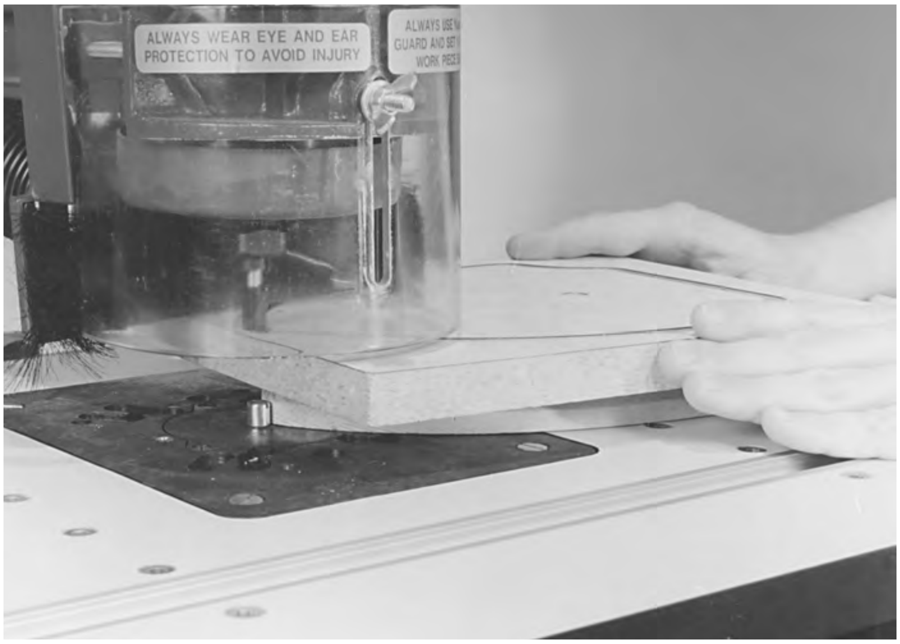


Figure 22-38. *Run the edge of the product against the guide pin to cut a matching groove in the laminate side of your fixture.*

particleboard side of the fixture, drop the groove in the laminate side of the fixture over the protruding table pin, and make your profile cuts. It's that simple! *Note:* By cutting another groove (shown with broken lines in Figure 22-29) in the fixture, you can also cut out a plaque-shaped picture frame, as well as a smaller plaque, all at once.

Using A Template—A template is a wood or plastic shape that is mounted to the fixture blank and used as a guide to cut the grooves in the fixture blank when making a fixture.

To make a template, first trace the desired shape onto a piece of stiff paper or cardboard to create a pattern (a pattern is the paper or cardboard "master" of your shape that is then traced or glued onto the template blank).

Then, cut out the shape of the design and trace the pattern onto a 1/2" thick piece of plywood or plastic. Once the pattern is traced onto the template blank, cut out the shape with a scroll saw, bandsaw or sabre saw. Remember that the grooves in your fixture will only be as smooth and perfect as the template you use to cut them with . . . so take extra care in cutting out and sanding the template so that it's as perfect as possible. *Note:* When building or working with intricate-shaped projects, it's a good idea to use the original template to trace the pattern of your project on your workpiece (or, when making your fixture, on the top side of the fixture) so you can clearly see each area as it is being cut.

Next, use screws or nails to affix the completed template to the particleboard side of a fixture blank that is slightly larger than the design. ***Warning: Be careful not to locate screws or nails in the path of your bit.***

Insert and align the matching bit and guide pin. When cutting out designs with tight curves, you may have to use a bit and pin combination that is smaller than 3/8".

Turn your fixture over with the template on the bottom, set the depth-of-cut as described earlier and turn on the router motor.

Ease your pattern towards the pin until it makes contact, lower the rotating bit into the laminate side of the fixture and cut the grooves to a depth of about 7/16", as described previously for making a fixture from an existing product.

If your template is intricate with lots of cut-outs, you will have to move your bit from cut-out to cut-out, raising and lowering the bit for each one. *Note:* If a cut-out is wider than the diameter of the pin and bit you are using, you must always maintain firm pressure against the pin while you guide the template through the cuts. If you allow the fixture to switch from one side of the cut-out to the other during operations, your fixture groove will become wider than the bit and could cause a loss of precision and a rough cut when duplicating your workpieces.

Important Tips on Building Fixtures

Screw-on Fixtures—*Caution: Be sure to countersink all screw heads on the laminate side of your fixture so it will glide smoothly across the routing system table without marring the table surface.*

Warning: Be certain all hold-down screws are located in areas that are not in the path of the router bit.

Drive-on Fixtures—Once the screws are positioned in the fixture, sharpen the points with a file to make it easier for them to grip your workpiece.

To ease insertion and removal of workpieces, drill a 1" diameter hole in the fixture bottom (away from the path of the router bit during cutting) to allow you to push the workpiece out after it is cut.

Clamp-in Fixtures—After you have cut the guiding grooves in the fixture base, attach 3/4" thick side and end rails to the base with screws and glue. Be sure the sides stick up above the base the same distance as the thickness of your project workpiece.

If your fixture has a floating bar to hold your workpiece, use T-nuts set into counterbored recesses and thumbscrews to apply adequate pressure against the floating clamp bar to hold the workpiece during operations (Figure 22-39).

An alternative to the floating bar clamping system is eccentric cams that can be rotated 1/2 turn or less to grip the workpiece firmly (Figure 22-40).

Drop-in Fixtures—For extra holding power, you can add protruding drive-on screw points to drop-in fixtures.

To ease insertion and removal of workpieces, drill a 1″ diameter hole in the fixture bottom (away from the path of the router bit during cutting) to allow you to push the workpiece out after it is cut.

All Fixtures—When making a fixture that contains small areas where all stock is to be removed (and the scrap will not be held in position by screws), remove all stock from this area on the fixture, as well. This will allow you to rout out the entire area in shallow passes and prevent the scrap from grabbing when you cut out your workpiece.

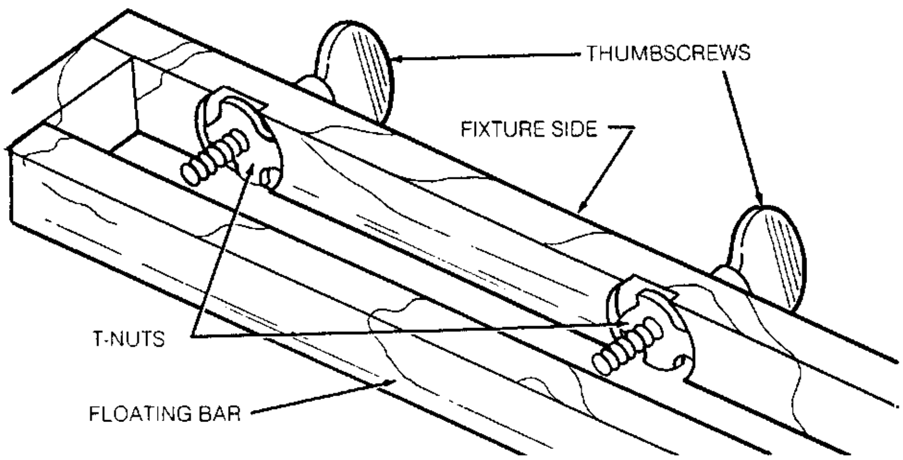


Figure 22-39. Use T-Nuts and thumbscrews to apply pressure against the floating bar which secures your workpiece in the clamp-in fixtures.

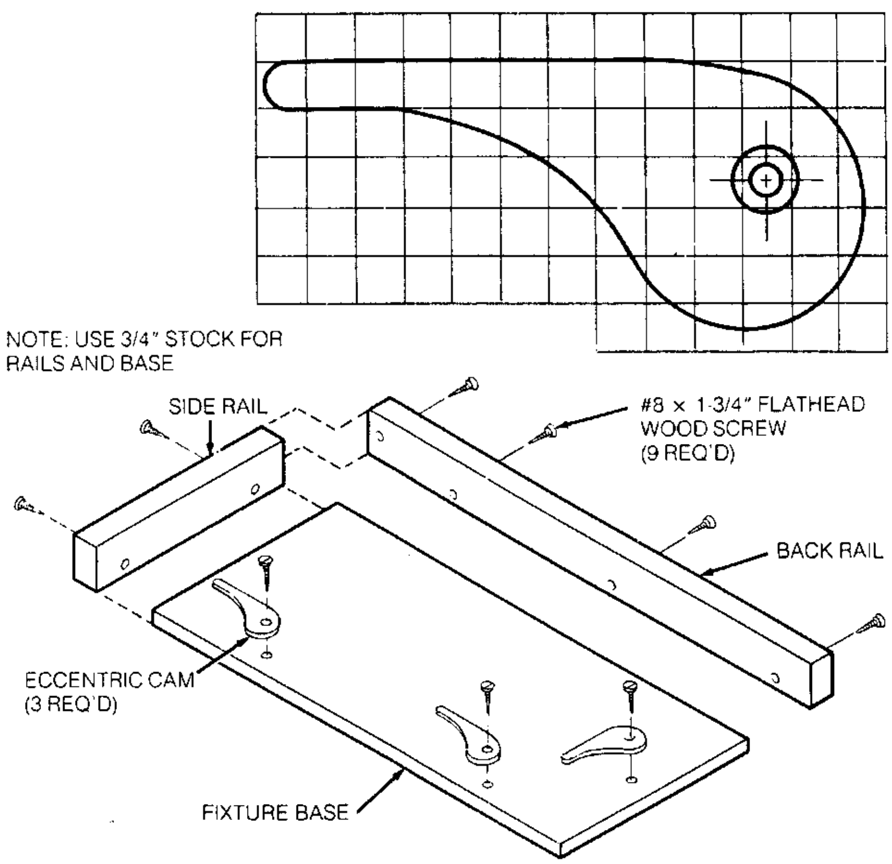


Figure 22-40. Using eccentric cams to hold a workpiece in a fixture.

Valuable Tips for Working with Fixtures

- Wax the laminate side of fixtures frequently to help them glide smoothly over the table surface.
- Clean the sawdust and debris out of the pattern grooves of your fixture occasionally to prevent jamming and help keep the fixture operating smoothly.
- If a fixture is expected to be used in a production environment for making a large number of the same item, use your original "master" fixture to make one or two more fixtures before it has a chance to wear out and lose its accuracy.
- When cutting out workpieces with a fixture, never allow your bit to cut into the particleboard side of the fixture more than 1/32″ to 1/16″.
- If you occasionally need to reduce the size of a project made on a fixture by a small amount, this can be done by using a smaller guide pin and a larger bit when cutting out your workpiece. Remember to work carefully and always guide your stock against the outside edges of your fixture grooves when doing this.
- If the edges of your project must be shaped after the profile is cut out, this can be done with the workpiece still attached to the fixture by merely switching bits (Figure 22-41). By changing to a smaller guide pin, you can alter the profile of your decorative

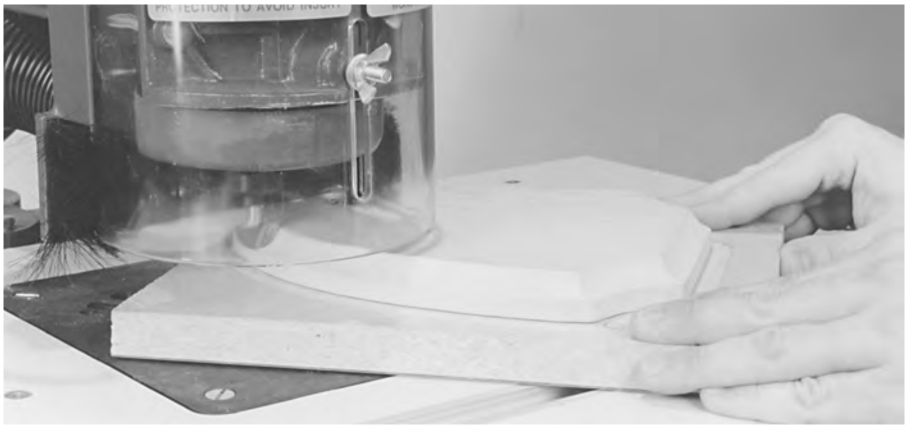


Figure 22-41. By changing to an edge cutting bit, you can use your fixture to shape the edges of a workpiece after it is cut out.

cut . . . but remember to always guide your fixture against either the outside or the inside edges of the grooves during this entire operation. If you switch groove sides in mid-cut, you will change the shape of your decorative cut.

• If you will be making a large number of the same project with shaped edges, it's a good idea to make several identical fixtures so you won't have to keep changing from a straight bit (for making cut-outs) to a profiled bit (for shaping the edges).

REPAIRING FURNITURE AND VENEERS

The routing system is the ideal tool for repairing damaged furniture and veneers (Figure 22-42) . . . if the damaged piece is small enough to work on the surface of the table.

To accomplish this task, first rout out the area to be repaired by guiding the damaged piece against a fence. Be sure to use a straight bit large enough to remove an area slightly larger than the damage (Figure 22-43).

If you're working with a solid wood piece, cut all the way through the stock to form an elongated hole in the wood. If you're repairing a veneered area, be careful to cut no deeper than the veneer.

If you have cut a through-hole in the piece to be repaired, position a piece of wood of approximately the same grain pattern under the hole and trace the shape onto it.

If you have cut only to the depth of the veneer, lay a piece of tracing paper over the cut-out area and trace the shape onto it. Then, using carbon paper, trace the shape onto the piece of stock you plan to use as a plug . . . being careful to make this tracing about 1/32" to 1/16" larger than the actual cut-out.

Next, using a scroll saw or bandsaw, cut the plug out of your workpiece (Figure 22-44).

Using a disc sander with the table tilted about 5°, carefully sand around the edges of your plug. By tilting the table, your plug should be slightly smaller at the bottom than it is at the top. This will allow the plug to drop into the damaged cut-out easily.

Now, test the plug for fit. If it is too large, keep sanding around the edges until it drops into the routed-out area snugly. Once the piece fits, glue it into position.

After the glue has dried, sand off any protruding stock (on both sides) and stain the plug to match (Figure 22-45). If there are any voids left by the taper of the plug on the back side, fill them in with wood putty or plastic wood before staining.

FLUTING

Fluting is a series of decorative cuts that are made with a core box or veining bit to enhance flat-sided or cylindrical posts and legs (Figure 22-46).

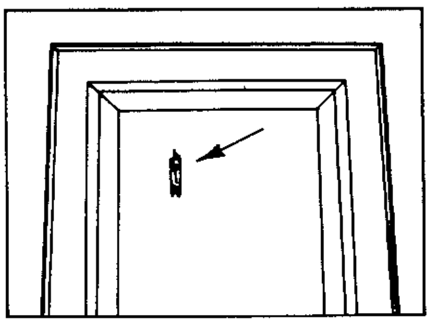


***Figure 22-42.** Damaged furniture or veneers such as this can be easily repaired on the routing system.*

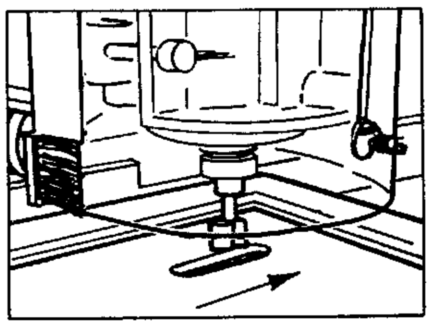


***Figure 22-43.** Using a fence or guide strip, rout out an area slightly larger than the damage.*

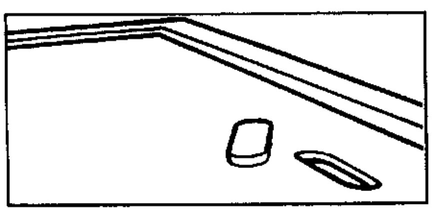


***Figure 22-44.** Make a plug of matching wood to drop into the routed-out area on your damaged piece.*

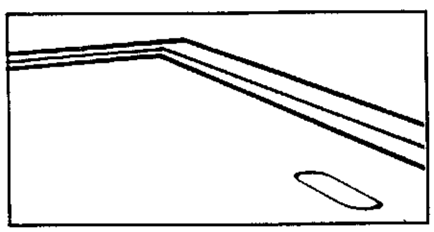


***Figure 22-45.** Drop your plug into position, glue and sand off flush with the surface. Stain to match.*

Flat Sided—Fluting of flat-sided (square, hexagonal, octagonal, etc.) legs and posts is a fairly simple matter.

Begin by setting up the fence and the fence extensions (Figure 22-21) to control the location of the flute. Then, firmly attach the stops to the extension fences to limit the length of the flutes (Figure 22-47).

Install your bit and set the depth stop rod to the depth-of-cut you desire.

Position your workpiece at one end of its intended travel and turn on your router motor. Slowly lower the bit into the stock and slide the workpiece against the fence extensions until the stop stops it. Raise the bit and turn off the router motor. Do not dwell or pause at either end of the cut or you will burn your workpiece.

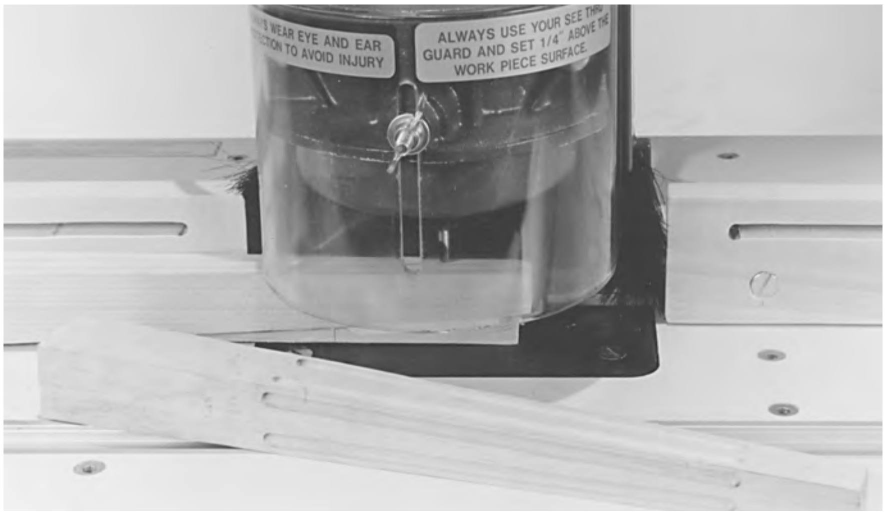


Figure 22-46. Fluting adds an attractive accent to legs or posts.

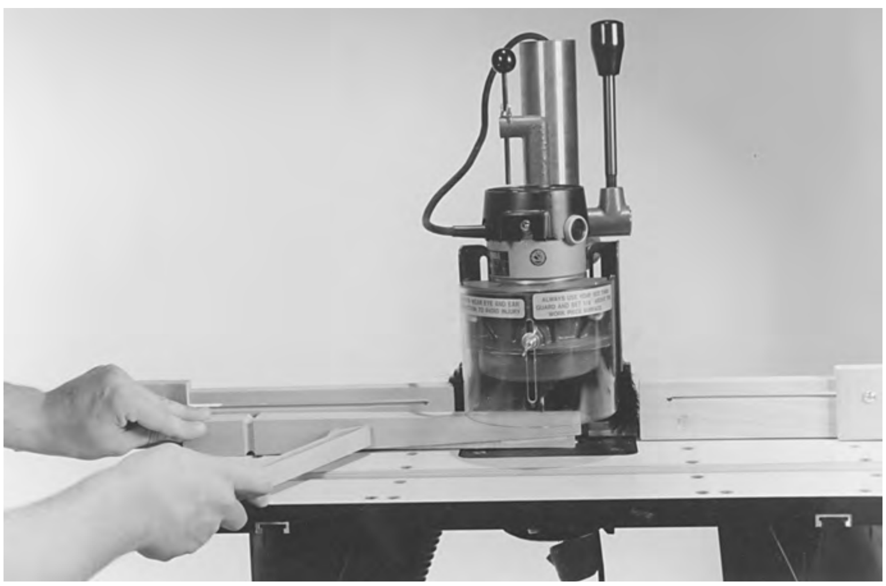


Figure 22-47. Fluting of workpieces with flat surfaces is accomplished by guiding the workpiece against the fence. Use stops to limit the length of the flutes.

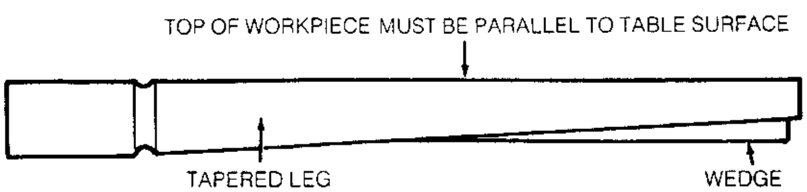


Figure 22-48. When fluting tapered workpieces, cut a wedge to make the top side of your workpiece parallel with the table surface during operations.

Flat-Sided with Taper—Fluting flat-sided legs or posts with a taper is slightly more involved. Begin by cutting a tapered "wedge" to make the top (or working) side of the leg or post parallel to the table surface during operations (Figure 22-48). Temporarily affix the wedge to the flat on the opposite (or bottom) side of the stock that you plan to flute with masking tape or double-sided tape. Place the stops in position and proceed as you would for fluting flat-sided projects.

Cylindrical—If you are planning to flute cylindrical legs or posts, you will need to build a special indexing fixture to hold the workpiece during the cuts (Figure 22-49).

Begin by inserting the workpiece between the two centers of the fixture. The top of the workpiece must be parallel to the table surface. Attach stops to the routing system fence and/or the bottom or sides of the indexing fixture to limit the length of your cuts as described under fluting flat-sided workpieces.

Next, decide how many flutes you want around the circumference of your workpiece. The indexing head is set up to cut up to 24 flutes, 15° apart. If you want eight flutes, simply index the head three holes for each flute, insert the nail, and make your cut. If you want six flutes, index the head four holes for each cut, etc.

Make your passes just as described earlier for fluting flat-sided legs or posts, guiding the fixture with the workpiece in position through each cut (Figure 22-50).

Cylindrical with Taper—If your cylindrical legs or posts are tapered, use a "wedge" between

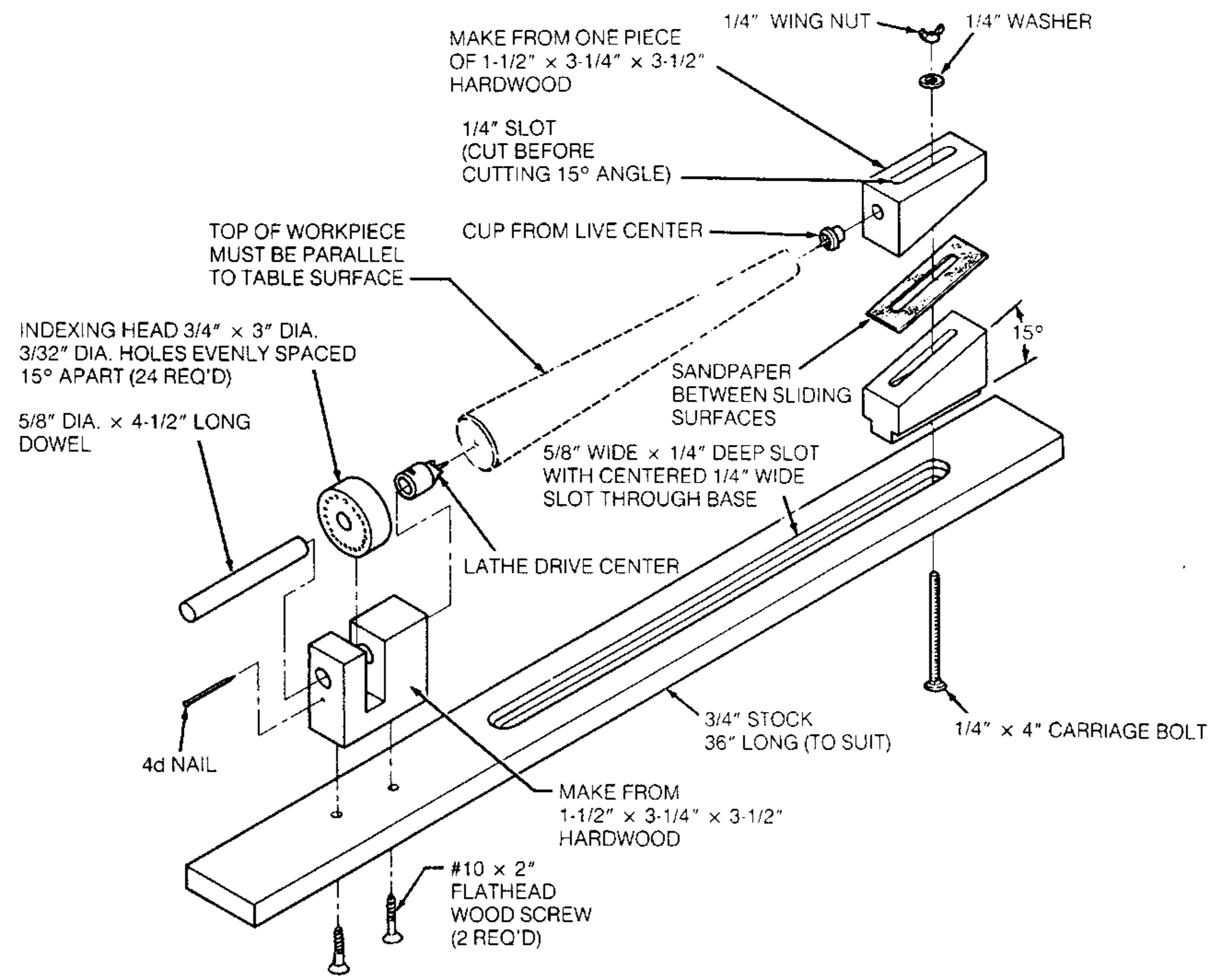


Figure 22-49. *Construction details of a special indexing fixture that is used for fluting cylindrical legs or posts.*

the bottom of the fixture and the table surface, just as you would for fluting flat-sided workpieces with a taper.

USING A DRILL PRESS VISE TO HOLD WORKPIECES

In some cases, you may have a workpiece that cannot be held properly for making cuts on a flat table surface or against a fence. An example of this could be cutting a mortise in a leg using a drill press vise (Figure 22-51).

To accomplish this task, make a sliding table to hold your vise like the one shown in Figure 22-52. Also use the fence extensions and stops (Figure 22-21) to control the length of the cut.

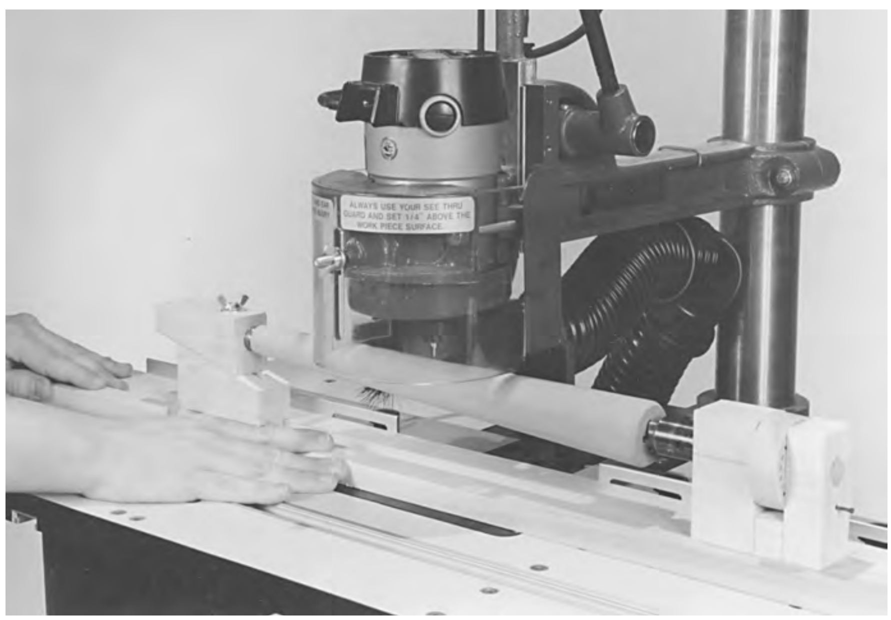


Figure 22-50. *Flute cylindrical legs and posts by guiding the fixture through the cuts with the workpiece mounted firmly between the two centers.*

UNDER-TABLE OPERATIONS

Many of the operations that have been explained in the overarm operations section of this chapter can be performed with equal ease in the under-table mode.

However, because the rotating bit is not always in plain view during under-table routing, extra care should be taken at all times when in the under-table mode.

Warning: Whenever possible, use piloted bits, fence, fence extensions, miter gauge or other guiding devices during under-table routing. NEVER press directly down on top of your workpiece during under-table routing. If your workpiece should break, your hand could slip into the rotating bit, causing serious injury. ALWAYS use a push block, push stick, feather board or other safety device to exert downward pressure on the workpiece during operations. The bit is often not visible during under-table operations, therefore extreme caution is necessary.

Figure 22-51. *A drill press vise is used for gripping workpieces.*

Edging

Although most of the same rules apply to both overarm and under-table edging, the bit is often not visible during under-table routing and therefore, it's even more important that you always use the fence, fence extensions, miter gauge and/or guiding device during under-table operations.

In addition, keep in mind that during under-table routing, the bit is rotating in the opposite direction as during overarm operations. ***Warning: The stock must always be fed from right-to-left during under-table routing.***

Full Edge Removal—Since full edge removal requires the use of an un-piloted bit, under-table edging should be restricted to straight-edged or round workpieces. Either of these can be handled safely with the aid of a fence, miter gauge, or other guiding device.

However, since odd-shaped workpieces cannot be controlled with fences or other devices and the operator cannot always see the cut as it's being made, full edge removal on odd-shaped workpieces should be performed only in the overarm mode and with a proper guiding device. ***Warning: Do not use the under-table mode to remove the full edge from an odd-shaped workpiece.***

Partial Edge Removal—Because of limited bit visibility during operations, partial edge removal in the under-table mode should always be performed with piloted bits or with the aid of a fence, miter gauge, or other guiding device to control the depth-of-cut.

When performing operations on straight-edged or round workpieces, use a fence, V-shaped fence faces or piloted bits. When working with odd-shaped project components, always use piloted bits to control your depth-of-cut.

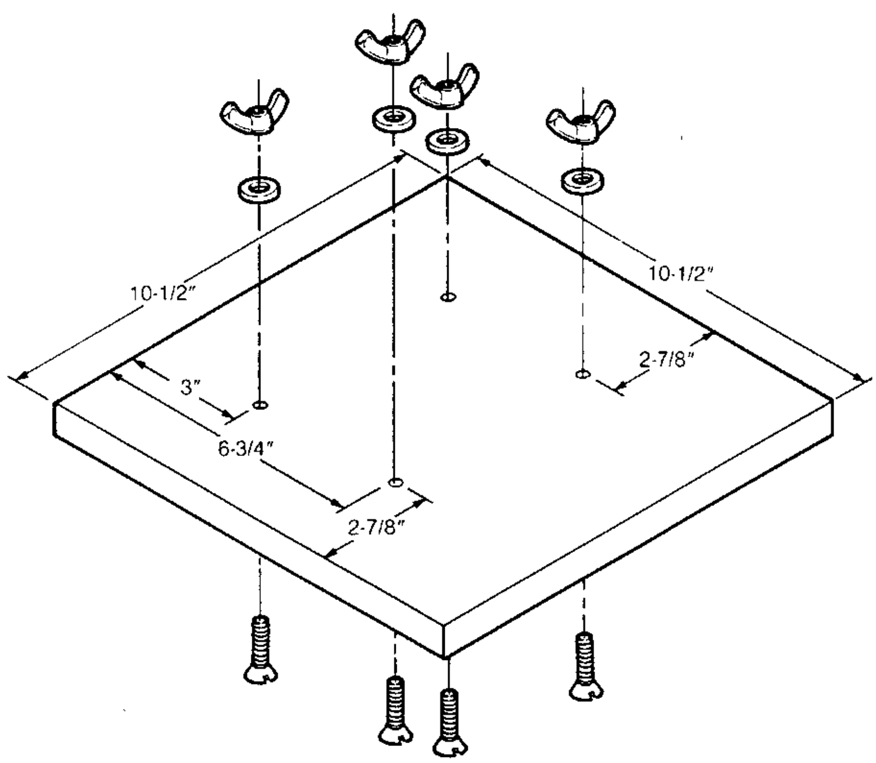


Figure 22-52. *Construction details of a sliding table for a drill press vise.*

Decorative Surface Cuts

If your decorative surface cuts are to be made in a straight line and will go all the way across a workpiece from one side to the other (no stopped cuts), they can be performed in the under-table mode with the aid of a fence, miter gauge or other guiding device.

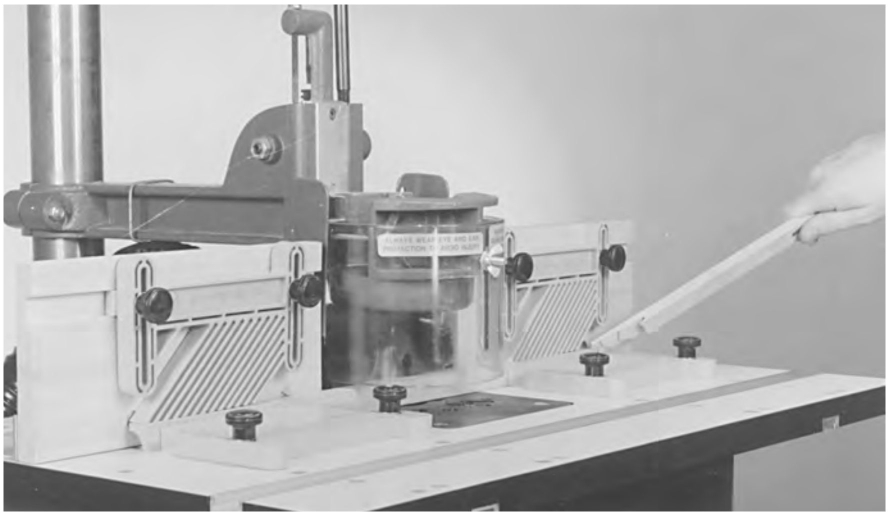


Figure 22-53. For maximum safety, use a setup like this when making small moldings in the under-table mode.

Because of limited visibility, making decorative stopped cuts in the surfaces of workpieces is not advised in the under-table mode of operation. These cuts are best performed in the overarm mode, where the workpiece and bit can both be kept in plain view at all times.

Moldings

The process of making moldings in the under-table mode is very similar to that discussed earlier in this chapter for the overarm mode, with a couple of important exceptions:

First, remember that with under-table operations, the bit pushes up on the workpiece instead of down. Therefore, when cutting straight moldings, the use of feather boards is essential (Figure 22-53). To use feather boards, you will have to construct hold-down fences (Figure 22-16). ***Warning: Be sure your stock is held firmly down against the table surface and inward, against the hold-down fences. With small workpieces, be sure to use shop-made wooden push sticks for added safety. Because the bit is not always in plain view, when making irregular-shaped curved moldings in the under-table mode, always use piloted bits.***

If your curved moldings are round, use V-shaped fence faces like those shown in Figure 22-14.

When making curved moldings, proceed as you would for overarm routing. First, form the edges on an oversized piece of stock. Then, cut your molding away with a scroll saw or bandsaw and sand the sawn edges smooth.

Joinery

With the exception of mortise and tenon joints, virtually all of the structural joints shown in Figure 22-27 can be formed with the routing system in the under-table mode. In fact, some of these joints (such as tongue and groove and splined joints) are actually easier and safer to form in the under-table mode than they are in the overarm mode.

Beyond the basic joints, under-table routing provides the ability to form two very unique joints that would be difficult (if not almost impossible) to form with any other machine. These joints are the false dovetail and the false finger-lap.

Both of these joints are formed by gluing your project together, cutting grooves for contrasting wood "keys" in the corners and gluing the keys into position. Once completed, the corners of your project have the look of dovetails or finger-lap joints.

To cut these unique joints, begin by building a false dovetail fixture like the one shown in Figure 22-54. Note that the dimen-

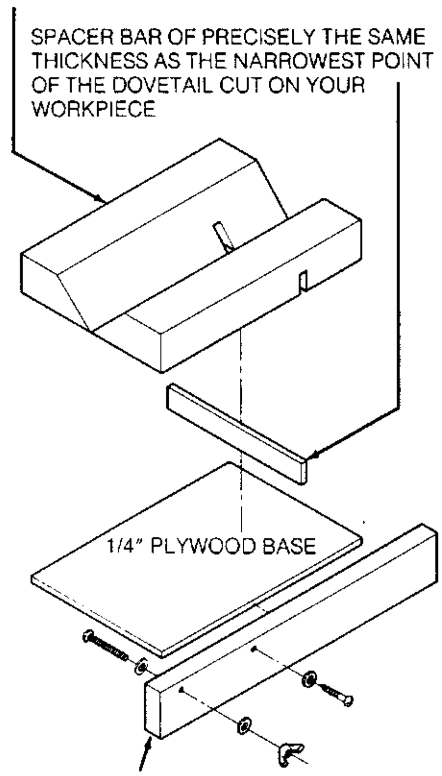


***Figure 22-54.** Construction details of a false dovetail fixture that is used to cut either false dovetails or false finger-lap joints.*

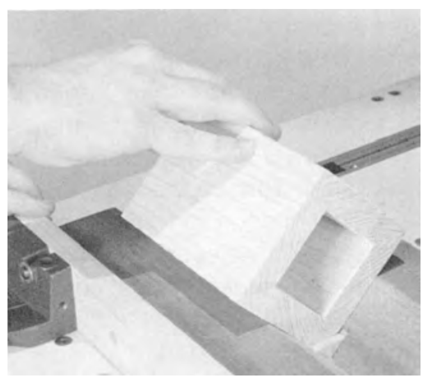


***Figure 22-55.** Start by placing one corner of your project in the fixture with its right side against the spacer bar. Make your first cut.*

Figure 22-56. *Drop the slot you just cut over the spacer bar in the fixture and make your next cut.*

sions for this fixture are based on 1/2″ dovetails spaced 1″ apart. If your dovetails will be larger, smaller, and/or spaced differently, you will have to adjust your fixture accordingly.

Before you can cut the dovetail slots (or square slots, if you're making finger-lap joints), you must first assemble your project with 45° mitered corners and glue it together. ***Warning: Clamp and let glued-up stock dry for at least 24 hours prior to routing.***

After the glue has dried, begin by positioning your project in the fixture with its side against the spacer bar. Turn on the router. Move the miter gauge (with fixture attached and project in position) into the bit to make the first cut (Figure 22-55). Turn off the router.

Return the miter gauge to its starting position. Move the project to the right in the fixture and drop the slot you just cut over the spacer bar (Figure 22-56). Move the miter gauge into the bit again to make the second cut. Repeat the above procedure for all subsequent slots on each corner of your project (Figure 22-57).

Next, make the dovetail "keys" that will slip into the grooves

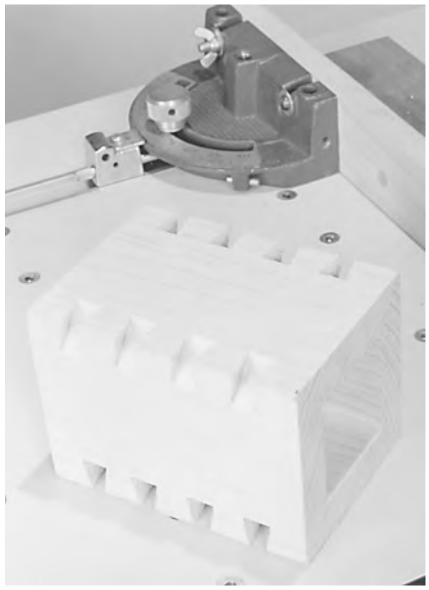


Figure 22-57. *Finish by cutting slots in all four corners of the project.*

you've cut. Begin by choosing a piece of contrasting stock, approximately 3/4″ thick × 3″ wide.

Set up the hold-down fences (Figure 22-16) and feather boards, and adjust the bit's depth-of-cut equal to the depth you cut in your project. Begin by making the first pass on one side of your key stock (Figure 22-58). Now, flip the stock over and make the second pass on the other side (Figure 22-59).

Check to see if the key fits into the slot you've cut in the corners of your project. If it's too snug, adjust your fence to make a slightly deeper cut in your key stock (which will create a narrower key). Keep working with this until the key fits snugly in the slots you have cut.

Next, saw the full-length keys off your key stock, and discard the scrap in the center. Then, cut the keys to about 1″ to 1-1/4″ long.

Spread glue on each side of the keys and insert them into the slots in the corners of your project (Figure 22-60). After they have dried, sand the keys flush with the project (Figure 22-61).

This same process will work for finger-lap joints. Instead of using a dovetail cutter, use a straight 1/4″, 3/8″ or 1/2″ un-piloted bit.

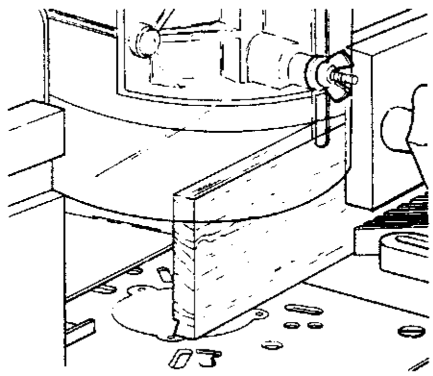


Figure 22-58. *Guide your key stock along the fences to make your first cut for the keys.*

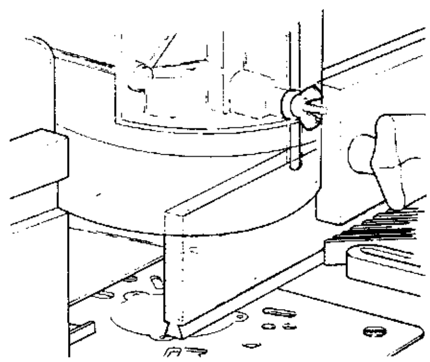


Figure 22-59. *Flip the stock over and make the second pass to finish cutting the key shape in your workpiece.*

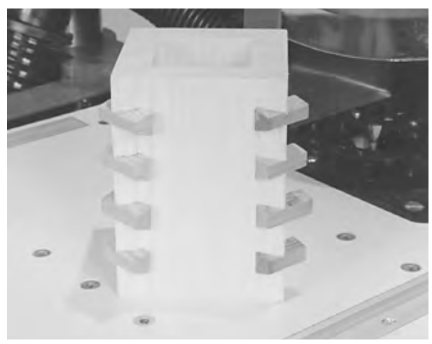


Figure 22-60. *Glue the keys into the slots in the corners of your project.*

Figure 22-61. *Sand the keys flush with the project.*

Chapter 23
Biscuit Joiner

Most woodworking projects require at least some assembly. This is especially true for projects such as tables, cabinets or bookcases where wide panels must first be built up from several narrow boards.

Traditionally, woodworkers have used dowels for these assemblies. As you might expect, dowels add strength to certain types of joints, but they serve an equally important function by keeping the pieces properly aligned during assembly and gluing. The major drawback with doweling, however, is that each hole must be perfectly positioned or the individual pieces simply won't go together. Even a slight error can cause a lot of pounding and frustration.

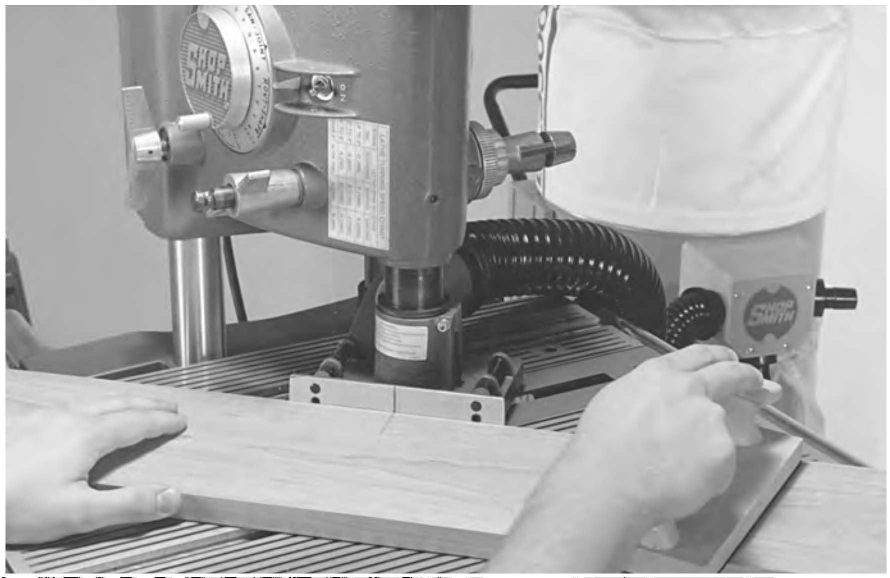


Figure 23-1. The biscuit joiner is powered by the Mark V's powerplant and can be used with either the Model 500 or Model 510.

During the 1950's a new assembly system called biscuit joinery was developed in Europe. This system uses flat wooden wafers or biscuits which are glued into semi-elliptical slots on each side of the joint. Due to the shape of the biscuits, the exact location of the slot is much less critical than a dowel hole. Minor adjustments can even be made during assembly, so projects go together much more quickly and yet there is no sacrifice in strength or overall performance. That's why biscuit joinery is rapidly becoming the preferred assembly system for professional furniture and cabinet makers worldwide.

In addition to its advantages for panel assembly, biscuit joinery can often be used to replace more complicated and time consuming techniques including spline, tongue-and-groove, mortise-and-tenon and dado joints.

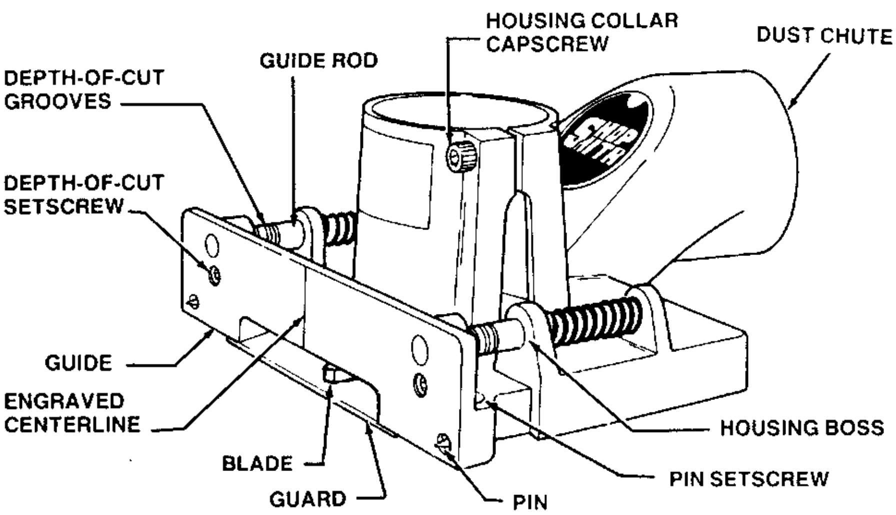


Figure 23-2. Familarize yourself with these important features of the Shopsmith biscuit joiner.

BISCUIT JOINER— SETUP AND FEATURES

The biscuit joiner housing attaches to the quill and the blade arbor attaches to the main power spindle of the Mark V's powerplant (Figure 23-1). It may be used with either the Mark V Model 500 or Model 510. Follow the setup instructions in the Owners Manual that came with your biscuit joiner.

Some of the important features (Figure 23-2) and capacities of your biscuit joiner are:

• Spring-loaded workpiece guide and safety guard help improve operator confidence and safety.

• Engraved centerline on guide permits easy alignment of workpiece.

• Adjustable depth stops and guide rod grooves permit easy use of three different biscuit sizes (#0, #10 and #20) for a variety of applications.

• Adjustable pins in guide penetrate stock to provide more positive control and reduce kick-backs.

• Carbide-tipped blade will provide years of normal service without sharpening.

• Built-in dust chute for easy attachment of standard 2-1/2″ dust collection hoses.

BISCUIT SIZES AND CONSTRUCTION

Shopsmith biscuits are produced from select grades of beech. For maximum strength, the grain is oriented at a 45° angle to the long axis of the biscuit. During production, biscuits are exposed to many tons of pressure which compresses the fibers and produces a waffle-like surface for better glue absorption and adhesion.

When glue is applied to the biscuits, the moisture in the glue causes the biscuits to expand by about 15% of their original thickness and the joint becomes tight. Since this expansion occurs very quickly, glue should never be applied to the biscuits until you are ready for final assembly. Biscuits should also be protected against water or extremely high humidity. A coffee can with a tight fitting lid makes a good storage container.

Biscuits are available in three different sizes to meet a variety of applications (Figure 23-3). All biscuits are 5/32″ thick.

#0 biscuits are 1-3/4″ × 5/8″. They are best for joining smaller workpieces and for edge-to-edge assemblies where high stress is not anticipated. They are also useful for joining narrow pieces such as cabinet frames end-to-edge.

#10 biscuits are 2-1/8″ × 3/4″. They are recommended for general purpose joinery on all types of projects.

#20 biscuits are 2-3/8″ × 1″. They are recommended for use on larger projects or joints—such as a table skirt and leg—which will be subject to high stress or twisting forces. They also provide greater penetration and a larger gluing surface, so they are well suited for plywood or particle board applications.

BISCUIT JOINER SAFETY

Read, understand and follow all safety and operating instructions in the Owners Manuals that came with the Biscuit Joiner and with the MARK V on which it is mounted.

• Wear safety goggles, safety glasses with side shields or a full face shield.

• Tuck long hair under a hat or tie it up. Do not wear ties, gloves, jewelry or loose clothing. Roll sleeves up above your elbows. Wear non-slip footwear.

• Before mounting the biscuit joiner on the Shopsmith MARK V, turn on the MARK V and set the speed dial to SLOW. Then turn off and unplug the machine before proceeding.

• When mounting the biscuit joiner on the MARK V, be certain all locking screws are tightened securely before turning on the machine.

• Be sure the blade is mounted in the biscuit joiner with the teeth pointing in the direction of the arrows on top the housing. Installing the blade backwards will result in kickbacks and injury.

• Connect a dust collection system to the biscuit joiner dust chute or wear a dust mask.

• Do not allow anyone to stand directly in front of the opening of the dust chute.

• Move the workpiece slowly into the blade—never force it. Feeding stock too rapidly could cause kickbacks.

• Do not stand directly in-line with the workpiece being fed. In the event of a kickback, you will be hit.

• Do not rest fingers in the miter gauge slots where they could be trapped and pinched by kicked back stock.

• Always use the push block in your right hand to feed stock into the blade. This is especially important when working with small stock.

• Use your miter gauge and/or rip fence as a stop when working with stock less than 6″ long or wide.

• Always be certain the pins protrude from the guide before beginning operations. Failure to do this could result in the workpiece being grabbed and thrown by the rotating blade.

• Listen for chatter and signs of looseness at start-up. If you hear, see or suspect problems, turn off the power and unplug the machine immediately. Correct any problems before proceeding.

• Never use the biscuit joiner for jobs it is not intended to

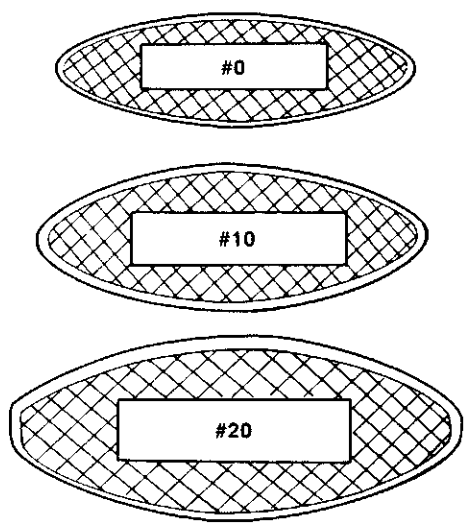


***Figure 23-3.** The three available biscuits are shown here actual size.*

Figure 23-4. Mark centerlines on both pieces of stock to assure proper alignment.

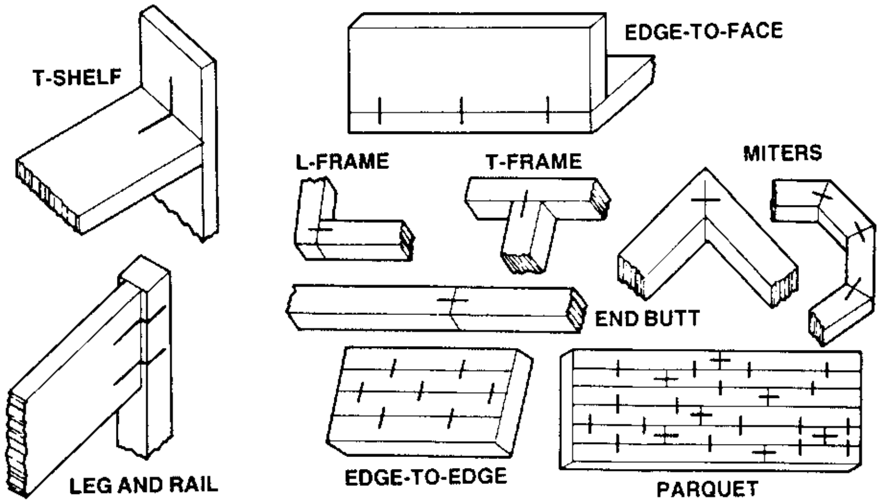


Figure 23-5. Here you see typical centerline markings for various types of joints.

perform such as sawing, grooving, etc.

- **Never exceed speed setting "T" on the MARK V's speed dial for biscuit joiner operations.**
- **Never attempt to use the biscuit joiner on stock less than 3/8″ thick.**
- **Never operate the biscuit joiner without the housing and guard in position.**
- **Always keep the blade clean and sharp.**
- **Use only Shopsmith blades and parts for your biscuit joiner. Using non-Shopsmith blades or parts will create a hazardous condition and will void your warranty.**

BASIC BISCUIT JOINERY TECHNIQUES

Marking Joints— The only marking normally required for biscuit joinery is to indicate the centerline for each biscuit's location. These markings are usually made on the back side of the stock and may be made with a square (Figure 23-4) or freehand. Marked centerlines are then aligned with the engraved centerline on the biscuit joiner guide while quill and worktable adjustments are then used to control the biscuit's vertical position. Figure 23-5 shows typical markings for various types of joints.

Basic Adjustments and Cuts— After mounting the biscuit joiner on the Mark V (Figure 23-6) and establishing a basic setup as shown in the biscuit joiner Owners Manual, several adjustments must be made before using the accessory. These basic procedures apply to all types of joints, so review these steps before each biscuit joiner operation.

Begin by selecting the size biscuit you will be using and set the depth-of-cut accordingly. This is done by unplugging the Mark V and compressing the spring-loaded guide until the desired grooves on the guide rods are even with the biscuit joiner housing. The three grooves in the guide rods indicate the correct settings for #0, #10 and #20 biscuits respectively. Adjust both depth stop setscrews (Figure 23-7), so that the guide cannot retract beyond the desired depth.

Next adjust the two pins in the guide face and lock them firmly in place (Figure 23-8). These pins provide important kickback protection and should penetrate about 1/32″ in hard woods and 1/16″ into softer woods.

When using the Mark V Model 510, position the worktable so the face of the biscuit joiner guide is above the table insert (Figure 23-6). This will keep the leading

Figure 23-6. Attach the biscuit joiner to the quill and tighten the housing collar capscrew. Don't forget to tighten the setscrew which holds the blade arbor to the spindle.

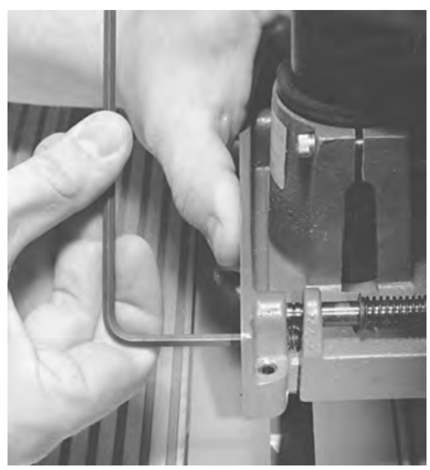


Figure 23-7. Adjust the depth-of-cut setscrews to match the biscuit size being used.

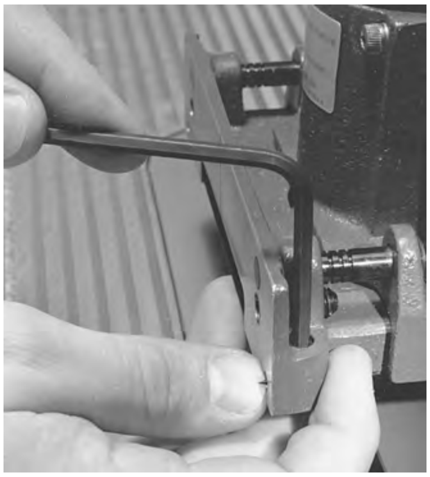


Figure 23-8. Adjust and lock pins to engage work during cuts.

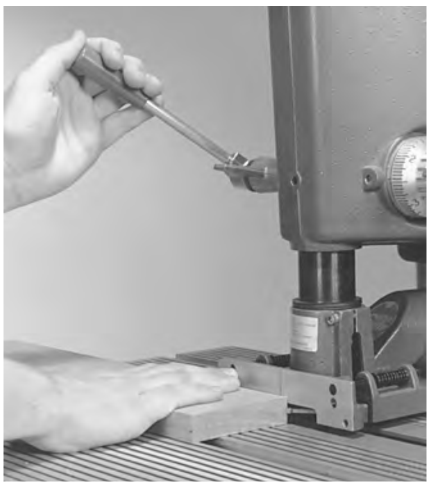


Figure 23-9. Use the quill adjustment to position blade for cut. Allow clearance between biscuit joiner and worktable.

edge of the stock from interfering with the ribs in the worktable surface.

Finally, adjust the height of the biscuit joiner. Press the stock against the joiner fence until the blade is visible and adjust the quill until the blade is at the desired height (Figure 23-9). Normally the biscuit location will be about midway between the top and bottom, but higher or lower positions may occasionally be desirable. The most important factor is that the cuts be at the same height on both pieces of stock. When making these adjustments, the quill should not be extended more than 3″ and be sure to allow clearance between the biscuit joiner arbor and the worktable in order to prevent damage to the table surface.

After all adjustments have been made, turn on the Mark V and set the correct speed. Guide the workpiece with your left hand until the biscuit centerline mark on the stock is aligned with the engraved centerline on the biscuit joiner guide. With a push block in your right hand (Figure 23-10), press the stock slowly against the guide, compressing the springs until the guide reaches the depth stops . . . then retract the stock. Repeat this procedure for each cut on both pieces of stock before changing the setup or height adjustment.

Panel Construction— Panel construction or edge-to-edge joinery is one of the most common woodworking operations. For best results, place the boards face down next to each other and mark biscuit centerlines on the back side. Then cut the biscuit slots and assemble the boards in this face-down position to help assure a flat, smooth final surface.

Typically, allow one biscuit for each foot of length in an edge-to-edge joint, with a minimum of three biscuits. Space the biscuits evenly and position the end biscuits at least 3″ from the ends of the boards so the boards will engage both of the pins in the guide when the biscuit slots are cut.

End Grain and High Stress Joints— Because of the wood's high porosity, end grain joints—such as T-Frame, L-Frame or End Butt—are almost impossible to make with glue alone. Using biscuits will strengthen these joints because the biscuits are glued face-grain-to-face-grain.

For best results, use the largest biscuit available that will allow at least 1/4″ of stock at each end of the biscuit slots. On wide joints, such as a T-shelf, use multiple biscuits, allowing as little as 1/2″ between biscuit slots.

On stock over 1″ thick— especially on high stress joints such as a table leg and skirt—two or more rows of biscuits may be used for added strength (Figure 23-11).

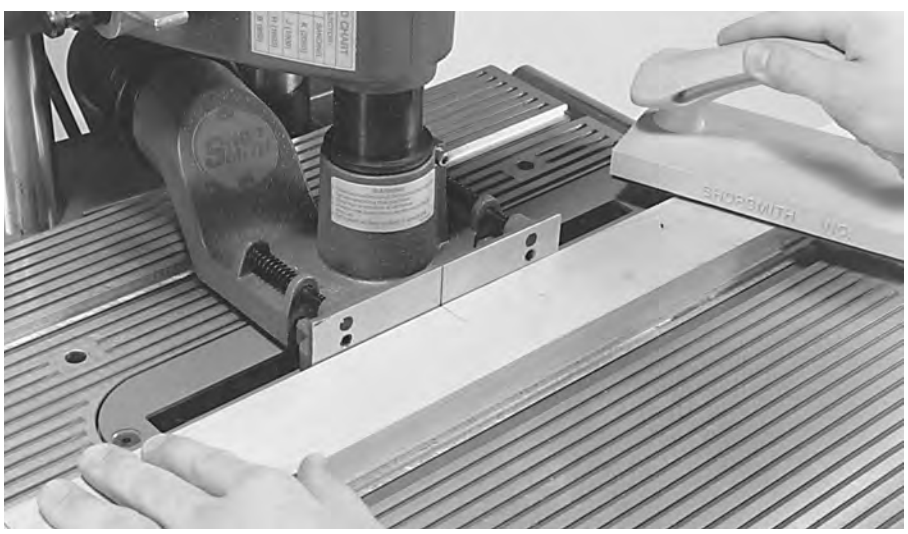


Figure 23-10. Align biscuit centerline with joiner guide and use a push block in your right hand when feeding stock.

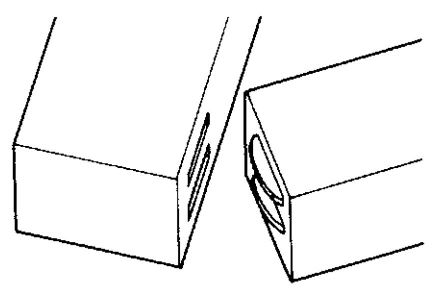


Figure 23-11. On stock more than 1″ thick, two biscuits may be used for added strength.

When joining stock of different thicknesses—such as a 1" thick skirt being joined to a 2" square table leg—a thin piece of scrap wood or hardboard can be used as a shim (Figure 23-12) to eliminate the need to make quill adjustments for each thickness. This assures that the setback will be exactly the same on all joints and that the biscuit slots will be aligned correctly for easy assembly.

Short and Narrow Stock— Workpieces less than 6" in width or length must be handled with special care because the pins in the joiner guide will not engage the stock and a kickback or injury is possible. For these cuts, align the centerlines and lock the miter gauge into the worktable to serve as a guide and stop. Hold the workpiece against the miter gauge face and advance it slowly and firmly into the biscuit joiner (Figure 23-13).

If you are making multiple matching components—such as door frames or rails and stiles for a cabinet front—you can make the setup once and cut all biscuit slots quickly and accurately.

Miter Joints— For corner miters, mount the biscuit joiner so that it faces the front of the Mark V with the guide perpendicular to the miter gauge slots (Figure 23-14). Adjust the worktable so one of the miter gauge slots is under the biscuit joiner and the quill is extended 3" to avoid interference between the safety grip and the Mark V's powerplant. Set your miter gauge to 45° (or to match the angle of the miter), place your workpiece against the miter gauge with the centerlines aligned, and adjust the safety grip to hold the stock securely.

Make the cuts by advancing the miter gauge and stock into the cut together. Do not slide the stock across the miter gauge and into the biscuit joiner as this will not produce an accurate cut. A piece of coarse sandpaper may also be attached to the surface of the biscuit joiner guide to keep the stock from creeping during the cut.

Edge Cuts in Wide Stock— Working with large or wide stock is similar to other edge joining operations, but additional support must be used to give the operator control of the stock for accuracy and safety. This is achieved by mounting the biscuit joiner diagonally, at about a 30° to 50° angle to the miter gauge slots (Figure 23-15). With the Model 510, check your setup to be sure the table height crank doesn't interfere with the stock.

If additional support is needed, use the extension table system

Figure 23-12. *When joining stock of different thicknesses a shim may be used to eliminate adjustments and assure accurate alignment.*

Figure 23-13. *If the stock does not engage both pins, use your miter gauge to maintain control of the workpiece.*

Figure 23-14. *Use your miter gauge to hold and advance the stock on mitered cuts. Do not slide the stock across the miter gauge face.*

Figure 23-15. *When working with large stock, mount the biscuit joiner diagonally for maximum support of the workpiece.*

Figure 23-16. *For surface cuts, adjust the table so it is flush with the biscuit joiner guide when fully depressed.*

(Model 510), a roller stand or a helper to gain control.

Surface Cuts—Surface cuts are necessary for two basic types of joinery: edge-to-face joints, such as along the corner of a cabinet, and T-shelf joints, such as where a shelf joins the sides of a bookcase. Surface cuts require special setups and additional care.

For edge-to-face joints, mount the biscuit joiner with the Mark V in the vertical position. Also lock the worktable vertically with the table edge slightly below the biscuit joiner. With the Mark V unplugged, depress the biscuit joiner guide to the desired depth stop and adjust the worktable until its surface is even with face of the guide (Figure 23-16). Finally, mount the rip fence on the table so that it supports the workpiece at the correct height for the biscuit position.

To make the cuts, tip the top edge of the work slightly away from the table and slide it along the rip fence until one of your centerlines marked on the top edge of the stock is aligned with the engraved centerline on the joiner guide. With a push block in your right hand, tilt the stock slowly back against the worktable. As you do the stock will engage the pins and compress the guide to make the cut (Figure 23-17). Pivot the stock toward you and away from the table before attempting to advance to the next cut.

A T-shelf or similar joint is more difficult because one side of the cut must be made "blind." The accuracy of the joint depends totally on the accuracy of your measurements and setup.

Mount the biscuit joiner with the Mark V in the horizontal position and slide the worktable close to the biscuit joiner. With the Mark V unplugged, depress the joiner guide to the desired depth stop, set the stops, and adjust the Mark V table to match this height (Figure 23-18).

A typical setup is shown in Figure 23-19. In this example, the rip fence on an extension table determines the position of the cut along the length of the stock and the miter gauge locked in its slot determines the position across the width.

After all measurements have been made and checked, hold one end of the stock elevated and place it against the rip fence and miter gauge. With a push block in your right hand, lower the stock slowly until it engages the pins, depresses the guide and finishes the cut. Lift the stock completely before attempting to move to the next cut.

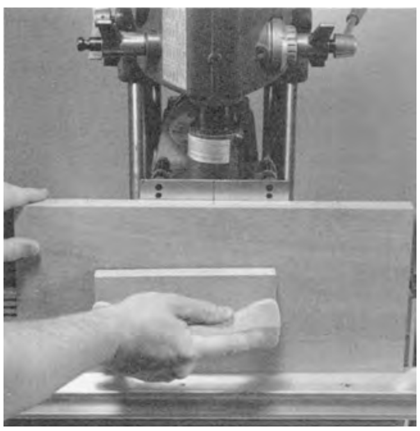


Figure 23-17. *This setup is ideal for surface cuts along the edge of the workpiece.*

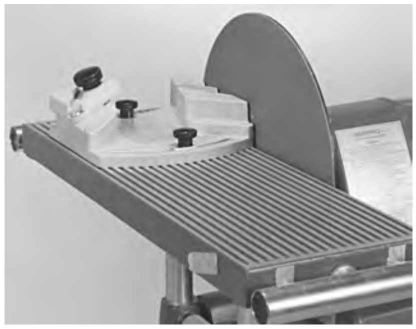
Figure 23-18. *For surface cuts, adjust the table so it is flush with the biscuit joiner guide when fully depressed.*

Figure 23-19. *The rip fence and miter gauge can be used as guides when cutting "blind" biscuits.*

Chapter 24
Sharpening

Sharpening (grinding and honing) woodworking tools is very personal and can be accomplished in many ways—you will sharpen tools the way that works best for you. Tools are **ground** on machines and then **honed** on several types of stones. Grinding eliminates defects in the cutting edge by removing metal from the tool. Honing puts a razor sharp edge on the ground cutting edge of the tool.

This chapter will cover the different ways of grinding and honing many of the basic cutting tools used for woodworking. Because of the diverse nature of woodworking and the thousands of tools available we can not possibly cover everything in just one chapter. For additional sharpening information consult the tool manufacturer or your local library.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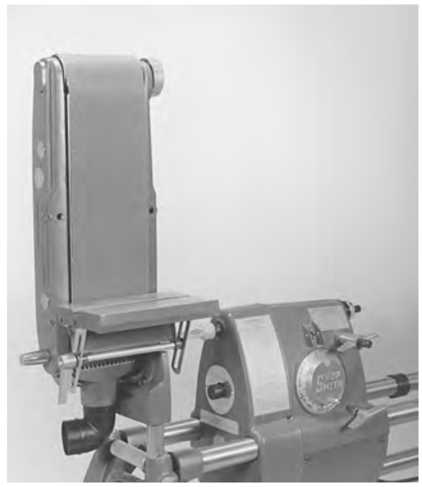
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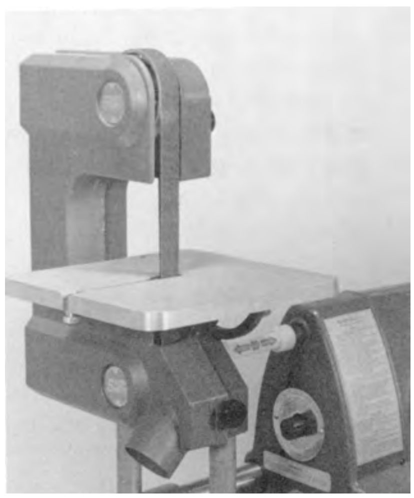
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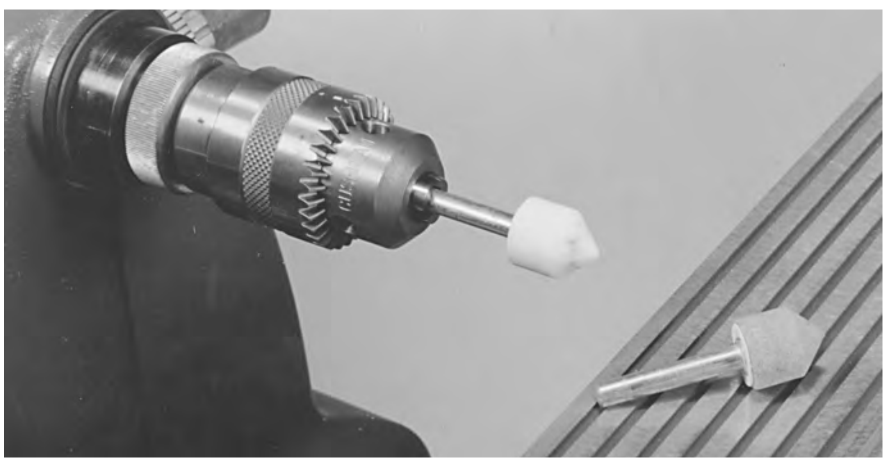
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Figure 24-1. *The machines and accessories used for grinding are: (A) disc sander, (B) belt sander, (C) strip sander, (D) grinding wheel, (E) specialty grinding stones, and the sharpening guide. The sharpening guide which is used with the disc sander, belt sander and strip sander is shown with the disc sander.*

GRINDING MACHINES AND ACCESSORIES

The Shopsmith machines and accessories that we will be using to show the different grinding techniques are the Disc Sander, Belt Sander, Strip Sander, Grinding Wheel, Sharpening Guide, plus specialty grinding stones (Figure 24-1).

The abrasives generally used to perform grinding tasks are: aluminum oxide and silicon carbide for belts and discs used on power sanders, and silicon carbide for wheels used in power grinders.

HONES—CLASSES AND TYPES

Most tools require a razor sharp cutting edge and **must** be honed after grinding. To do this there are four different classes of hones that you can use: oil stones, water stones, rubber bonded abrasives and diamond hones.

As the names imply, oil stones and water stones are used with liquids. The liquids keep the pores of the hone from filling (loading) up and the surface from glazing over. Plus the combination of metal particles and the abrasive forms a paste (swarf) that actually helps the hone cut faster and smoother.

An important difference between hones is their hardness. The hardness dictates the direction that the cutting edge of a narrow or round tool is moved in relationship to the hone.

Oil Stones

There are many types of oil stones ranging from coarse to ultra-fine. The most common types are: silicon carbide (coarse, medium, and fine), aluminum oxide (coarse and medium), and Arkansas (soft is fine and hard is ultra-fine).

The hard oil stones are usually used by moving the cutting edge of the tools into the stone as if you were trying to cut it.

Silicon Carbide (Carborundum®)—Silicon carbide oil stones are the least expensive of any type of stone. They are dark blue-black in color and relatively soft. They will dish and wear away where used frequently. They are very porous and will soak up a lot of oil when new. They are a good general purpose starter stone that, when taken care of, will last a lifetime.

Aluminum Oxide (India)—The aluminum oxide oil stone is a slightly more expensive type of stone. The coarse stone is black and the medium is a reddish-brown. Both are relatively hard and less likely to wear than the silicon carbide stones. They are porous and will soak up some oil when new. This is a fast cutting stone that is easy to use. They are also good general purpose intermediate stones that, when taken care of, will last a lifetime.

Arkansas—The Arkansas oil stone is an expensive but very high quality type of stone. They are the only natural sharpening stones still mined. The soft Arkansas (fine) is usually white with a slight reddish or grey marbling and the hard Arkansas (ultra-fine) is almost always pure white and sometimes looks translucent. They are very hard and not likely to wear but they are fragile and will shatter like glass when dropped. The hard Arkansas is not porous, however the soft Arkansas is slightly porous and will soak up a small amount of oil when new. These are polishing stones. They are not fast cutting or easy to use, but will produce the sharpest cutting edges of any oil stone. They will, when taken care of, last a lifetime and be able to be passed on to future generations.

The Oil—The oils used with oil stones are as varied as the stones they are used on. Some "highly refined honing oils" are nothing but mineral oil. Others contain "special secret additives" that the manufacturer may claim will make the stone cut faster and keep it cleaner.

All that is really needed is a clean natural petroleum based oil. Avoid food oils like those made from corn, vegetables, or animal fats. They will spoil and become rancid.

Maintenance—Along with using oil to keep the stones clean while honing, they will also need cleaning periodically. All that it takes to clean, even a badly abused stone, is a generous amount of oil. Rub the oil on the surface of the stone with your fingers to float the debris from the pores. Then blot the dirty swarf from the surface of the stone. You will notice an immediate opening of the pores and improved honing surface.

Water Stones

There are two types of water stones: aluminum oxide and "rare earth compound". They come in four different grits ranging from coarse to ultra-fine that are classified like sandpaper: 800, coarse; 1000, medium; 1200, fine; and 6000, ultra-fine.

The softer water stones are usually used by moving the cutting edge **into** the stone. To avoid gouging a soft water stone, the cutting edges of tools narrower than 1/2", and/or curved tools must be moved **away** from the stone as if you were trying to smooth it.

Aluminum Oxide—The 800, 1000, and 1200 grit water stones are aluminum oxide. These reddish-brown stones are relatively soft and likely to wear and dish even when used properly. When worn they are easily flattened. They are porous and must be soaked in water overnight when new. They are fast cutting, easy to use general purpose intermediate stones that, when taken care of, will last a lifetime.

Rare Earth Compound—The 6000-grit water stone is made of a "rare earth compound". Exactly which earth compound is considered a trade secret by the makers of this white, very high quality polishing stone. It is porous and must be soaked in water overnight when new. It is slow cutting, but relatively easy to use and will leave a mirror-like surface on the bevel of the tool and the sharpest cutting edge possible. It will, when taken care of, last a lifetime and be able to be passed on to future generations.

The Water—As the name implies, water stones are used with (and in) water. In fact they are best kept and stored submerged in water. The water keeps the stone clean and cutting well. Out of water these stones will only glaze over and almost immediately stop cutting. The water used with these stones is nothing more than distilled water with a drop or two of chlorine bleach added to prevent the growth of bacteria.

Maintenance—The water stone will dish after use even with the best of care. Either after using these stones, or before each use, they should be flattened. Just how soft these stones are will be very evident the first time you flatten one.

To flatten a water stone, lay a sheet of 220-grit wet/dry, silicon carbide sandpaper or a drywaller's sanding screen, on a flat, waterproof surface. A piece of laminate covered sink cut-out works well.

Apply a generous amount of water to the abrasive sheet. Place the stone on the sheet and hold it with one hand while rubbing the stone over the abrasive sheet with the other (Figure 24-2). Work the stone until all the gouges are gone. You will find that this process takes only a few minutes.

The last step in this flattening process is to bevel the edges to prevent them from chipping (Figure 24-3).

Rubber Bonded Abrasives

These hand-held or machine mounted hones consist of an abrasive material permanently imbedded in a rubber compound. They may just be the easiest hones of any to take care of because there is no oil or water to slop around, flattening is required only if misused, and they will **not** break if you drop them.

Hand-held rubber bonded hones are used just like the water stones. ***Warning: When you are using a machine-mounted rubber bonded abrasive wheel, the cutting edge of the tool must always be pointing away from the direction of rotation. If not, the cutting edge will dig into the soft rubber abrasive wheel and throw the tool from your hands possibly causing personal injury and certainly damaging the tool and the abrasive wheel.***

Maintenance—To store these hones, keep them in a clean, dry place. If a power hone is abused and gouged, accessories known as "dressing sticks" are available to flatten and recondition the surface of the wheel.

Diamond Hones

These hones are made with diamond particles permanently attached to either a metal grid laminated to a plastic base, or a solid metal backing. This flat, rigid backing is necessary for accurate work.

When new the diamond hone will seem very coarse. This is due to the manufacturing processes and will wear away very soon. This is not a wearing out of the hone, but only a revealing of the diamond particles.

Types of Diamond Hones—Because of the rigid metal backing, these diamond hones will cut with the tool moving in any direction. The makers of these hones generally do not give you a choice of coarse, medium, or fine grit because the aggressiveness of the hone is controlled by the pressure applied to it.

Start the honing process with heavy pressure for fast metal removal. As the burr is removed and you wish to polish the edge, simply ease up on the pressure, alternate from side to side of the cutting edge, until the edge is razor sharp.

Maintenance—This type of hone needs little or no maintenance. The metal backing is slightly magnetic and will attract metal particles which should be wiped away after each use. Left unchecked, these particles will pack between the diamonds and make the hone appear worn out. To remedy this, wash the hone with soap and water, then dry thoroughly. Store diamond hones in their protective covers in a clean dry place.

Securing the Hones

It is very helpful to secure the oil stones and dry hones to a work surface or secure the water stones in the reservoir and the reservoir to a work suface. This allows you to use both hands to control the tool or cutter. You can make a fixture to hold the oil stones or dry hones (Figure 24-4), or a fixture to hold the water stones in the reservoir (Figure 24-5). Then simply hold the fixture or the reservoir between padded vise jaws or bench dogs.

SHARPENING SAFETY

As with other power tool operations, sharpening safety is Paramount! Know the machine that you are about to use. To protect

Figure 24-2. *To flatten a water stone, use a generous amount of water and rub the stone over wet/dry silicone carbide sandpaper.*

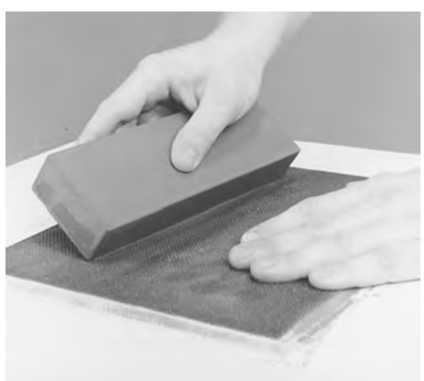


Figure 24-3. *After the water stone is flat, bevel the edges as shown.*

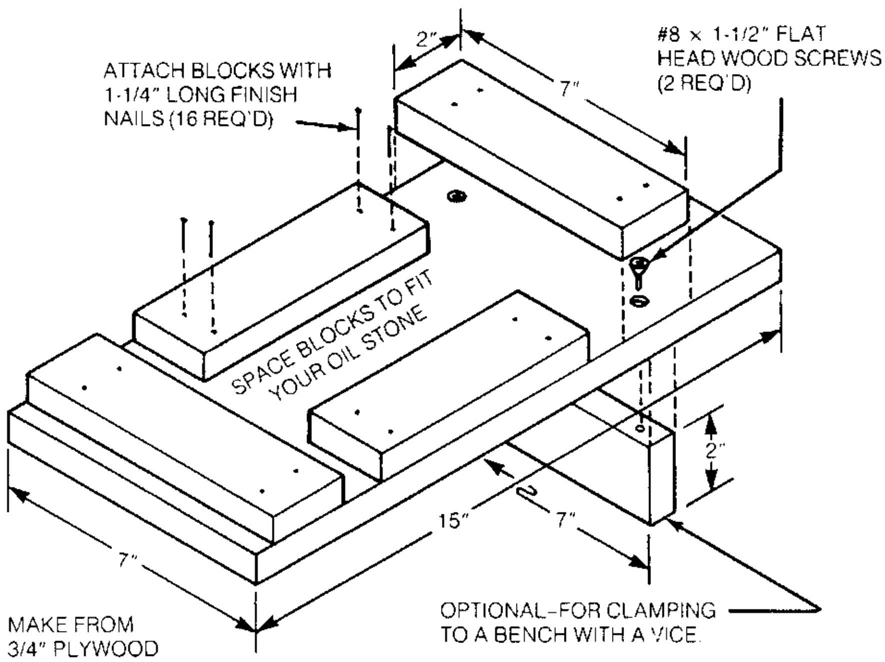


Figure 24-4. Construction details of an oil stone holding fixture that clamps to a bench.

yourself and others from personal injury take the time to review these important safety considerations:

- **Read, understand, and follow ALL the safety and other information in the Owners Manual that applies to the machine, machines or accessories you plan to use.**
- **Always wear proper eye and face protection.**
- **Always support the tool that you are grinding.**
- **Always operate the machine at the recommended speed.**
- **Never turn on the machine with the tool or cutter already against the abrasive.**
- **Never connect a dust collection system to the grinding machine or accessory during grinding operations. Sparks and/or hot pieces of metal could ignite the sawdust or debris in the collection bag.**
- **Never perform any grinding operations without the appropriate shields and guards in place and properly positioned.**
- **Always inspect the abrasive surface of the disc, belt, or wheel for any wrinkles, tears or cracks. Replace any defective abrasive materials IMMEDIATELY.**
- **Always grind with the tool's cutting edge pointing AWAY from the direction of rotation of the disc, belt or rubber bonded abrasive wheel.**
- **Never mount the Velcro® Sanding System on the disc sander for grinding operations. The cutting edge of the tool or cutter will dig into the soft-backed sandpaper and throw the tool or cutter from your hands possibly causing injury and certainly damaging the tool and the sanding system.**

GRINDING LATHE CHISELS

Lathe chisels can be ground on several Shopsmith machines. However using the Shopsmith Sharpening Guide with the disc sander, the belt sander or the strip sander is probably the easiest. Chisels can also be ground on the grinding wheel accessory but there is less apparatus to guide the chisels so accuracy is more difficult.

As explained in Chapter 12, lathe chisels are held three different ways for scraping, cutting, and

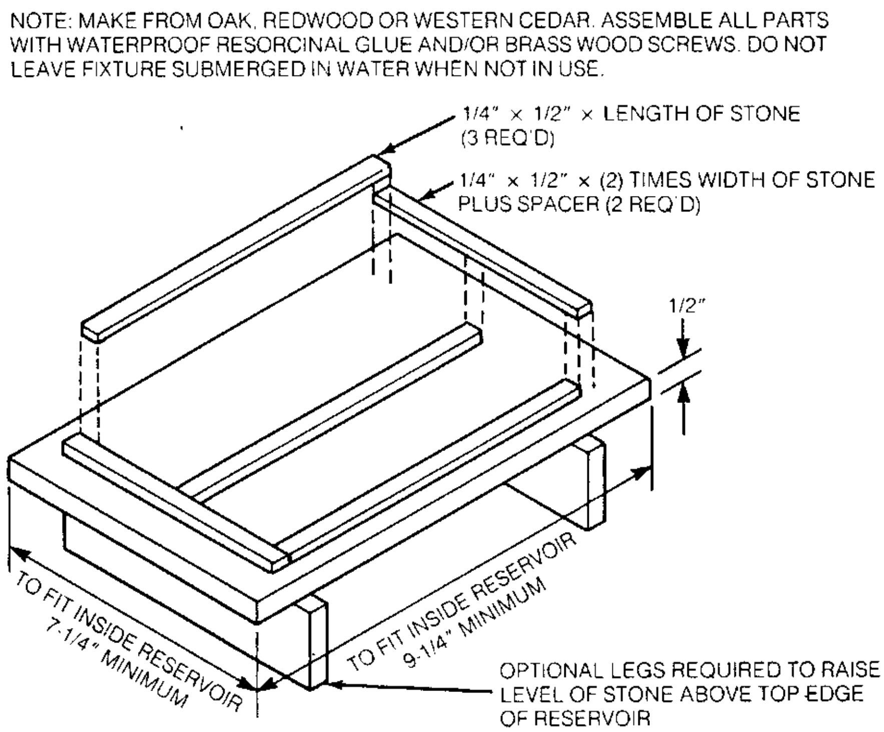


Figure 24-5. Construction details of a water stone holding fixture that sets in the water reservoir.

shearing. Therefore, they must be ground properly for the way they are going to be used. Some chisels can be ground and held to cut in more than one way while others are designed to cut stock one way only.

The skew and the gouge are generally ground for shearing with a long bevel and then honed to a razor sharp edge. They are intended to shear or cut (depending on how they are held) and are used to make spindle turnings. They can, however, also be ground and used as scraping tools.

The parting tool is ground for either cutting or scraping and is honed razor sharp only when it is intended for cutting.

The roundnose chisel is generally ground with a short bevel and the burr is left on the cutting edge. This chisel is seldom honed and is intended to scrape. It is used to make both spindle and faceplate turnings.

Shearing chisels can be used to scrape and scraping chisels can be used to shear if this works best for you, but there are a few things to remember.

Warning: When any chisel ground to a shearing angle is used to remove stock with a scraping technique, especially with alternating grain direction, the sharp cutting edge will dig into the stock, stalling the machine or throwing the chisel and/or the stock. This will leave a deep gouge in the stock and possibly throw the tool from your hands causing injury and certainly damaging the tool.

Round bottom gouges, even when ground for scraping, will roll when the upper corners come in contact with the rotating stock causing them to dig into the stock. This will throw the tool from your hands possibly causing injury and certainly damaging the tool and the workpiece.

The double beveled chisels, skew and parting tool, are measured across both bevels. This is known as an included angle. (This angle includes both bevel angles.)

The longer the bevel or the smaller the angle ground on the chisel, means a sharper tool that will leave a smoother cut. However, the tool will be more difficult to control.

As you grind away metal, the chisel will become short and the handle ferrules will hit the sharpening guide, especially at the shearing settings. By then you will have ground past the heat treated end. For this reason, the chisel dulls quickly and needs to be replaced.

When you're using the disc sander or the belt sander mounted on the Mark V, always grind at "Slow" speed. For grinding on the strip sander, follow the recommended speeds for the different grits in the Owners Manual.

Because grinding removes metal with a moving abrasive working against a stationary metal tool, a great deal of frictional heat is created. To keep this heat from building up and destroying the factory heat treating and hardening of the tool (temper), hold the tool against the abrasive momentarily then slide it away. Repeat this procedure until the tool has been sufficiently ground. *Caution: Have a container of water nearby to cool (quench) the tool if it becomes too hot to touch. If you notice that the tool is discoloring and turning blue, you are either holding the tool against the abrasive too long or too hard, the abrasive is dull or the speed setting is too fast.*

When you're using the disc sander, the dust chute is used to contain the abrasive particles and protect the way tubes from grit. An alternative to using the dust chute is to place an 8" to 12" wide piece of scrap lumber on the way tubes under the sanding disc. *Caution: When you're finished grinding, always slide the power plant away from the grinding position and wipe the way tubes clean.*

Grinding Lathe Chisels using the Sharpening Guide

The Shopsmith Sharpening Guide mounts on the disc sander, belt sander and the strip sander and is used to grind skews, gouges, parting tools and roundnose chisels. Set up the machine you will be using and grind the chisels according to the applicable instructions below. To determine the sharpening guide angle settings, refer to Table 24-1.

Disc Sander Setup—Mount the sharpening guide on the Mark V extension table (Figure 24-6). ***Warning: To sharpen lathe chisels, mount the sharpening guide to the extension table only. Mounting the guide to the worktable may cause the cutting edge of the chisel to dig into the abrasive and the tool to be thrown from your hands.***

Adjust the sharpening guide to the desired angle setting. Slide the sanding disc to within 1/16" of

Table 24-1: Sharpening Guide Angle Settings

	Left Setting (Shearing)					Right Setting (Scraping)			
	20°	15°	10°	5°	0°	5°	10°	15°	20°
Skew	25°	30°	35°	40°	45°	50°	55°	60°	65°
Gouge	25°	30°	35°	40°	45°	50°	55°	60°	65°
Parting Tool	40°	45°	50°	55°	60°	65°	70°	75°	80°

the sharpening guide then secure the power plant lock. ***Warning: Never use the Velcro® Sanding System to grind tools.***

Belt Sander Setup—Position the belt sander vertically and set the table to the "0" setting. Position the parting tool station of the sharpening guide in front of the belt sander backup plate. Adjust the guide to the desired angle setting. ***Warning: Position the sharpening guide to within 1/16" of the belt and secure the table locking setscrews (Figure 24-7).***

Strip Sander Setup—Set the strip sander worktable to 90° and adjust the sharpening guide to the desired angle setting. Because there are no table slots or mounting holes in the strip sander table, the sharpening guide must be clamped to the table top. An index line is used to align the guide. Draw this line 3-5/8" from, and parallel to the platen (Figure 24-8).

When setting the angle, position the hole in the rear of the sharpening guide and the angle setting indicator directly over the index line. Slide the sharpening guide along the line until the desired station is in front of the belt. Make sure the sharpening guide is within 1/16" of the belt, then clamp the guide securely to the table (Figure 24-9).

Grinding the Skew—The skew chisel has a bevel ground on both sides at an angle not perpendicular to either the side faces or the top and bottom edges. To grind this compound angle the skew must be held at an angle to the abrasive and leaned to the left and to the right. These angles are controlled by the sharpening guide.

Position the tip of the skew **down** and the side against the **left** wall of the second station of the sharpening guide (Figure 24-10). Be sure the skew **is not** touching the abrasive and the speed dial is set to "**Slow**" (if you are using the Mark V), then turn on the machine.

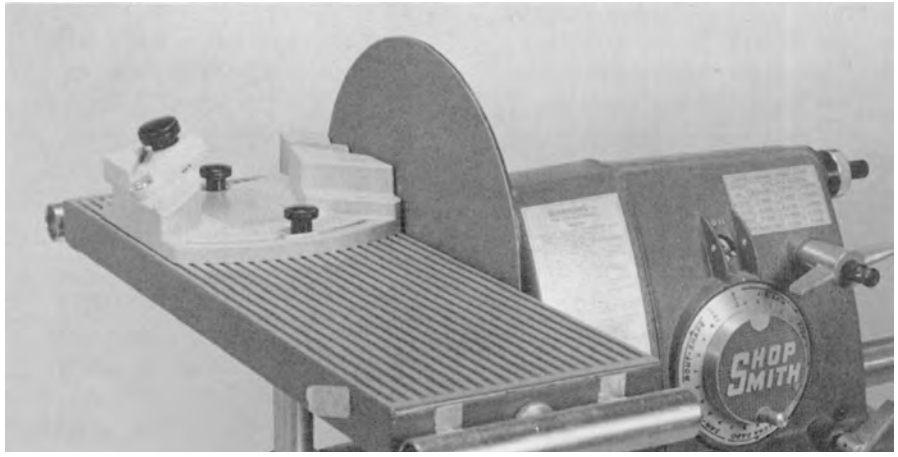


Figure 24-6. *To sharpen lathe chisels, mount the sharpening guide on the extension table only.*

Figure 24-7. *Position the guide to within 1/16" of the belt.*

Figure 24-8. *Draw an index line 3-5/8" from, and parallel to the platen.*

Figure 24-9. *Clamp the sharpening guide to within 1/16" of the belt.*

Gently slide the skew against the wall of the skew grinding station and into the moving abrasive. Hold the chisel there momentarily then back it away. Repeat this several times.

Turn the skew over and position the tip of the skew **up** and lay the side of the skew against the **right** wall of the second station (Figure 24-11).

Gently slide the skew against the station and into the moving abrasive. Hold it there momentarily then back it away. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. If the skew is being ground for scraping, then it is ready to use (the burr is sharp and scrapes very well). If the skew is being ground for shearing or cutting, it will need to be honed to a razor sharp edge.

Grinding the Gouge—The gouge chisel has a bevel ground on the convex side (bottom) at an angle measured from the concave side (top). This bevel is curved to form a rounded cutting edge. To grind this complex curved bevel, the gouge must be held at the proper angle, fed into the abrasive and rotated. The angle is controlled by the sharpening guide.

Figure 24-10. *Position the tip of the skew* ***down*** *and the side against the* ***left*** *wall of the second station.*

Figure 24-11. *Position the tip of the skew* ***up*** *and the side against the* ***right*** *wall of the second station.*

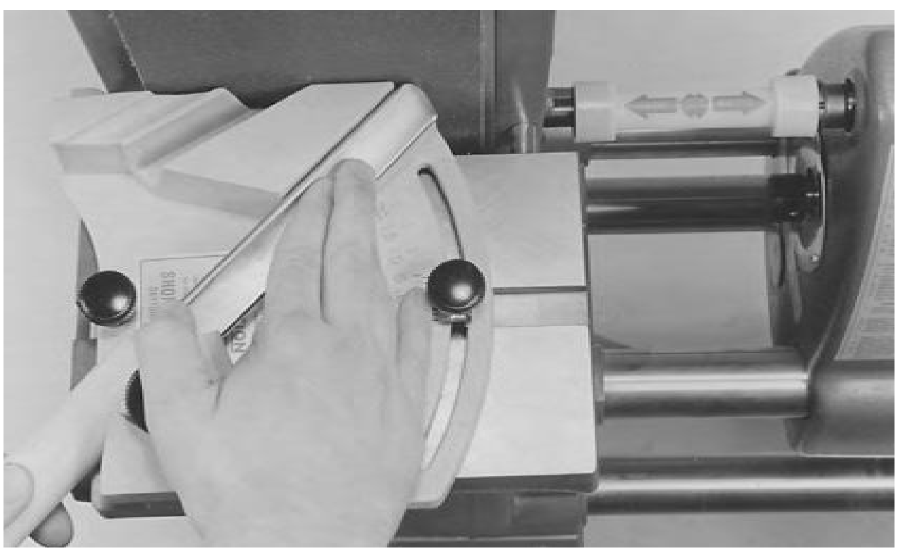


Figure 24-12. *Set the gouge in the third station and lay its side against the* ***left*** *wall.*

Place the gouge in the third station of the sharpening guide and lay the side of the gouge against the **left** wall of the station (Figure 24-12). Rotate the gouge until its center touches the abrasive.

With the machine "OFF" practice rotating the gouge, first clockwise from the center to the edge, and then counterclockwise from the center of the gouge to the edge. You should notice while rotating the gouge that in order to keep the bevel in contact with the abrasive, you must slide the gouge forward on the station as the bevel is ground from the center to each edge.

After you get the feel of this grinding motion, be sure the gouge **is not** touching the abrasive and the speed dial is set to "**Slow**" (if you are using the Mark V), then turn on the machine.

Gently slide the gouge against the wall of the station and into the moving abrasive. Start rotating the gouge, like you practiced. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. If the gouge is being ground for scraping, it is ready to use (the burr is sharp and scrapes very well). If the gouge is being ground for shearing or cutting, it will need to be honed to a razor sharp edge.

Grinding the Parting Tool—The parting tool has a bevel ground on both the top and bottom edges. To grind these angles the parting tool must be held on its side at the proper angle to the moving abrasive, turned over and reset at the exact same angle. These angles are controlled by the sharpening guide.

To grind the parting tool, lay the side of the parting tool in the first station of the sharpening guide (Figure 24-13). Be sure the parting tool **is not** touching the abrasive and the speed dial is set to "**Slow**" (if you are using the Mark V), then turn on the machine.

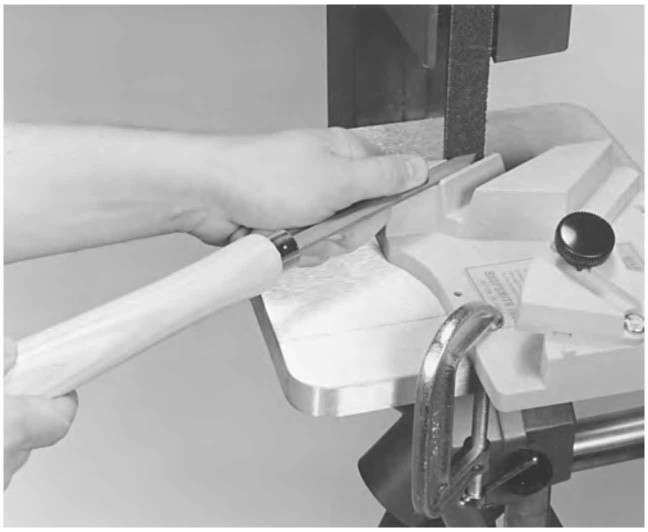


Figure 24-13. Set the parting tool's side in the first station.

Figure 24-14. Position the roundnose chisel, ***bevel up*** *in the fourth station. Tighten the knob.*

Gently slide the parting tool on the station and into the moving abrasive. Hold it there momentarily then back it away. Repeat this several times.

Turn the parting tool over and lay the other side in the first station. Slide the parting tool on the station and into the moving abrasive. Hold it there momentarily then back it away. Repeat this several times. Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. It is VERY important to grind an equal amount from each bevel so that the widest part of the parting tool is **exactly** at the cutting edge. If the parting tool is being ground for scraping, then it is ready to use (the burr is sharp and scrapes very well). If the parting tool is being ground for cutting, it will need to be honed to a razor sharp edge.

Grinding the Roundnose Chisel—The roundnose chisel has a bevel ground on the bottom at an angle measured from the top. This bevel is curved to form a round cutting edge. To grind this curved bevel the roundnose chisel must be held at the proper angle to the moving abrasive, pivoted and fed into the abrasive. The bevel angle is controlled by the sharpening guide.

Grinding the roundnose chisel on the fourth station is the only grinding operation that does not repeat the "factory" angle. The new 15° bevel angle is ideal for scraping. The distance between the pivoting station and the moving abrasive will set the radius of the cutting edge. Position the pivoting station close to the abrasive and the cutting edge will be ground completely around the chisel leaving no sharp corners. Position the pivoting station further away from the abrasive and the cutting edge will be ground around the chisel on a large radius leaving sharp corners where the sides and the curved cutting edge join.

To grind the roundnose chisel, position it, **bevel up** in the fourth station (the pivoting station). Slide it under the knob until the center of the roundnose chisel touches the abrasive and tighten the knob (Figure 24-14).

With the machine "OFF" practice pivoting the roundnose chisel first to the left, and then to the right to complete the edge. You will notice that the chisel will need to be repositioned further forward on the grinding station to complete the bevel.

After you get the feel of this grinding motion, be sure the roundnose chisel **is not** touching the abrasive and the speed dial is set to "**Slow**" (if you are using the Mark V), then turn on the machine.

Gently slide the roundnose chisel in the fourth station until it just touches the moving abrasive. Tighten the knob and start pivoting the roundnose chisel, like you practiced. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. The roundnose chisel is ground for scraping, so it is ready to use as is and should not be honed (the burr is sharp and scrapes very well).

Grinding Lathe Chisels using the Grinding Wheel

The Shopsmith Grinding wheel mounts on the Mark V and will grind skews, gouges, parting tools and roundnose chisels. Set up the grinding wheel on the Mark V and grind the chisels according to the applicable instructions below.

Grinding the Skew—The skew chisel has a bevel ground on both sides at an angle not perpendicular to either the side faces or the top and bottom edges. To grind this compound angle the skew must be held at the proper angle to the **side** of the wheel and

*Figure 24-15. Hold the skew on the tool rest with the tip **up** and the bevel against the wheel.*

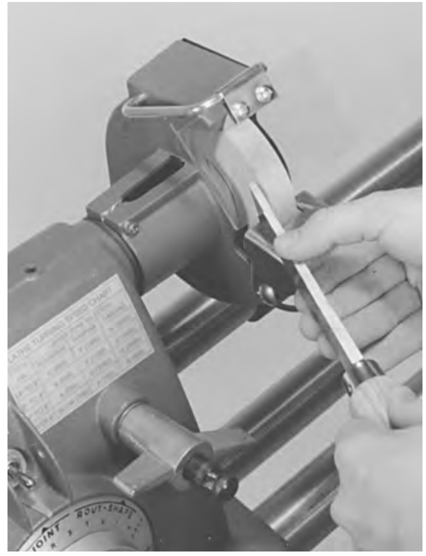


*Figure 24-16. Position the tip **up**, and lay the **right** side bevel against the **left** side of the grinding wheel.*

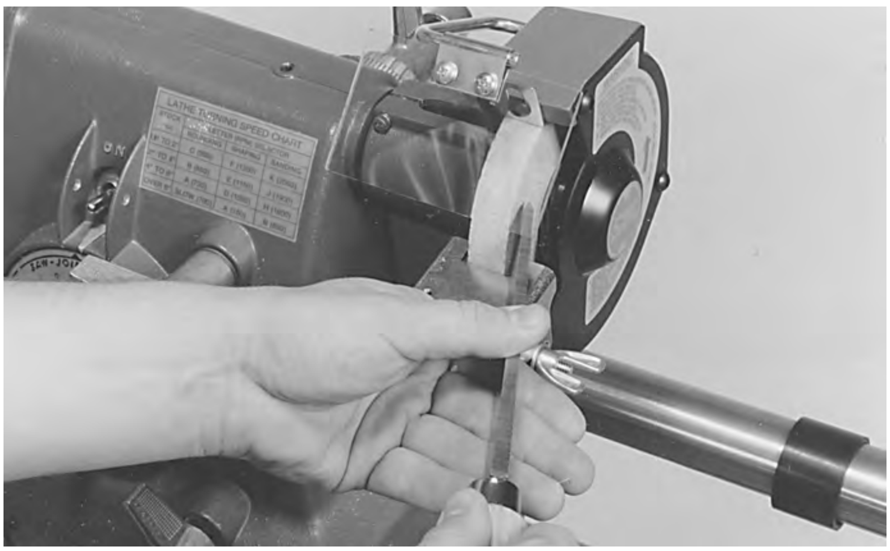


*Figure 24-17. Position the **left** bevel, with the tip **up**, near the **right** side of the wheel.*

leaned to either the left or to the right on the appropriate sides of the wheel. ***Warning: Do not grind the skew on the front of the wheel. This will leave a hollow ground bevel on the skew that may make the chisel difficult to control.***

One angle is controlled by the tool rest and the other angle (the lean of the tool) is controlled by feel.

To find the desired tool rest angle setting hold the skew on the tool rest with the tip **up** and the bevel of the cutting edge against either side of the wheel. Loosen the wing nut and pivot the tool rest until the cutting edge is parallel to the rotation of the wheel (Figure 24-15). At the same time, slide the tool rest to within 1/16″ of the wheel and then secure the wing nut.

To grind the skew, position the tip **up** and lay the **right** side bevel against the **left** side of the grinding wheel (Figure 24-16).

Tilt the skew away from the wheel and be sure the skew **is not** touching it and the speed dial is set to "**Slow**". Then turn on the Mark V and set the speed dial to "R" (3400 RPM).

Gently lean the skew back toward the side of the grinding wheel. Feel for the bevel of the skew against the side of the grinding wheel. Hold it there momentarily then lean it away. Repeat this several times.

Reposition the **left** bevel with the tip **up** near the **right** side of the wheel (Figure 24-17).

Gently lean the skew into the side of the grinding wheel. Feel for the bevel of the skew against the side of the grinding wheel. Hold it there momentarily then lean it away. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. If the skew is being ground for scraping, then it is ready to use (the burr is sharp and scrapes very well). If the skew is being ground for shearing or cutting, it will need to be honed to a razor sharp edge.

Grinding the Gouge—The gouge chisel has a bevel ground on the convex side (bottom) at an

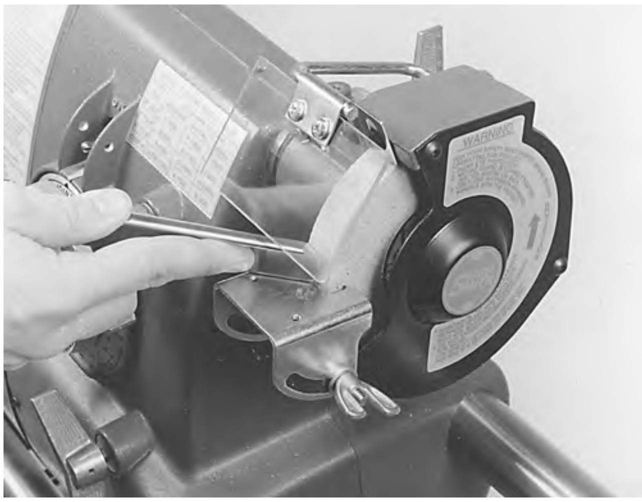


Figure 24-18. *Practice rolling the gouge toward the front of the tool rest. Feel the bevel seat on the wheel.*

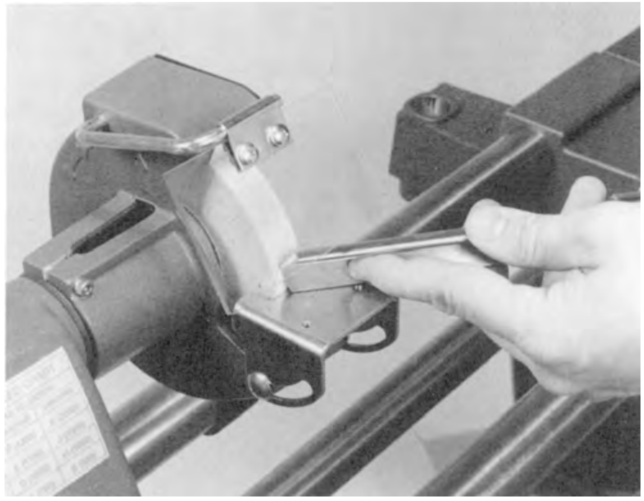


Figure 24-19. *Roll the gouge to the front of the tool rest, this time with the handle pointing to the right.*

angle measured from the concave side (top). This bevel is curved to form a rounded cutting edge. To grind this complex curved bevel, the gouge must be held at the proper angle to the grinding wheel, rotated and fed into the wheel. The angle and the roll of the gouge is controlled by feel.

Set the tool rest to 90° and slide it to within 1/16″ of the wheel and then secure the wing nut. Set the gouge on the tool rest with the center of the bevel against the **front** of the grinding wheel and the handle pointing to the **left**.

Practice rolling the gouge toward the front of the tool rest (Figure 24-18). Feel for the bevel against the grinding wheel while keeping the side firmly against the tool rest. Repeat this movement with the gouge handle pointing to the **right** (Figure 24-19).

When you feel confident with the rolling movement of the gouge, slide it away from the wheel. Be sure that the gouge **is not** touching the wheel and that the speed dial is set to "**Slow**". Then turn on the Mark V and set the speed dial to "R" (3400 RPM).

Gently slide the gouge into the grinding wheel. Feel for the bevel of the gouge against the grinding wheel. Roll the gouge just as you practiced, first with the handle to the right, then with the handle to the left. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. If the gouge is being ground for scraping, then it is ready to use (the burr is sharp and scrapes very well). If the gouge is being ground for shearing or cutting, then it will need to be honed to a razor sharp edge.

Grinding the Parting Tool— The parting tool has a bevel ground on both the top and bottom edges. To grind these angles the parting tool must be held on its edge at the proper angle to the grinding wheel, turned over and held at the exact same angle. Adjust the tool rest to match the center of the bevel previously ground on the parting tool and slide the tool rest to within 1/16″ of the wheel and then secure the wing nut.

Lay the edge of the parting tool on the tool rest (Figure 24-20). Practice sliding the tool forward while holding it perpendicular to the tool rest and the grinding wheel. Try this on both sides of the parting tool.

When you feel confident with the movement of the parting tool, slide it away from the wheel. Be sure that the parting tool **is not** touching the wheel and that the

Figure 24-20. *Lay the parting tool edge on the tool rest as shown.*

speed dial is set to "**Slow**". Turn on the Mark V and set the speed dial to "R" (3400 RPM).

Gently slide the parting tool on the tool rest and into the grinding wheel. Hold it there momentarily then back it away. Repeat this several times.

Turn the parting tool over and lay the other edge on the tool rest. Slide the parting tool on the tool rest and into the grinding wheel. Hold it there momentarily then back it away. Repeat this several times.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. Be sure to grind an equal amount from each side so that the widest part of the parting tool is exactly at the cutting edge. If the parting tool is being ground for scraping, then it is ready to use (the burr is sharp and scrapes very well). If the parting tool is being ground for cutting, it will need to be honed to a razor sharp edge.

Grinding the Roundnose Chisel—The roundnose chisel has a bevel ground on the bottom at an angle measured from the top. This bevel is curved to form a rounded cutting edge. To grind this curved bevel the roundnose chisel must be held at the proper angle to the grinding wheel, pivoted and fed into the wheel. The bevel angle is controlled by the tool rest.

Set the tool rest to a 5° to 10° angle to the wheel and slide the tool rest to within 1/16″ of the wheel. Then secure the wing nut.

Grinding the roundnose chisel is the only grinding operation that does not repeat the "factory" angle. The hollow-ground 5° to 10° bevel angle is excellent for scraping.

Set the roundnose chisel, **bevel down** on the tool rest. Slide the chisel forward until the center of the chisel touches the grinding wheel (Figure 24-21).

With the machine "OFF" practice pivoting the roundnose chisel first to the left, and then to the right to complete the edge. After you get the feel of this grinding motion, be sure the roundnose chisel **is not** touching the wheel and that the speed dial is set to "**Slow**". Turn on the Mark V and set the speed dial to "R" (3400 RPM).

Gently slide the roundnose chisel on the tool rest and into the grinding wheel. Like you practiced, pivot the chisel to grind the bevel.

Grind away only enough metal to remove any damage to the cutting edge and create a slight burr. The roundnose chisel is ground for scraping, so it is ready to use as is and should not be honed (the burr is sharp and scrapes very well).

HONING LATHE CHISELS

After the skews, gouges, and parting tools are ground for either shearing or cutting, their cutting edges **must be** honed razor sharp. Refer to "Hones–Classes and Types" for information about hones.

In order to hone the chisel you must be able to find and recognize the burr created by grinding. This **must** be done properly and with extreme care to avoid cutting yourself. As you progress from coarser to finer stones, the burr will become smaller and more difficult to find, but after you become more practiced at honing this will become second nature.

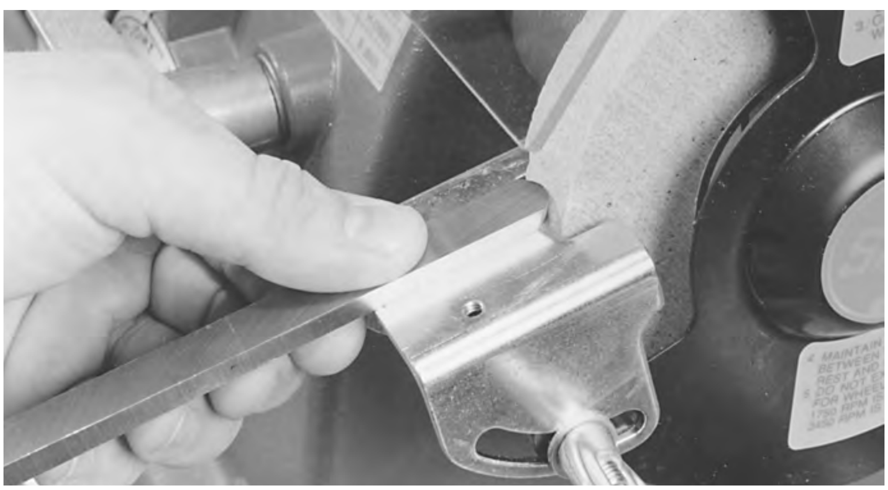


Figure 24-21. Slide the chisel, bevel down, until its center touches the grinding wheel.

To find the burr, lightly rub your finger at right angles to the cutting edge from the **back** of the bevel **toward** the cutting edge and across it (Figure 24-22). ***Warning: Be careful not to slide your finger along the cutting edge. Even though the chisel is not yet honed, the burr is sharp.***

Start honing with a coarse stone. Apply a generous amount of liquid (if required) to the surface of the stone. Set the chisel in the center of the hone, and rock the chisel on the bevel until you see the liquid squeeze out from between the ground surface and the stone. This helps to show that you're holding the chisel at the proper angle. Repeat this until you easily feel the bevel seat flat on the stone. Slide the chisel over the hone as directed for each class of hone.

By repeating this procedure on progressively finer stones you will be able to hone the cutting edge of the chisel razor sharp.

There are a couple of tests to check the "sharpness" of the cutting edge: (1) A razor sharp cutting edge will cut end grain of wood with little effort. (2) A razor sharp cutting edge will seem to drag rather than slip when pulled across the corner of a piece of hardwood. Do not use paper to test the sharpness because the glues in the paper will dull the edge you worked so hard to obtain.

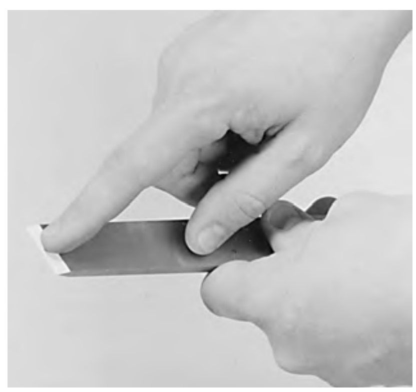


*Figure 24-22. Feel the burr by carefully rubbing your finger **toward** the cutting edge.*

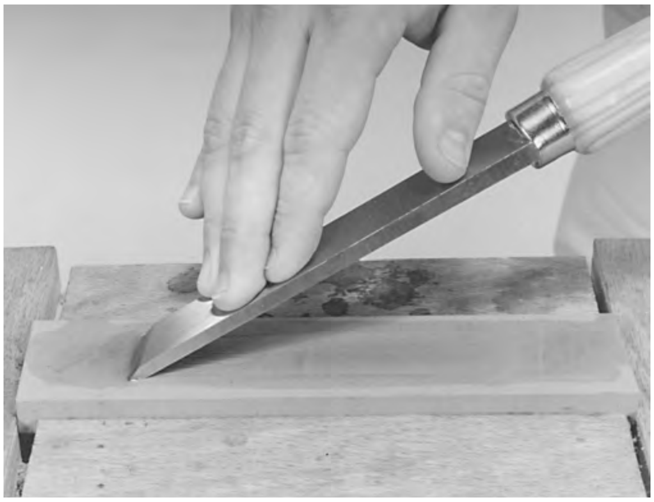


Figure 24-23. Point the cutting edge in the same direction you are sliding the skew.

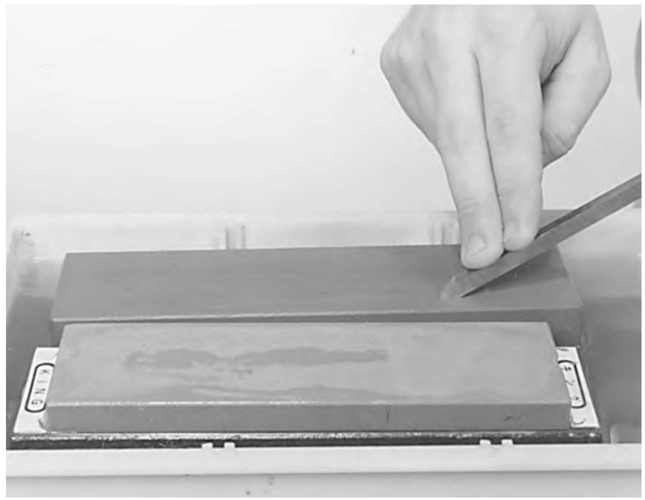


Figure 24-24. For narrow chisels, point the cutting edge away from the direction you are sliding the skew.

Honing the Skew

The skew is honed much like a pocket knife. Each has a bevel ground on both sides of their cutting edge. The skew must be honed on the two bevels. This will remove the grinding burr and sharpen the cutting edge. By repeating this procedure on progressively finer stones you will be able to hone the cutting edge razor sharp.

Using Oil Stones and Diamond Hones—Hold one bevel of the skew on the hone. Slide the skew over the hone with the cutting edge pointing in the same direction you are sliding the skew (Figure 24-23). Think of it as trying to shave off a thin sliver of the hone. Turn the skew over and repeat the procedure to hone the other bevel.

Using Water Stones and Rubber Bonded Abrasives—To hone skews with a cutting edge wider than 1/2" follow the oil stones and diamond hones instructions.

For skews with narrower cutting edges, slide the skew over the hone with the cutting edge pointing **away** from the direction you are sliding the skew (Figure 24-24). Think of it as trying to smooth over the surface of the hone. Turn the skew over and repeat the procedure to hone the other bevel.

Honing the Gouge

The gouge must be honed on both the bevel ground on the outside and the concave inside. This will remove the grinding burr and sharpen the cutting edge.

A gouge slip or other rounded (convex) slip will be needed to hone the inside (concave) of the gouge. This medium or fine slip should match the profile of the gouge as close as possible.

Using Oil Stones and Diamond Hones—Hold the bevel of the gouge on the hone. Roll the gouge as you push it over the hone. The cutting edge should be pointing in the same direction you are pushing the gouge (Figure 24-25). Think of it as trying to shave off a thin sliver of the hone as you roll the gouge.

Change to the slip. Apply a generous amount of oil to the inside of the gouge. Set the hone in the gouge. Slide the slip from the cutting edge to the handle while rotating the gouge so the entire cutting edge on the inside is honed (Figure 24-26). Then return to the flat bench hone.

Using Water Stones and Rubber Bonded Abrasives—Hold the bevel of the gouge on the hone. Roll the gouge as you pull it over the hone. Slide the gouge over the hone with the cutting

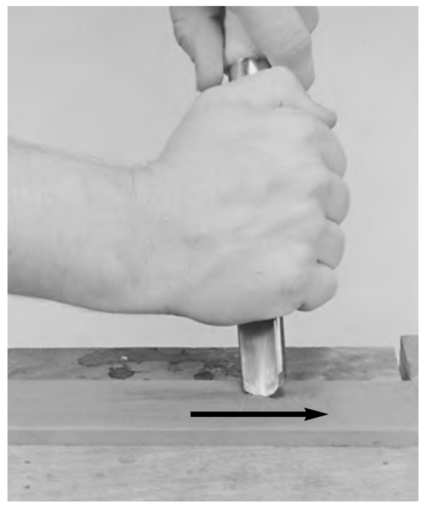


Figure 24-25. Point and roll the outside of the cutting edge in the same direction you are pushing the gouge.

Figure 24-26. Use a rounded slip to hone the inside of the gouge.

edge pointing **away** from the direction you are sliding the gouge (Figure 24-27). Think of it as trying to smooth over the surface of the hone as you roll the gouge.

Change to the water slip hone. Apply a generous amount of water to the top surface of the hone. Set the concave side of the gouge down on the slip. Slide the gouge away from the slip while rotating the gouge so the entire cutting edge is honed on the inside. Then return to the flat bench hone.

Honing the Parting Tool

The parting tool is honed on the bevel ground on both sides of the cutting edge. This will remove the grinding burr and sharpen the cutting edge.

Using Oil Stones and Diamond Hones—Hold the bevel of the parting tool on the hone. Slide the parting tool over the hone with the cutting edge pointing in the same direction you are sliding the tool (Figure 24-28). Think of it as trying to shave off a thin sliver of the hone. Turn the parting tool over and repeat this on the other bevel.

Using Water Stones and Rubber Bonded Abrasives—Hold one bevel of the parting tool on the hone. Slide the tool over the hone with the cutting edge pointing **away** from the direction you are sliding the tool (Figure 24-29). Think of it as trying to smooth over the surface of the hone. Turn the parting tool over and repeat the procedure to hone the other bevel. ***Warning: Never attempt to hone the parting tool with the rubber bonded abrasive wheel mounted on the grinding wheel accessory. The cutting edge of the parting tool will dig into the soft abrasive and throw the tool from your hands, possibly causing injury and certainly damaging the tool and the rubber bonded abrasive wheel.***

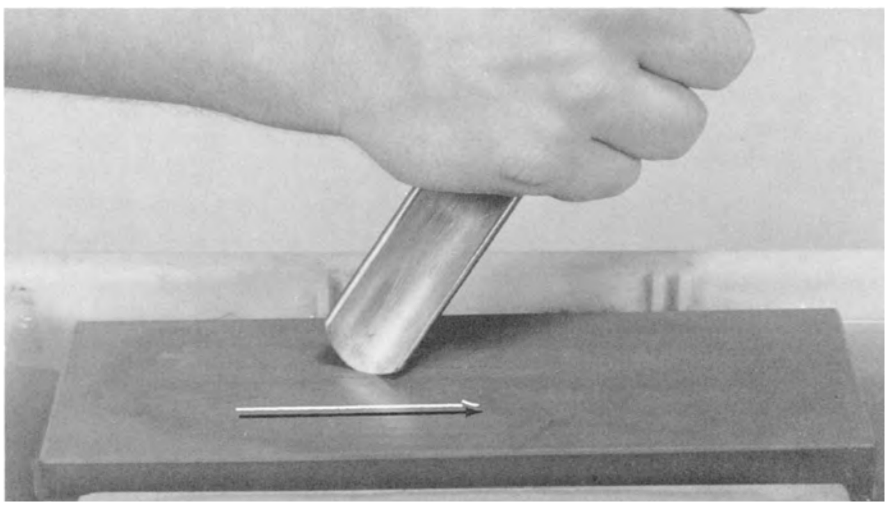


Figure 24-27. *Point and roll the cutting edge away from the direction you are sliding the gouge.*

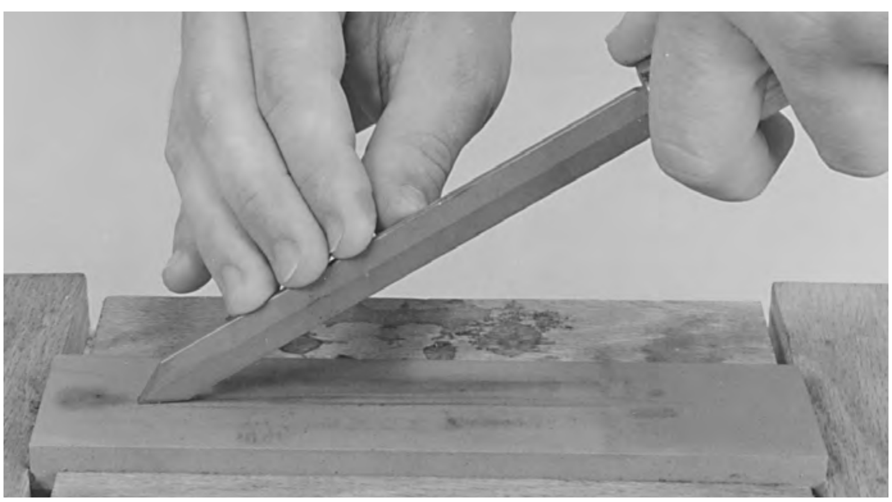


Figure 24-28. *Point the cutting edge in the same direction you are sliding the tool.*

SHARPENING BENCH CHISELS

A bench chisel may be one of the most used and most abused tools in the shop. Along with chiseling, it's sometimes used as a pry tool, a wedge, or even a substitute for a screwdriver. Because of this, the bench chisel could be the most sharpened tool in the shop. To sharpen bench chisels, they must be ground, then honed.

Grinding Bench Chisels using the Sharpening Guide

The Shopsmith Sharpening Guide mounts on the disc sander, belt sander and the strip sander and is used to grind bench chisels. Set up the machine you will be using and grind the chisels according to the applicable instructions below. To determine the sharpening guide angle settings, refer to Table 24-1.

Disc Sander Setup—Mount the sharpening guide on the Mark V worktable and adjust the worktable height. Mount the sharpening guide to the worktable only. Mounting the guide to the extension table will not allow the required 9° table tilt.

Tilt the worktable 9° toward the abrasive. To adjust the sharpening guide to the desired angle setting, lay the flat bottom of the bench chisel against the right-hand wall of the second station. With the tip of the chisel against the abrasive, pivot the sharpening guide until the bevel of the chisel sets flat against the abrasive. Secure the sharpening guide in place.

Warning: Position the sanding disc to within 1/16" of the sharpening guide. Then secure the power plant lock.

Belt Sander Setup—Set up the belt sander vertically. Mount the sharpening guide to the table and secure it by tightening the two lock knobs. Tilt the table 9° toward the table. ***Warning: Position and secure the sharpening guide to within 1/16" of the belt and secure the table locking setscrews.***

Strip Sander Setup—Because there are no table slots or mounting holes in the strip sander table, the sharpening guide must be clamped to the table. An index line is used to align the guide. Draw this line 3-5/8" from, and parallel to the platen as shown in Figure 24-8 earlier in this chapter.

When setting the table tilt and the sharpening guide angles, hold the chisel against the left wall of the second station of the guide. Position the hole in the rear of the sharpening guide and the angle setting indicator directly over the index line.

Slide the sharpening guide along the line until the chisel in the second station of the guide is in front of the belt. ***Warning: Position the sharpening guide to within 1/16" of the belt.*** Then clamp the sharpening guide securely to the table (Figure 24-30).

Grinding Bench Chisels—Turn on the machine and set the chisel in the second station of the sharpening guide. Slide the chisel into the abrasive while holding it firmly against the left wall of the station. Hold the chisel against the abrasive momentarily, then back it away (Figure 24-31).

Repeat this several times until any damage to the cutting edge is removed.

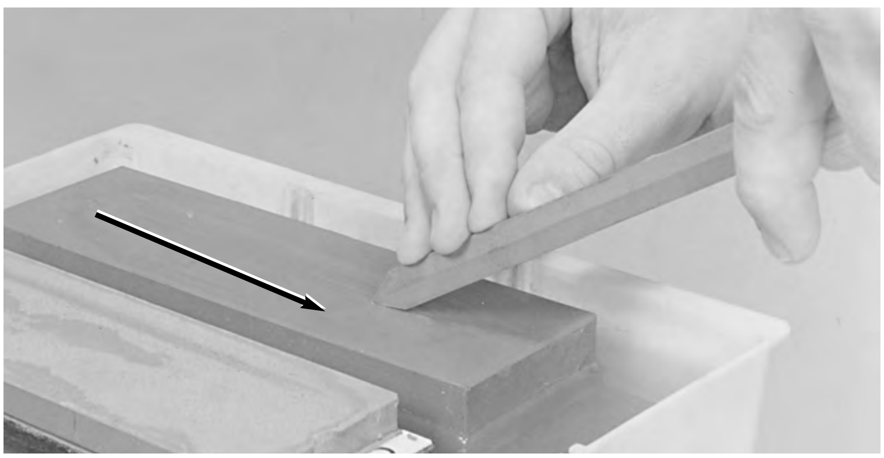


Figure 24-29. *Point the cutting edge away from the direction you are sliding the the tool.*

Grinding Bench Chisels using the Grinding Wheel

The Shopsmith Grinding Wheel mounts on the Mark V. Select the proper wheel for the severity of the cutting edge damage (coarse for nicks and a badly worn cutting edge and fine for routine grinding). Set up the grinding wheel according to the Owners Manual that came with the Grinding Wheel Accessory.

The bench chisel can be ground on the front or on either side of the grinding wheel. When the chisel is ground on the front of the wheel, the bevel will be hollow ground. Because this hollow ground edge is so thin, a secondary bevel will need to be honed on

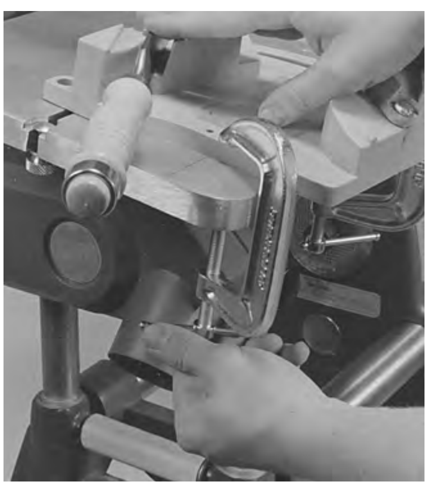


Figure 24-30. *Position the sharpening guide within 1/16" of the belt and clamp it to the table.*

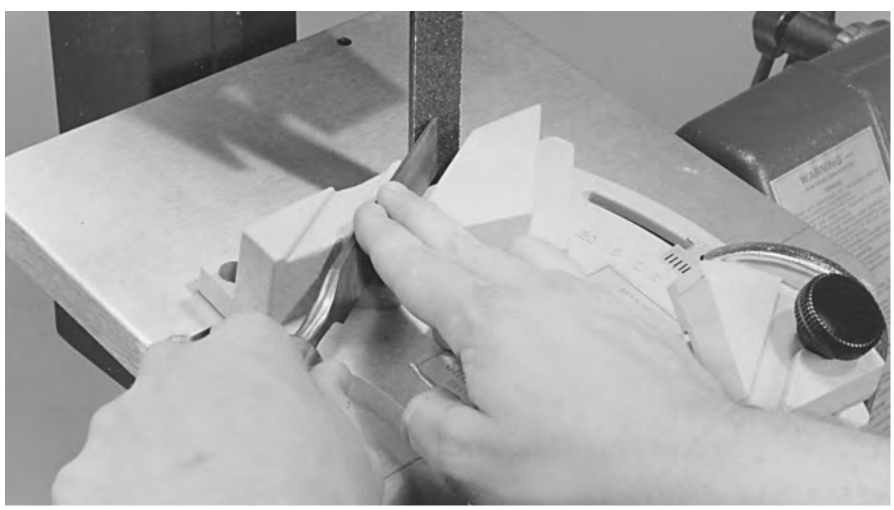


Figure 24-31. *Slide the bench chisel into the abrasive. Hold the chisel there momentarily, then back it away.*

Figure 24-32. Set the angle so that the wheel is centered on the flat bevel. Tighten the wing nut securely.

the cutting edge. This will be done with a coarse sharpening stone.

When the chisel is ground on the side of the wheel, the bevel that is left is flat and can be honed to a razor sharp cutting edge without the need for a secondary bevel. ***Warning: Grinding on the side of the wheel is tricky because there is nothing but feel to guide the chisel to the proper angle and is not the best approach. Use extreme caution.***

Grinding Bench Chisels—Hold the chisel on the tool rest, loosen the wing nut and tilt the tool rest so the bevel sets against the wheel. If the chisel has a flat bevel, set the angle so that the wheel is centered on the flat bevel. Tighten the wing nut securely (Figure 24-32). Remove the chisel from the tool rest and make sure the speed dial is set to "**Slow**". Then turn on the Mark V and set the speed dial to "R" (3400 RPM).

If the chisel is narrower than the width of the wheel, slide the chisel up into the wheel, hold it there momentarily and back it away (Figure 24-33).

If the chisel is wider than the wheel, follow the instructions above, except you must slide the chisel from side to side after it comes in contact with the wheel (Figure 24-34).

Grind away only enough metal to remove any damage. This will complete grinding the primary bevel. To create the secondary bevel, hone the chisel.

Figure 24-33. If the chisel is narrower than the width of the wheel, hold the chisel there momentarily, then back it away.

Figure 24-34. If the chisel is wider than the width of the wheel, move the chisel side to side, then back it away.

Honing Bench Chisels

The bench chisel has a bevel ground on one side of its cutting edge. This bevel as well as the flat bottom face must be honed. This will remove the grinding burr and sharpen the cutting edge.

Start with a coarse hone and moderate-to-heavy pressure to create the secondary bevel. By repeating this procedure on progressively finer hones you will be able to hone the cutting edge razor sharp.

Using Oil Stones and Diamond Hones—Hold the bevel of the chisel on the hone. Slide the chisel over the hone with the cutting edge pointing in the same direction you are sliding the chisel (Figure 24-35). Think of it as trying to shave off a thin sliver of the hone. Turn the chisel over and repeat the procedure on the flat side.

Using Water Stones and Rubber Bonded Abrasives—To

Figure 24-35. Hone bench chisels on oil stones, by pointing the cutting edge in the same direction you are sliding the chisel.

Figure 24-36. For narrow chisels, on water stones, point the cutting edge away from the direction you are sliding the chisel.

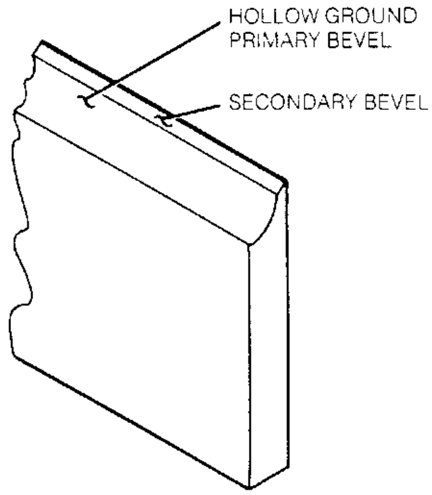


Figure 24-37. First, grind the primary bevel. Then grind the strengthening secondary bevel.

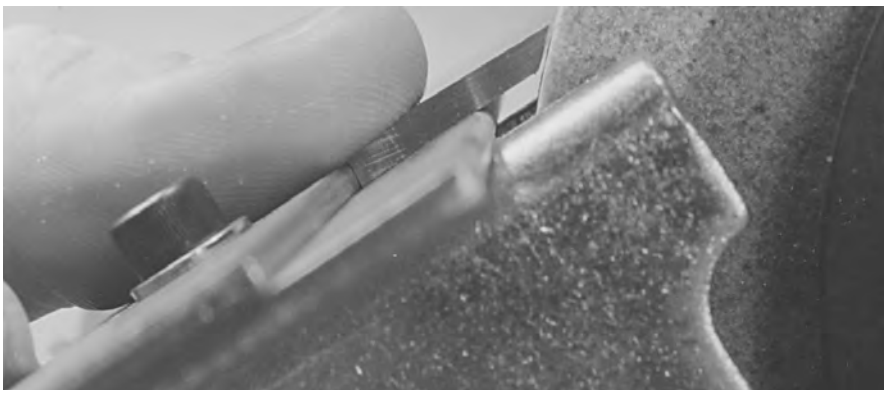


Figure 24-38. Center the knife bevel on the wheel.

hone bench chisels with a cutting edge wider than 1/2″, follow the oil stones and diamond hones instructions.

For bench chisels with narrower cutting edges, slide the chisel over the hone with the cutting edge pointing **away** from the direction you are sliding the chisel (Figure 24-36). Think of it as trying to smooth over the surface of the hone. Turn the chisel over and repeat the procedure on the flat side.

GRINDING PLANER AND JOINTER KNIVES

Jointer and planer knives need occasional maintenance. This upkeep consists of a simple cleaning and honing of the knives on the machine (see the Jointer or the Planer Owners Manual). However, this type of edge repair will only go so far before the knives need to be removed and thoroughly ground.

The best way to grind jointer and planer knives is to use the Shopsmith Grinding Wheel and Knife Sharpening Accessory that mounts on the Mark V. Set up the grinding wheel according to the Owners Manual that came with the Grinding Wheel.

Select the proper **hard** wheel for the severity of the cutting edge damage (coarse for nicks and a badly worn cutting edge and fine for routine grinding). ***Warning: Never use the soft rubber-bonded abrasive or all-purpose wheels to grind jointer or planer knives. The sharp cutting edge of the knives will dig into the soft wheel and cause the knife to be thrown from your hands, causing serious hand cuts and damaging the wheel and the knife.***

Remove the knives from the cutterhead according to the Jointer or the Planer Owners Manual. Planer and jointer knives are ground in a two-step operation. First, the primary bevel is ground. Then a secondary bevel is ground on the front edge of the primary bevel (Figure 24-37). This strengthens the cutting edge and helps dissipate the heat during cutting.

After the knives are used, they can be either honed in the jointer or planer, or reground on the secondary bevel. You will be able to re-grind the knives in this manner several times until the secondary bevel becomes either wider than the primary bevel or wider than 1/8″.

Grinding Wheel Setup—Set the primary bevel angle by placing the knife on the knife rest in front of the knife guide. Loosen the wing nut and tilt the tool rest until the knife bevel is centered on the wheel (Figure 24-38). ***Warning: Position the tool rest no further than 1/8″ away from the wheel.*** Then tighten the wing nut.

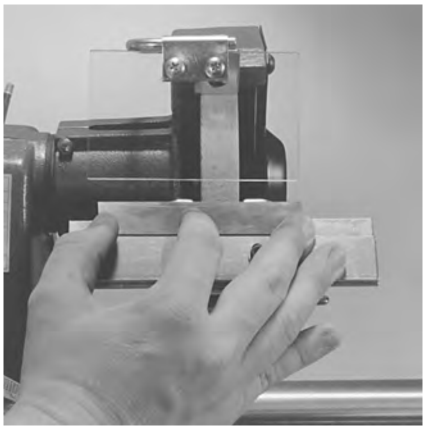


Figure 24-39. Hold the jointer knife with one hand while sliding it back and forth across the wheel.

Position the knife guide behind the knife so that it aligns the knife parallel to and just touching the wheel. Securely tighten the two screws that hold the knife guide in place. Remove the knife.

Grinding the Knives—Be sure that the speed dial is set to **"Slow"**. Turn on the Mark V and set the speed dial to "R" (3500 RPM). Hold the knife firmly on one end of the knife rest and feel for it seating solidly against the knife guide.

The 4″ **jointer** knives are held with one hand and slid back and forth across the knife rest (Figure 24-39). The 12″ **planer** knives are ground in three overlapping sections (Figures 24-40A, B, and C).

Slide the knife slowly across the knife rest and knife guide, and past the wheel. *Caution: Keep the knife moving. If you hesitate, the wheel will heat up the knife and turn the edge blue. This will ruin the factory heat treating.*

Grind the knives at this setting until the sparking stops. When the sparking stops, the knife should be evenly ground.

If some of the nicks are still showing on the edge of the first knife, or only part of the bevel is ground, you may need to reset the guide and continue grinding the primary bevel. But if the remaining edge damage is minor or all but a slight part of the bevel is yet to be ground, the secondary bevel

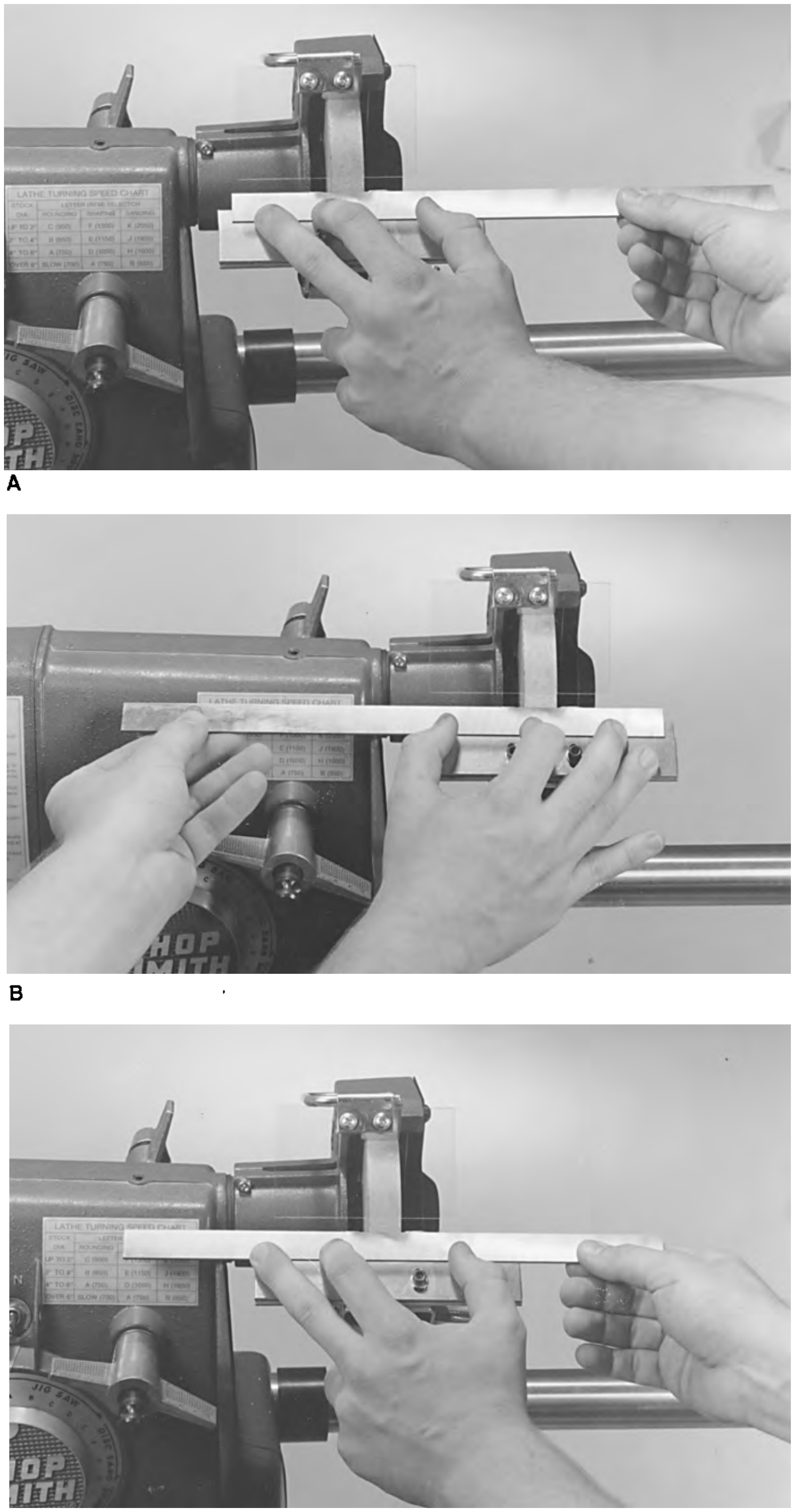


Figure 24-40. Planer knives are ground in three overlapping sections: (A) grinding the left end, (B) grinding the right end, and (C) grinding the center.

grinding operation will grind away and true up the edge.

Grind the primary bevel on the other two knives at this setting. Then turn the speed dial to "**Slow**" and turn off the machine.

Set the secondary bevel angle by loosening the wing nut and resetting the tool rest approximately 10° to 15° toward the wheel. Tighten the wing nut.

Place the knife on the knife rest and reposition the knife guide so that the knife just touches the wheel (Figure 24-41). Repeat the knife grinding procedures explained above. It should only take one or two passes to grind the secondary bevel.

It is **not** necessary to hone the jointer and planer knives after they are ground. The burr that is left on the cutting edge is small, and will be knocked off at the first contact with the stock.

GRINDING SHAPER CUTTERS

Two and three wing shaper cutters may be the most misunderstood cutters in the workshop when it comes to sharpening. It may appear that all the complicated curved wings, on each cutter, must be identically ground and then honed on their curved surfaces. Well this is only partially true and **not** nearly as difficult as it may sound. These cutters need only be accurately sharpened on the leading flat face.

For shaper cutters this is made easy be using the Shopsmith Sharpening Guide. By precisely grinding the face of each wing of each cutter, the cutting edge is sharpened.

Mount the sharpening guide on the Mark V worktable and position it according to the Owners Manual. Mount the sanding disc and position it 3" away from the worktable.

To mount the shaper cutter to the sharpening guide, first, slip the small rub collar on the 1/2" shaper arbor. Then slide the arbor, from the bottom up, through the hole in the base of the sharpening guide.

Slip the cutter over the arbor. Hold the cutter wing firmly against the face of the sharpening guide. Install the tongue washer and nut. Tighten the nut fingertight to hold the cutter in place (Figure 24-42).

Adjust the sharpening guide to the "0" setting. Position the guide on the worktable until the disc will completely cover the face of the cutter when the quill is extended. Lock the sharpening guide securely in place (Figure 24-43).

Position the disc no further than 2" away from the face of the cutter and lock the power plant lock.

Extend the quill until the disc comes in full contact with the face of the cutter. Slight adjustments of the sharpening guide may be needed at this time to position the cutter face precisely in front of the disc.

Set the depth stop to "0" and lock it in place. When the quill is extended the abrasive will remove a slight amount of metal from the wing.

Be sure that the speed dial is set to "**Slow**", then turn on the machine. Allow the abrasive to contact the cutter for only a moment then allow the quill to retract. Continue this until the sparking stops. Turn off the machine.

With the quill retracted, unplug the Mark V, loosen and remove the arbor nut and tongue washer holding the cutter in place. Slide the cutter off the arbor. Rotate the cutter so that the flat of the next wing is facing the disc. Replace the nut and tongue washer. While holding the cutter against the side of the sharpening guide, tighten the arbor nut securely.

Repeat the previous grinding steps without moving either the depth stop, carriage or the power plant. Rotate the cutter as described above to grind the third wing of the cutter. Then hone the face of each wing.

***Figure 24-41.** Reposition the knife guide so that the knife just touches the grinding wheel.*

***Figure 24-42.** Hold the cutter wing against the sharpening guide and tighten the nut finger tight.*

***Figure 24-43.** Position the cutter fully in front of the disc and lock the guide in place.*

HONING SHAPER CUTTERS AND ROUTER BITS

It is a simple matter to remove the grinding burr from a shaper cutter left by the abrasive. To avoid changing the cutter's profile, do not hone its curved or beveled edges. ***Warning: Because of their size, router bits are not easily ground so it is recommended that these bits only be sharpened by honing the leading flat face.***

To hone steel cutters and bits, start with a coarse hone (of any type) and progress to fine. To hone solid carbide or carbide tipped cutters and bits, you must use a diamond hone. As you progress, reduce the pressure applied to the hone.

Lay the flat face of the cutter or bit on the flat top surface of the hone with the rest of the cutter overhanging the edge. Rub the cutter or bit up and down the hone (Figure 24-44). Be sure to hold the cutter flat against the surface of the hone while working it back and forth.

Count your honing strokes and hone each wing of the cutter or leading flat face of the bit an equal amount. This will assure equal metal removal and keep the cutter or bit properly balanced. The slight burr that may be created after the grinding burr is removed from the cutter will be knocked off when the cutter first contacts the wood.

HONING MOLDER KNIVES

Warning: Molder knives should be honed only. Start with a coarse hone (of any type), then progress to fine. Lay the flat face of the molder knife cutting profile on the surface of the hone with the rest of the knife overhanging the edge.

To avoid changing the cutter's profile, do not hone its curved or beveled edges. Hold the knife flat against the surface of the hone while working it back and forth. (Figure 24-45). ***Warning: Hone ONLY the area of the knife that cuts the wood. Do not hone the part of the knife that is held inside the molder head. If the surface of the knife inside the molder head is thinned, the knife holding system will be weakened and the knife may break.***

Count your honing strokes and hone each molder knife an equal amount. This will assure equal metal removal from each knife and keep the assembled molder head properly balanced. The slight burrs that may be created by honing will be knocked off the cutting edges when the molder knives first contact the wood.

HONING LATHE DUPLICATOR CUTTERS

Warning: Lathe duplicator cutters should be honed only. To hone the solid carbide cutters (round, triangle, square or diamond), you must use a diamond hone. ***Warning: DO NOT attempt to grind the solid carbide cutters. The carbide dust is hazardous and may cause health problems.***

Lay the flat side of the **square or triangle** cutter on the surface of the hone. Hold the edge of the cutter flat against the surface while working it up and down the hone (Figure 24-46). Count your honing strokes and hone each side of the multi-sided cutters an equal amount. This will assure equal stock removal from each side of the cutter.

To avoid honing a flat spot in the **round** cutter's profile, roll the cutter as it is honed (Figure 24-47).

To hone the **cone** (steel) cutter, start with a medium hone (of any type). Hone the cutter progressing from medium to ultra-fine. Use the edge of a curved slip stone to remove the burr on the inside of the cutter and produce a razor sharp edge (Figure 24-48).

Each cutter can only be honed a few times before its size and profile are reduced so that it will not

Figure 24-44. *Lay the flat face of the cutter on the surface of the hone and rub the cutter across it.*

Figure 24-45. *Lay the flat face of the molder knife on the surface of the hone and rub the knife back and forth.*

Figure 24-46. *Lay the flat side of the cutter on the surface of the hone and rub it across the hone.*

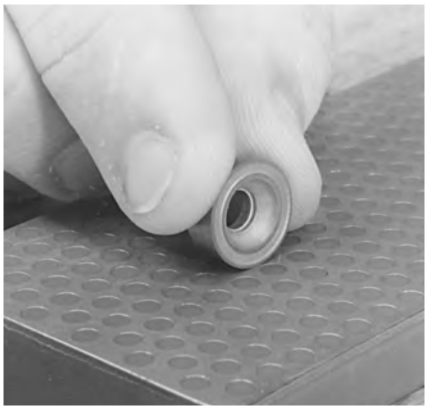


Figure 24-47. To avoid honing a flat spot in the round cutter, roll it while honing.

Figure 24-48. Use the edge of a curved slip stone to hone the inside edge of the cone cutter.

match the follower. When this happens, the cutter may be discarded or the follower can be sanded (by hand) with fine sandpaper to match the cutter.

SHARPENING MORTISING CHISELS

The inside of the mortising chisels are ground and honed with special cone-shaped grinding stones mounted in the drill chuck. The outside is then honed on a flat bench stone.

Grinding Mortising Chisels

Even when new the chisels will usually need to be ground or at least honed. All four corners as well as the edges **MUST** be razor sharp. This is critical to the accurate operation of the mortising accessory.

Use the white conical grinding stone to sharpen the 1/4″ chisel, and the red conical grinding stone to sharpen the 3/8″ and the 1/2″ chisels.

To properly grind mortising chisels, a support fixture must first be made (Figure 24-49). The fixture will be mounted to the miter gauge. Set up the Mark V in the horizontal boring mode. Instead of mounting a drill bit in the chuck, install the proper grinding stone for the size chisel being ground.

Clamp the support fixture on the table. Set the chisel on the fixture and back up the chisel with the rip fence. Hold the chisel against the fixture and the fence, and center the chisel on the grinding stone and lock the table in position.

Position the power plant, with the stone mounted in the chuck, so that the stone is 2″ from the chisel. Extend the quill until the stone touches the chisel and set the depth stop to "0" and allow the quill to retract. ***Warning: Be sure that the speed dial is set to "Slow," then turn on the machine.*** Extend the quill until it contacts the chisel momentarily then allow it to retract (Figure 24-50). Repeat this until the stone ceases to remove any more metal.

Inspect the tips and the edges of the chisel. Look for the grinding burr on all edges and the four tips. If there are still un-ground surfaces or tips, repeat the above steps to remove additional metal.

If the stone becomes loaded with metal particles, it can be cleaned. Turn off the Mark V and apply a generous amount of oil to the stone. Rub the oil into the stone to lift out the metal particles.

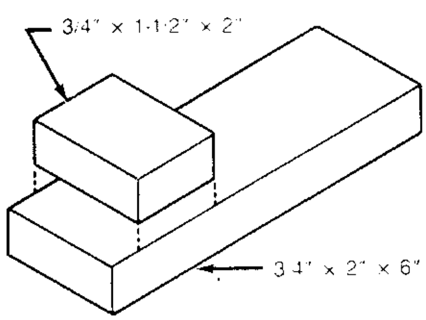


Figure 24-49. Construction details of a mortising chisel support fixture.

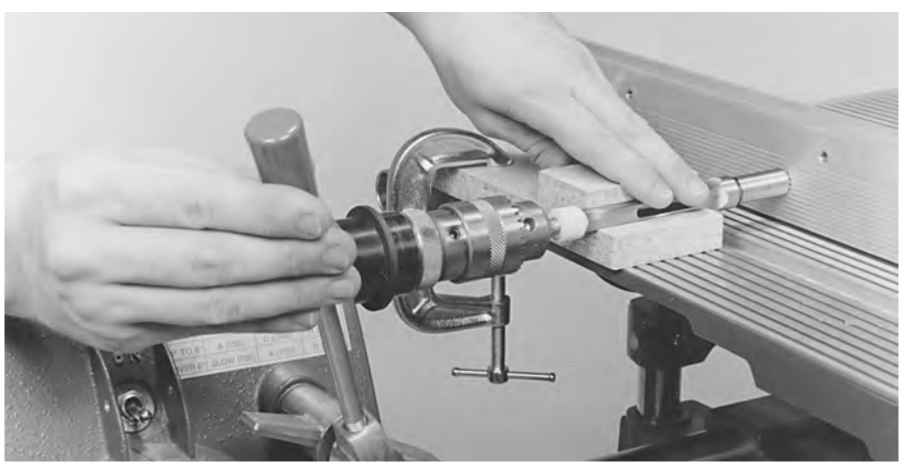


Figure 24-50. Grind a mortising chisel as shown. Retract the quill and repeat until the stone stops removing metal.

Figure 24-51. Lay the chisel on a flat stone and move it back and forth to remove the grinding burr.

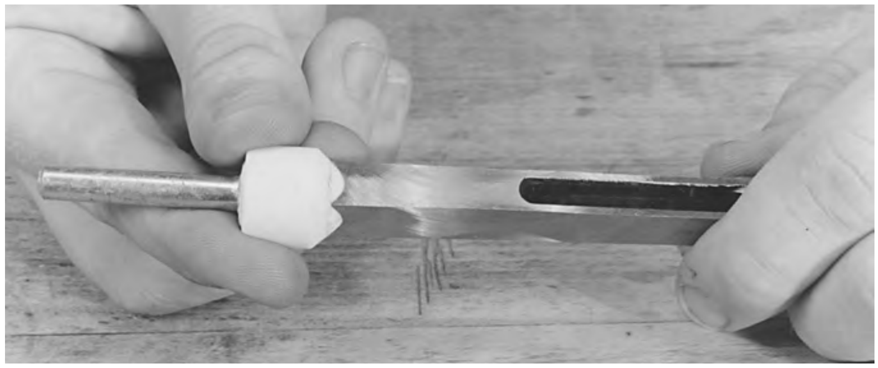


Figure 24-52. Use the cone-shaped grinding stone to remove the internal burr.

Honing Mortising Chisels

After grinding is complete or the chisel has become slightly dull, hone the mortising chisel on a flat bench stone and the cone-shaped grinding stone.

Lay the chisel flat on a bench stone and move it back and forth to remove the grinding burr from the outside (Figure 24-51). Count the strokes and hone each side of the chisel an equal amount.

To remove the burr from the inside of the chisel, hand-hold the cone-shaped stone straight in the end of the chisel and rotate the chisel back and forth several times (Figure 24-52).

Repeat the honing on the bench stone with progressively finer stones along with the internal honing with the cone-shaped stones until the tips and edges are razor sharp.

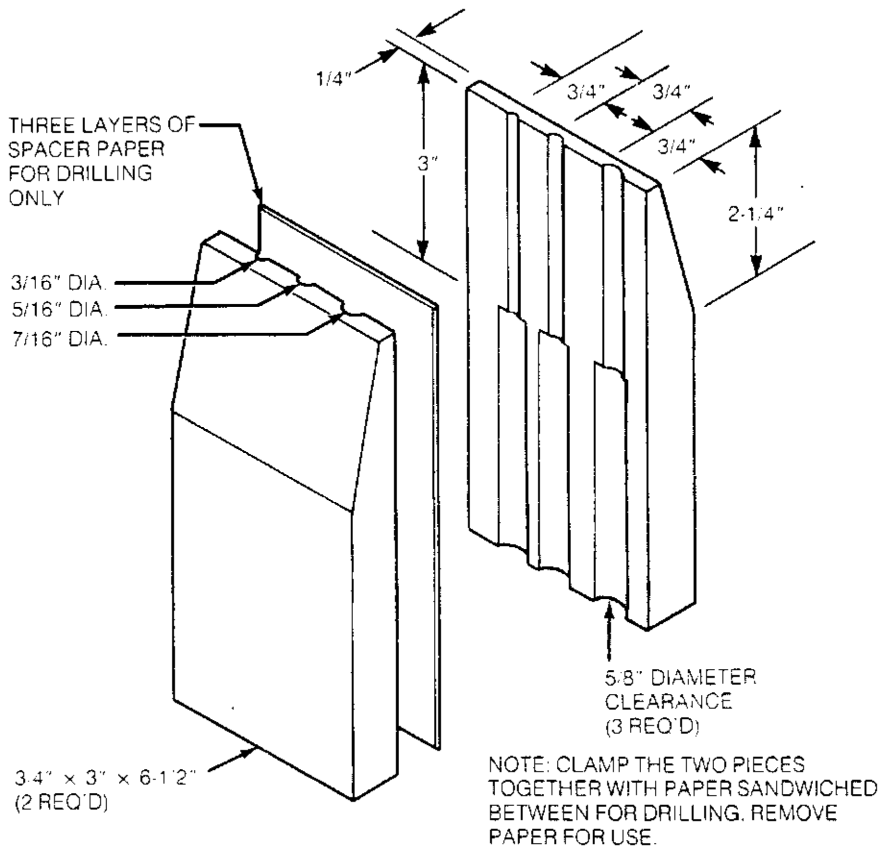


Figure 24-53. Construction details of a filing block for filing and honing mortising bits.

SHARPENING MORTISING BITS

Along with the chisels, the bits must be periodically sharpened. They can be honed with contoured slips when only slightly dull, but must be filed and then honed after they become extremely dull. Clean the bit thoroughly before attempting to file or hone it.

Filing Mortising Bits

Before the bits can be filed you must make a filing block that fits in a vise (Figure 24-53). Use drill bits, not mortising bits, to drill the holes in the filing block. Mortising bits flair out at the tip and will drill an oversized hole.

Attach the filing block to the inside of the vise jaws with double-sided tape. Close the vise to within 1/16". Slide the mortising bit in the proper hole with the cutting flutes of the bit parallel to the vise jaws and no more than 1/4" above the top of the wooden blocks. Close the vise to clamp the bit in position (Figure 24-54).

Use a small square or rectangular fine single or double cut file to sharpen the cutting edges of the mortising bit. Filing should take only a couple of strokes. Start with the inside surface of the two side cutters. Follow the "factory ground" angle on the inside of the bit.

File from the back of the cutting edge to the front on one of the side cutters. Count your strokes and repeat the same number of strokes on the inside surface of the other side cutter (Figure 24-55).

In a similar manner, hold the file on the "factory ground" bevel forming the bottom relief angle of the bit and file this surface. Count the strokes and repeat the same number of strokes on the other bottom relief angle (Figure 24-56).

The final filing steps are performed on the front of the cutting edge. This will remove the burrs created by the previous filing steps. Hold the file almost vertical against the front cutting bevel and push the file down along the bevel (Figure 24-57). Count the strokes and repeat the same number of strokes on the other front cutting bevel.

Honing Mortising Bits

In most cases the use of a fine enough file will sharpen the bit sufficiently. If there is a burr on the cutting edge, or tearing of the wood fibers during use, honing of the bit's cutting edge will be necessary.

Use a fine contoured slip stone. A triangular or a tear-drop shape works well. These are usually oil stones, rubber bonded abrasives, or diamond hones. All work equally well.

Hone only the inside edges of the two side cutters (Figure 24-58) and the two front cutting bevels (Figure 24-59). Do not attempt to hone the bottom relief angle on the bottom of the bit. Honing is done in the same manner as filing. Remember to count your strokes and hone each surface equally.

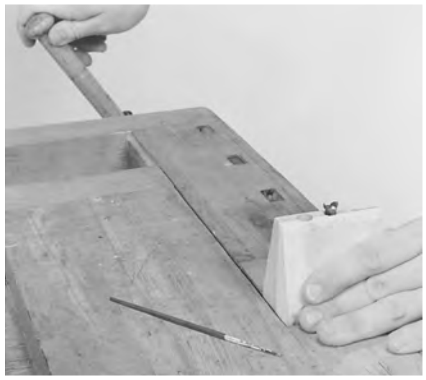


Figure 24-54. *Position the moritising bit in the filing block and close the vise.*

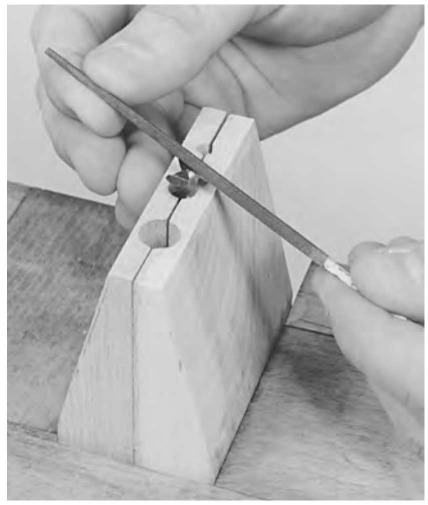


Figure 24-55. *File from the back of the cutting edge to the front on the side cutters.*

Figure 24-56. *File the bottom relief angles from back to front.*

Figure 24-57. *File vertically to sharpen the front cutting bevel.*

Figure 24-58. *Hone only the inside edges of the two side cutters.*

Figure 24-59. *Hone the two front cutting bevels.*

Chapter 25
Dust Collector

The Dust Collector (Figure 25-1) provides an efficient and effective means to collect wood shavings and sawdust from your workshop. Unlike conventional shop vacuums, the Dust Collector is designed to collect and filter the large volume of dust and shavings produced by modern woodworking equipment. When used in conjunction with efficient dust collection chutes and attachments, the Dust Collector will help you approach dust-free woodworking.

The "heart" of the Dust Collector is a large industrial blower which moves large volumes of air. Sawdust and wood shavings pass through the blower, slow down, and then settle in the disposable bag. The air returns to the room after passing through a large, permanent filter capable of capturing even the smallest wood dust particles.

When you put your hand over the end of the Dust Collector hose you will not feel the high vacuum, or sealed suction, of a home or shop vacuum. A home vacuum cleaner needs this sealed suction to move air through small openings. A typical shop vacuum also requires a high sealed suction when used for water pickup. The large airflow of the Dust Collector can be felt by placing a few fingers into the end of the hose. The airflow of the Dust Collector is much higher than any home or shop vacuum.

ASSEMBLY AND FEATURES

Use the standard accessories or your choice of optional accessories shown in Figures 25-2 and 25-3 for dust collection operations. To assemble your Dust Collector, follow the instructions in the Owners Manual that came with your unit. Also, pay special attention to the electrical requirements listed in the manual.

Figure 25-1. *The Shopsmith DC3300 Dust Collector.*

Some of the important features of your Dust Collector are:

- The large airflow and filter capacity make it suitable for other dust producing activities such as drywall sanding (Figure 25-4). Through use, you'll discover more.
- The heavy polyester/felt filter hood filters out sawdust particles from the air and returns virtually dust-free air to the room. The standard seven square feet of filter area allows the Dust Collector to move air at normally 330 cubic feet per minute (cfm).
- A choice of hookups gives you greater versatility. For portable operation using the standard 3-way inlet, you can connect one 2-1/2" diameter hose or use two or three hoses simultaneously. For equipment that has a 4" dust chute or for a permanent piping dust collection system, an optional 4" inlet assembly can be substituted. Its elbow can be set at four different positions 90° apart.
- The powerful 1/2 hp motor is enclosed to keep out harmful dust particles, is fan cooled, and has no brushes to wear out.
- The large 4-vane fan creates maximum airflow to eliminate the settling of debris in the hoses.
- The heavy duty, see-through collection bag has a 30 gallon capacity and is 4 mils thick. A quick-release strap and bag retainer clips make changeovers a one-person job.
- The oversize wheels and casters provide easy mobility while making the Dust Collector relatively tip-proof.
- Standard accessories include (Figure 25-2):
  - The durable and kink-resistant flexible hoses attach to stationary or hand-held power woodworking equipment having 2-1/4" dust chutes.
  - The reducer allows you to connect equipment with 1-1/4" chutes found on older models of the Mark V Model 500 and Belt Sander.
  - The two extension wands eliminate back bending for floor cleanup.

Figure 25-2. *The standard accessories for the Dust Collector are: (A) two 2-1/2" × 8' flexible pickup hoses, (B) floor nozzle, (C) two extension wands, (D) 2-1/2" to 1-1/4" reducer, (E) utility nozzle, (F) elbow brush, (G) two inlet plugs, (H) six 30-gallon waste disposal bags, and two inlet plug caps (not shown).*

Figure 25-4. *Use your Dust Collector for other dust producing activities such as drywall sanding.*

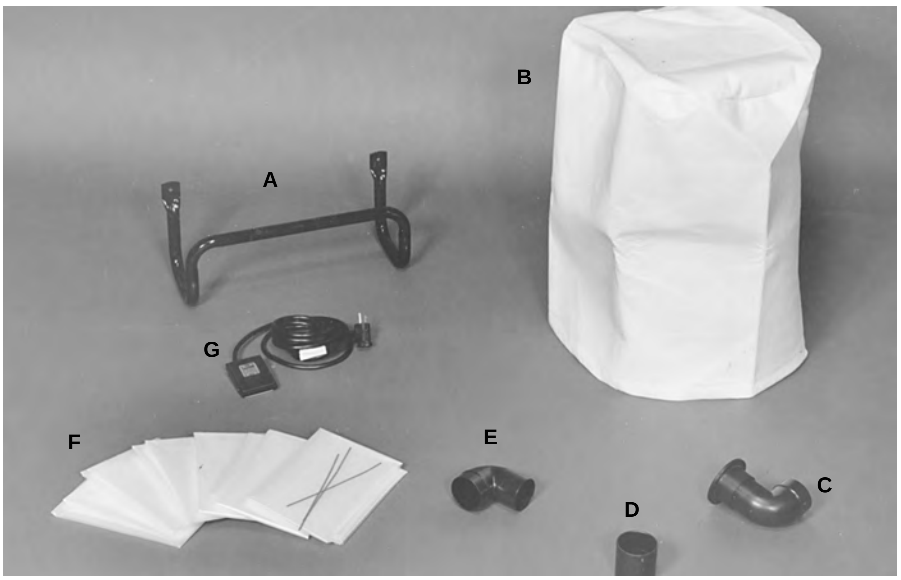


Figure 25-3. *Some optional accessories for the Dust Collector are: (A) Hose Rack, (B) 24" Filter Hood, (C) Bandsaw Dust Chute, (D) 2-1/2" Hose Connector (coupler), (E) 2-1/2" Elbow, (F) Six 30-gallon waste disposal bags, and (G) Remote Foot Switch and 4" inlet assembly (not shown).*

— The floor nozzle has a built-in brush and roller wheels for quick and easy floor work.
— The utility nozzle is designed for bench top cleaning and for tight spots where the floor nozzle is too big.
— The elbow brush can be used for sweeping shelves, walls, equipment, or work-pieces.

• Optional accessories include (Figure 25-3):
— The hose rack, on which you can neatly store your hoses, including extras.
— The 4" Inlet Assembly, used to build a permanent dust collection piping system (described later in this chapter).
— The extra large 24" filter hood has twice the capacity as the standard filter hood, allowing twice as much time between cleanings.
— The remote foot switch gives you convenient and complete control of the Dust Collector.

THE IMPORTANCE OF EFFICIENT DUST COLLECTION

As cautioned in Chapter 1, uncontrolled sawdust can be both a nuisance and a hazard—especially the potential health hazard of breathing sawdust. Because this involves even the most common woods, you should be particularly aware of woods that are known to be toxic.

For your safety, please refer to the list of toxic woods and the reactions they may cause (Table 25-1). Not everyone is sensitive to these woods, but you should still be very careful when working with them.

DUST COLLECTOR SAFETY

Before you get ready to use the Dust Collector, read these important safety considerations:

• **Ground the Dust Collector. The Dust Collector comes**

Table 25-1: Toxic Woods and Possible Reactions

Wood	Respiratory Ailments	Skin and Eye Allergies
Arborvitae	X	
Ayan		X
Blackwood, African		X
Boxwood	X	X
Cashew		X
Cedar, Western Red	X	X
Cocobolo		X
Cocus		X
Dahoma	X	
Ebony	X	X
Greenheart	X	X
Guarea	X	
Ipe (lapacho)	X	X
Iroko	X	X
Katon	X	
Mahogany, African	X	X
Mahogany, American		X
Makore	X	X
Mansonia	X	X
Obeche	X	X
Opepe	X	X
Peroba Rosa	X	X
Peroba, White	X	X
Ramin		X
Rosewood, Brazilian		X
Rosewood, East Indian		X
Satinwood, Ceylon		X
Satinwood, West Indian		X
Sequoia, Redwood	X	
Sneezewood	X	
Stavewood	X	
Sucupira		X
Teak		X
Wenge	X	X

Note: This table has been reprinted from *Fine Woodworking* Magazine, copyright 1983, The Taunton Press, Inc., 63 South Main Street, Box 355, Newtown, CT 06470.

equipped with an approved 3-conductor cord and a 3-prong grounding type plug to fit the proper grounding type receptacle. The green conductor in the cord is the grounding wire. Never connect the green wire to a live terminal.

• Avoid dangerous environments. Electric shock could occur if the Dust Collector is used on wet surfaces. Do not expose it to rain, snow or wet floors. Store it indoors.

• Do not operate the Dust Collector without the 3-way inlet or the 4" inlet assembly securely mounted in place. The powerful suction can actually pull body parts into the intake opening and cause contact with the motor fan.

• Do not pick up water or wet materials with the Dust Collector.

• Position the hose(s) out of the way so you won't trip over them.

• Do not pick up hot or burning materials such as cigarettes and ashes. They could ignite a fire in the bag. These materials should be properly disposed of in a fire-proof container.

• Do not attach the Dust Collector to a tool used for metal grinding or sharpening. Sparks generated during grinding could ignite dust and shavings inside the bag. They may also damage the hose and the fittings.

• Do not reach across a power tool to turn off the Dust Collector. Turn off the power tool and then go around to the Dust Collector and turn it off.

• Do not force the Dust Collector to do a job for which it was not designed.

• Check damaged parts. A damaged part should be properly repaired or replaced before further use. If a strange noise or vibration develops, immediately turn off the power, unplug the Dust Collector and correct the problem.

• Avoid unintentional starting. Make sure the switch is in the "Off" position before plugging in or unplugging the Dust Collector.

• Turn off and unplug the Dust Collector before changing bags and performing maintenance or service.

• Do not stand or lean on the Dust Collector. You could fall onto it, or it could tip over, injuring you and/or damaging the Dust Collector.

• Use only recommended Shopsmith replacement parts and accessories on your Dust Collector. NEVER use non-Shopsmith replacement parts or accessories. Using non-Shopsmith parts may cause a hazardous condition and will void your warranty.

• Do not leave the Dust Collector running unattended.

• Do not drag the cord across sharp tools or edges which could damage the cord. Do not try to move or unplug the Dust Collector by pulling on the cord.

NOTE: Static electrical discharge sometimes builds up on the Dust Collector, hoses and wands. It is rarely a safety problem, but it can give you an unpleasant sting—especially when you're not expecting it while using the Dust Collector. When the Dust Collector is operating under "dry" conditions (dry air and/or dry wood), static electricity can build up in the flexible hose(s). To keep static electricity to a minimum, before and during vacuuming, maintain hand contact with a metal surface of the nearest **turned off** machine.

PORTABLE USE

Position the Dust Collector conveniently near the power equipment. Connect the hose(s) to the 3-way inlet and to the dust chute(s) on power equipment. See Figure 25-5 for the various hose connection points.

FLEXIBLE HOSE AIRFLOW (2-1/2″ × 8′ SIZE)

No. Used	Airflow (CFM)
1	107
2	100 Each
3	95 Each

CFM = Cubic feet per minute.

Push the plug caps onto the inlet plugs. Then place an inlet plug assembly in any inlet not being used. These plugs help to muffle noise and slightly increase the suction power. If you desire, you can leave inlets open to help filter dust from the air.

Remember that all materials picked up pass through the blower. While the fan will not be damaged by small scraps which you may occasionally pick up, don't make a practice of picking up scraps. They will pass through the fan and be struck at high velocity by the fan blades and flung against the blower fan housing with a loud noise. In some instances, large scraps could even become jammed in the fan.

When the Dust Collector is attached to woodworking equipment by the hoses, there is no occasion for large scraps to be sucked into the blower. However, when sweeping the floor and cleaning up, pick up large wood scraps **before** you use the dust collector. *Caution: Do not sweep into the Dust Collector scraps or solid objects the size (or larger) of those shown below. They may damage or jam the fan.*

PERMANENT PIPING SYSTEM

For some workshops, it may be more convenient to install permanent piping rather than to move the Dust Collector to various locations throughout the shop.

The optional 4″ inlet assembly is the link to a permanent installation. It replaces the 3-way inlet of the Dust Collector to connect to a permanent piping system along the walls of your workshop. With a permanent setup using PVC (polyvinyl chloride) pipes and 2-1/2″ diameter flexible hoses, you can conveniently work with as many as three machines in succession without moving the Dust Collector or changing hose connections.

Inlet Installation

Warning: Turn off and unplug the Dust Collector. Remove the cover plate and 3-way inlet from the Dust Collector. Attach the 4″ inlet assembly with the four screws that attach the 3-way inlet.

The elbow of the inlet assembly can be set at four positions 90° apart. If necessary to change the position of the elbow, take out its two attaching screws. Turn the elbow to the desired position, making sure that the mounting holes of the elbow and inlet line up. Reinstall the two screws securely.

System Requirements

In planning a permanent system, keep in mind that long lengths of flexible hose will reduce airflow. Also, smooth piping causes much less resistance to airflow and is strongly recommended for the main collection line of your system. Rigid PVC pipe and various fittings are available at most home centers or plumbing supply distributors, and are best suited for permanent systems.

Figure 25-6 illustrates a **suggested** permanent piping system. The following requirements should be met in building an efficient dust removal system:

- Make your system simple, compact and efficient. Avoid long runs, sharp turns and restrictions.
- The overall length of the PVC piping **should not exceed 25 feet.** This length permits use of:
  - — Two 90° elbows (including the 4″ inlet assembly). Elbows reduce airflow. So, for each additional elbow used, you should reduce the overall length of your system. Refer to the chart in Figure 25-6 to determine the amount of piping reduction recommended for the addition of certain fittings.
  - — One 4″ dia. × 8′ long flexible hose from Dust Collector (not available through Shopsmith). This will make it more convenient when changing bags or moving the Dust Collector. However, it will reduce airflow slightly.

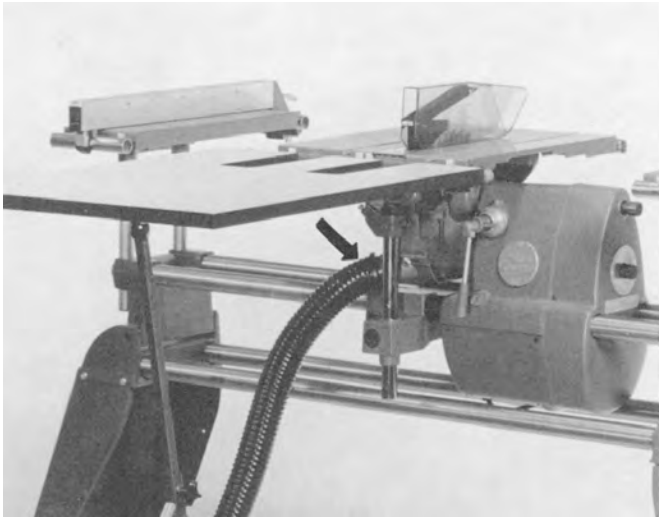


TABLE SAWING WITH MODEL 510
(Chapters 2-5)

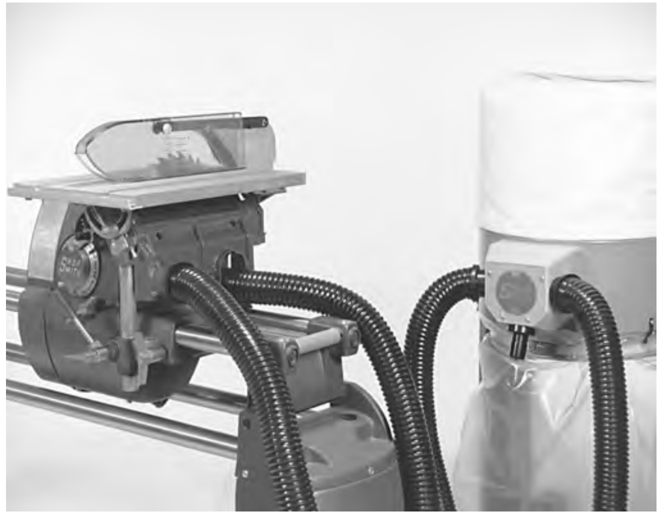
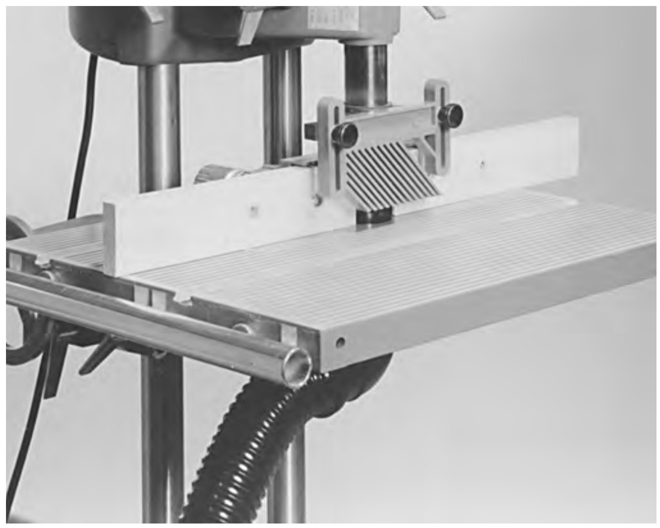


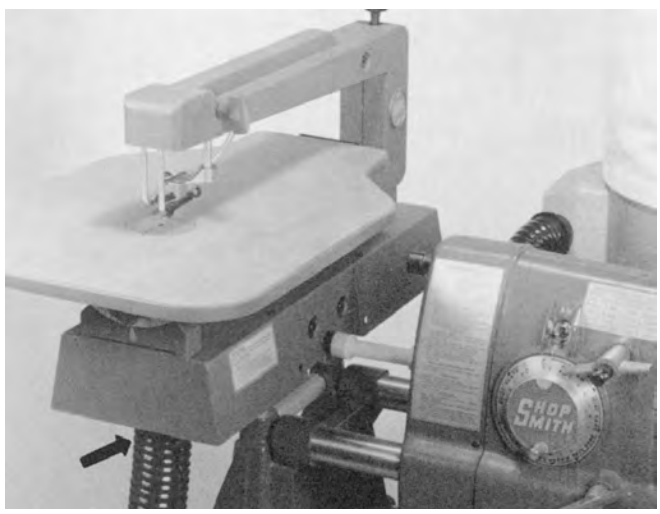
TABLE SAWING WITH MODEL 500
(Chapters 2-5)

JOINTER (Chapter 6)



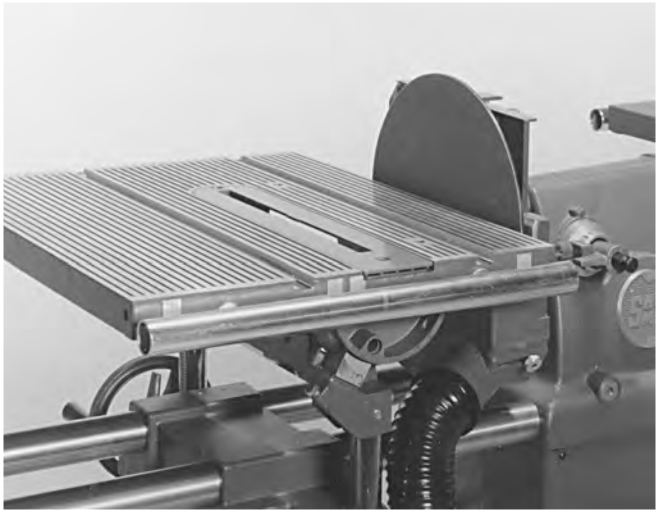
SHAPING (Chapter 9)

BANDSAW (Chapter 14)

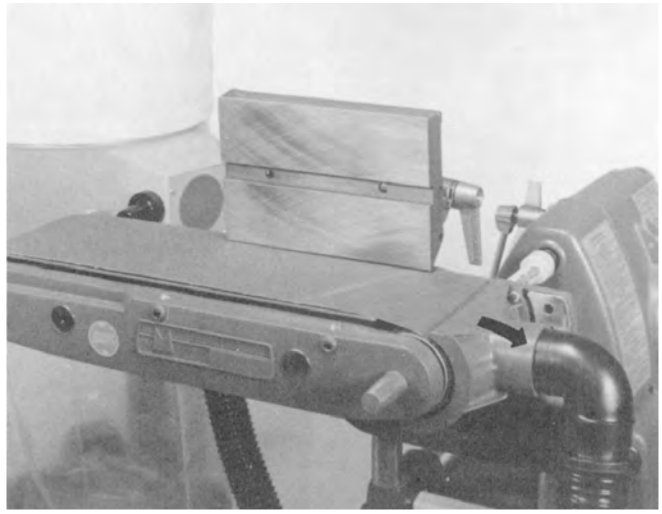


SCROLL SAW (Chapter 15)

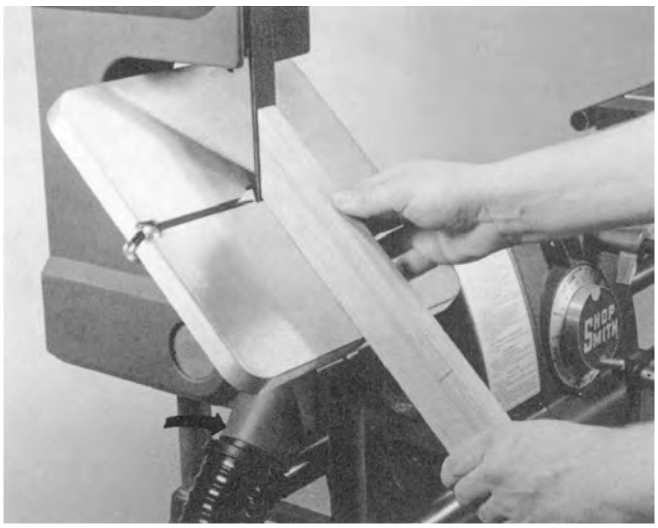
Figure 25-5. *Dust Collector hose connection points (1 of 2).*



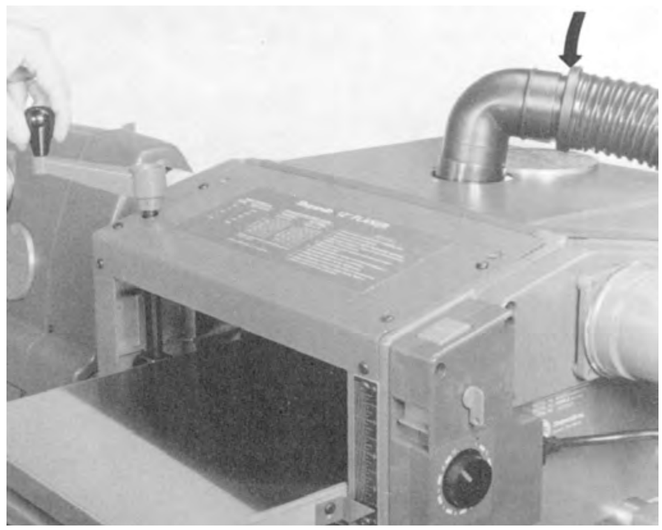
DISC SANDER (Chapter 17)



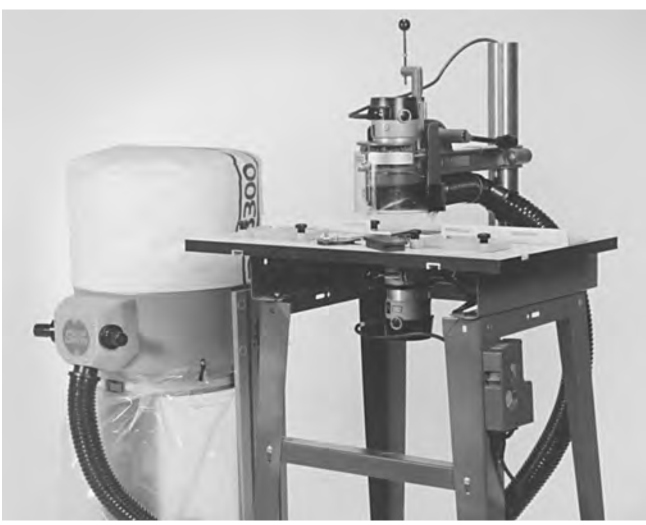
BELT SANDER (Chapter 19)



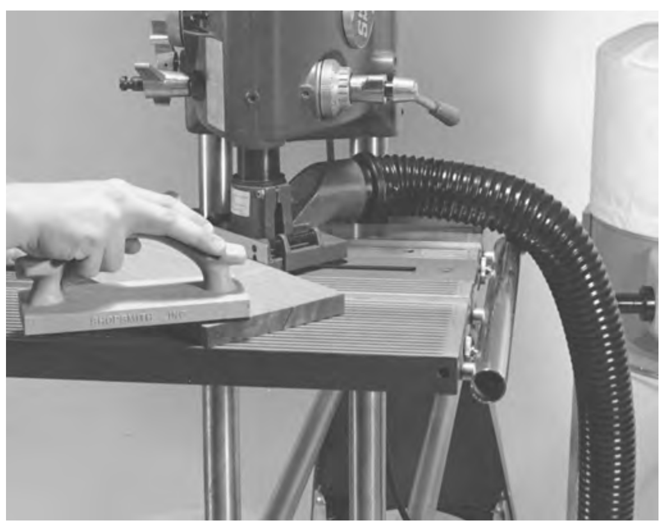
STRIP SANDER (Chapter 20)



PLANERS (Chapter 21)

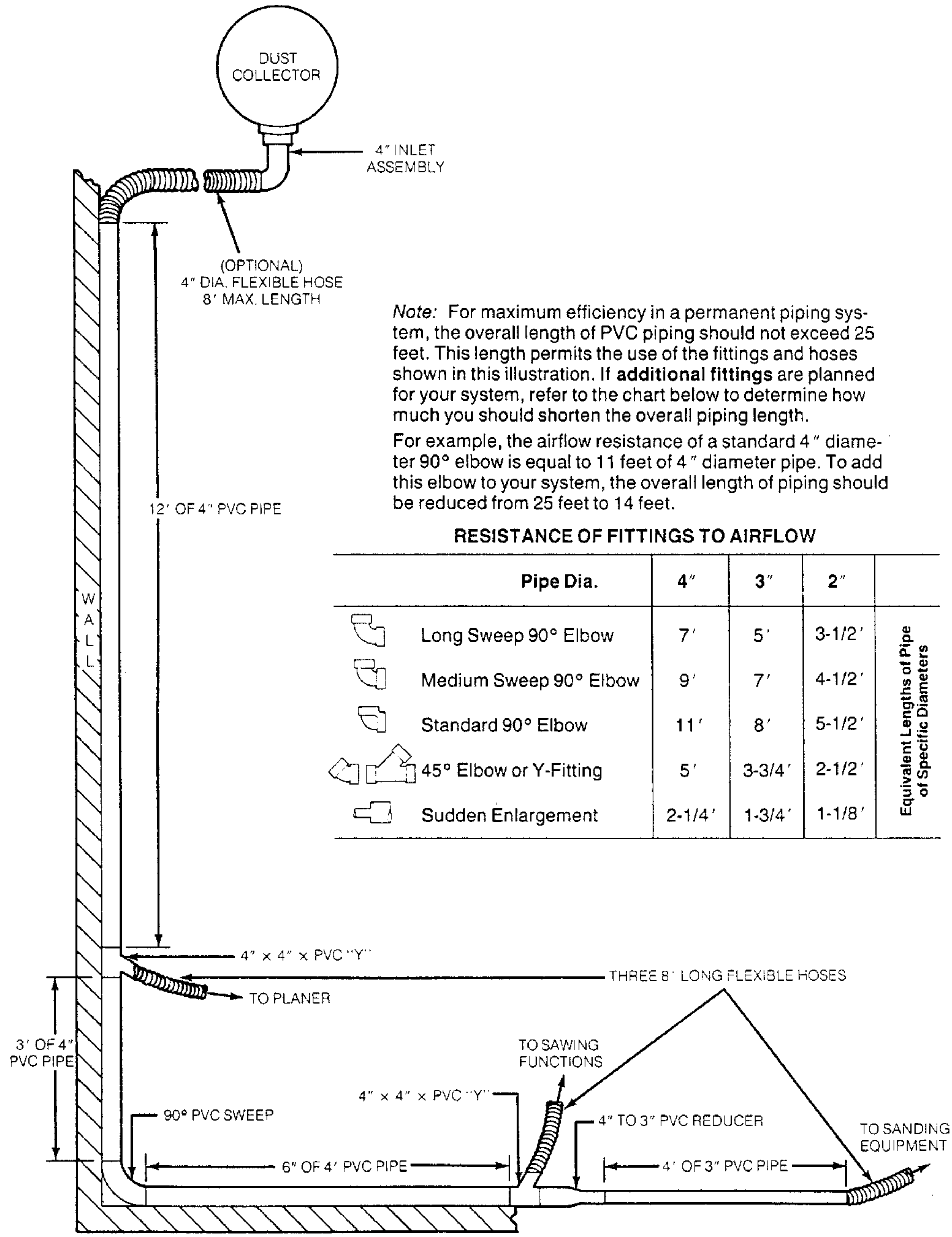


ROUTING SYSTEM (Chapter 22)



BISCUIT JOINER (Chapter 23)

Figure 25-5. *Dust Collector hose connection points (2 of 2).*



Note: For maximum efficiency in a permanent piping system, the overall length of PVC piping should not exceed 25 feet. This length permits the use of the fittings and hoses shown in this illustration. If **additional fittings** are planned for your system, refer to the chart below to determine how much you should shorten the overall piping length.

For example, the airflow resistance of a standard 4" diameter 90° elbow is equal to 11 feet of 4" diameter pipe. To add this elbow to your system, the overall length of piping should be reduced from 25 feet to 14 feet.

RESISTANCE OF FITTINGS TO AIRFLOW

Pipe Dia.	**4"**	**3"**	**2"**	
Long Sweep 90° Elbow	7'	5'	3-1/2'	**Equivalent Lengths of Pipe of Specific Diameters**
Medium Sweep 90° Elbow	9'	7'	4-1/2'	
Standard 90° Elbow	11'	8'	5-1/2'	
45° Elbow or Y-Fitting	5'	3-3/4'	2-1/2'	
Sudden Enlargement	2-1/4'	1-3/4'	1-1/8'	

Figure 25-6. *Suggested permanent piping system (overhead view).*

— Three 2-1/2″ dia. × 8′ long flexible hoses to connect to machinery. If you're planning a system that will connect more than three machines, have provisions for plugging or switching the hoses. Only connect three hoses at a time. Failure to do this would cause the machine at the end of the line to have insufficient airflow, with too little suction to remove sawdust from the machine.

• Use Schedule 10 (thin wall) PVC pipe and fittings. If Schedule 10 plumbing is not available, thicker walled pipe and fittings (higher Schedule number such as 40 or 60) may be used. However, because of the resulting differences in diameters, the flexible hose and piping connections will have to be taped securely with duct tape to prevent reduced airflow due to leakage.

• If multiple-size "Y" fittings are not available, 4″ × 4″ × 4″ "Y" fittings may be used. Wooden "doughnut" reducers can then be made to adapt the 4″ I.D. branch of each "Y" to accept the 2-1/4″ (outer diameter) male fitting of the 2-1/2″ diameter flexible hoses. (See Figure 25-7.)

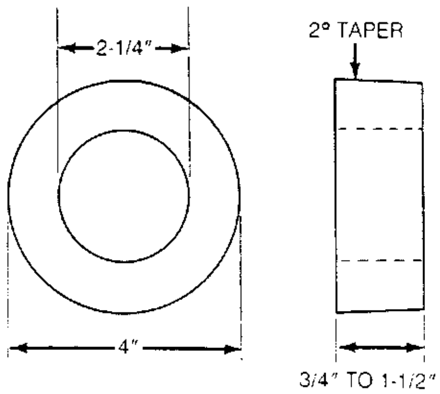


Figure 25-7. *How to make a "doughnut" reducer:*
1. Make a 4″ diameter wooden disc on a bandsaw (see illustration for the range of thicknesses).
2. Drill a hole 2-1/4″ through the center of the disc.
3. Disc sand the outer circumference of the wooden disc to get a slight taper.

• 90° elbows should be used only where absolutely necessary. Long sweep elbows are recommended. Do not use 90° tees in place of the "Y" fittings.

• Mount the PVC piping on your shop walls **at the same height as the inlet of the Dust Collector.** Use nylon straps and screws, wire and screws, or L-brackets, screws and wire to support the pipe. Place supports at each fitting or every 4 feet, whichever is closer.

• Avoid vertical lines.

• Limit the length of flexible hoses.

• Locate equipment which produces high volumes of chips and sawdust closest to the Dust Collector.

• Plug or cap unused openings, but keep at least two 2-1/2″ openings in use at all times to ensure sufficient airflow in 4″ pipe sections.

• Use duct tape, PVC cement or silicone around all permanent joints to prevent air leakage.

CLEANING THE FILTER HOOD

During operation, dust will build up on the inside surface of the filter hood. After every 8 to 10 hours of Dust Collector operation, vacuum the exterior of the filter hood. **Just before you change the collection bag,** tap the top and sides of the filter hood to dislodge the dust buildup. If you're generating a lot of fine dust, tap off the dust buildup more often.

After every 15 to 30 hours of operation, wash the filter hood to maintain optimum performance. Before washing, dislodge the dust buildup and **remove the retaining strap.** Then, hand or machine wash the hood in cold water using a mild detergent. Line dry or tumble dry on no heat. When the hood is dry, reinstall the retaining strap assembly.

CLEARING THE AIR

When cleaning up and before you open the door(s) of your shop to adjacent rooms, use the Dust Collector to remove the remaining airborn sawdust.

If your Dust Collector is portable, use one hose for vacuuming, with the remaining two inlets open to pull in the dusty air. If you have a permanent piping system, disconnect the flexible hoses from the equipment and then turn on the Dust Collector. How long it takes depends on the size of your workshop and the amount of airborne sawdust.

Glossary

Abrasives—Any substance such as aluminum oxide, silicon carbide, garnet, emery, flint or similar materials that is used to abrade or sand wood, steel or other materials. Substances such as India, Arkansas, crystolon, silicon carbide and waterstones used to sharpen steel edged tools are included.

Alternating Grain Direction—The process of gluing-up or laminating wood for project components with alternating pieces having the grain running perpendicular to one another (as opposed to parallel). Usually, this practice is enlisted to provide superior strength in a project that is expected to be under stress. It is also used occasionally for decorative purposes.

Bevel—An angular edge on a piece of stock, usually running from the top or face surface to the adjacent edge or the opposing (bottom) surface. In most cases, bevels are formed for joinery, but are also occasionally used for decorative purposes.

Chamfer—A slight angular edge that is formed on a piece of stock for decorative purposes or to eliminate sharp corners. Chamfers are similar to bevels but are less pronounced and do not go all the way from one surface to another.

Compound Cutting—The act of cutting out a project or project component (usually with a bandsaw) to create a three-dimensional or "sculpted" shape. This is accomplished by cutting one profile, taping scraps back in place, and rotating the workpiece to cut a second profile, usually 90° to the first.

Compound Miter—A combination miter and bevel cut. Generally a compound miter is used in building shadow box picture frames and similar projects where angled or "deep set" project sides are desired.

Compound Rip Cut—An operation that is performed by tilting the work table to the desired angle and guiding the workpiece through the cut with the aid of a taper jig. Typical uses for this cut would include the construction of pyramid-shaped projects; hollow, tapered posts or cylinders; or concrete forms for deck mountings, etc.

Concave—Generally a reduced surface relative to the surrounding surfaces. In lathe turning, a concave cut is called a cove.

Convex—Generally a raised surface relative to the surrounding surfaces. In lathe turning, a convex cut is called a bead.

Counterbore—The act of making one end of a drilled hole larger than the other to permit the head of a bolt or screw to drop below the surface of the workpiece. Counterbores, unlike countersinks, have straight sides (not angled). In woodworking, counterbored holes are often filled with wood plugs or screw buttons to create the illusion of dowel joinery.

Countersink—A shallow angled or beveled hole that is formed to allow the head of a flathead screw or bolt to be recessed and tightened flush with the surface of the workpiece. The tool designed to produce this special hole is called a countersink.

Coving—The creation of a concave cut or "groove" in the edge or surface of a workpiece. A cove can be produced with a router bit or by passing the workpiece across the top of a rotating table saw blade at an angle with the aid of a special coving fixture.

Cross Bevel—A bevel formed on the end of a workpiece by cutting perpendicular to the grain of the stock. Cross bevels are used most often in creating "invisible" joints where the sides of square, octagonal or other shaped boxes and similar projects meet.

Crosscut—A cut made across (or perpendicular to) the grain of the wood.

Dado—A U-shaped, square-cornered cut in the surface of a board that is made **across** the grain (not with it). This cut is easily made with a special adjustable dado accessory or by making repeat passes with a saw blade to create cuts of different widths. Dadoes are most frequently used for shelf support in cabinets and bookshelves, but are also used in the formation of many other types of joints.

Depth-Of-Cut—A universal term used to describe how deep a tool will be set to cut into the surface or edge of a workpiece. This term can be applied to any cutting tool such as saw blades, drill bits, router bits, shaper cutters, molding knives, etc.

Direction Of Rotation—The direction in which a blade, cutter, or disc turns during operation. In most cases, power tools rotate in a counter-clockwise direction when looking head-on at the shaft or arbor of the tool. With very few exceptions, when moving a workpiece into a cutter, blade or disc, it is best to move **against** the rotation of the cutter or blade for safety and best results.

Dovetail—A very strong joint in which a tapered, fan-shaped "pin" on one part of a project slips into a matching recess on the mating part. Dovetail joints are usually formed with a special router bit, and most frequently used in drawer and cabinet construction.

Dwell—The act of pausing during the process of making a cut with a power tool. Depending upon the tool, dwells can cause unsightly workpiece burning and should therefore be avoided, if possible.

Faceplate Turning—The process of turning a project on a lathe such as a bowl, cup, vase or other piece with a hollowed-out center. Faceplate turning enables this hollowing because unlike spindle turning, the workpiece is usually only supported on one end during operations.

Feather Board—A special safety device with many slender, springy "fingers" that press against a workpiece during operations to maintain the stock's position in relation to the blade or cutter and helping to keep hands out of the danger zone.

Fence Straddler—A unique, adjustable safety device that has been designed to straddle the rip fence on a table saw and serve as a pushing device during rip cuts. The fence straddler is especially useful when cutting strips that are too narrow to permit the use of a push stick or push block.

Fence Extension—A special, shop-made extension that is attached to the fence of a table saw, jointer or other piece of machinery and used to extend its length or height for specialized operations or to provide additional workpiece support. The use of such an extension often improves the accuracy of the cut as well as the safety of certain operations.

Finger Lap Joint—A very strong corner joint in which a series of square or rectangular "pegs" are formed on one workpiece to mate with interlocking, matching recesses on the adjoining piece. Finger joints are most often used in drawer and box construction, and are sometimes called a "box joint".

Fixture—A special aid or device that is used to guide a workpiece through a cut or help position stock accurately for a specific operation. Fixtures are most frequently used for repetitive operations or in production situations where precision is critical, often providing the added benefit of improved operator safety.

Grinding—In woodworking, the process of shaping metal with a motor driven abrasive wheel or grinding disc, usually in preparation for honing.

Grit—A term most commonly used to describe the fineness or coarseness of "sandpaper" and other abrasive materials. This degree of coarseness is expressed by a grit number.

Groove— A U-shaped, square-cornered cut in the surface of a board that is cut **with** the grain of the wood (not across it). Used in joinery as well as for decorative purposes.

Guide Pin—In overarm or pin routing, the center pin that protrudes up from the surface of the machine table and is used to guide a duplicating fixture through its cuts.

Honing—The final step in the process of sharpening an edged tool, after the blade or edge has been ground to the proper size and correctly shaped for its intended use. Honing which is done by hand removes the fine "wire edge" or burr that is formed during filing, grinding or shaping of the cutting edge on a coarse stone.

Indexing—In woodworking, the rotation of a round or cylindrical object a specified number of degrees for the purpose of performing a given operation. This process is most frequently used when drilling holes around the circumference of a circular object in the drill press mode, but can also be applied to reeding or fluting operations on the lathe or routing system.

Kerf—The slot that is created when a saw blade passes through a piece of stock.

Key—A small piece of wood that is used to strengthen or accent the corner joints of mitered projects. With keyed joints, the project is usually assembled and glued together first. Then, after the glue has dried, the keyways are cut and the keys are glued into position. Keys can be virtually any shape (square, dovetail, "butterfly", etc.) and are, in most cases, visible after assembly.

Kickback—A dangerous situation whereby a rotating blade, cutter or disc "grabs" a workpiece and throws it backwards in the direction of rotation. Kickback is best prevented by using accurate alignment and the appropriate safety devices such as the upper saw guard and feather boards, and by feeding your workpiece into the cutter slowly without forcing and supporting the workpiece properly.

Laminate—The bonding together of two or more pieces of material for decorative or strengthening purposes. An example of decorative lamination is a countertop made of plastic material glued to the surface of particleboard or flakeboard. An excellent example of lamination for strength is provided by ordinary plywood. Lamination can also be used for gluing up bent wood projects without the use of steam, chemicals or water.

Lap Joint—A common term that can be applied to several different types of joints in which one piece of wood overlaps and fits onto or into another. As a rule, the surfaces of lap joints are usually flush when assembled.

Loading Up—A term most commonly used to indicate that abrasive materials such as sandpaper, grinding wheels and sharpening stones are becoming clogged-up with wood or metal particles. Can also be applied to the loading of the twist grooves in drill bits. "Loaded" abrasives or other tools should be cleaned or replaced to restore their cutting efficiency.

Mill Marks—Small parallel ripples or ridges produced on the surfaces or edges of wood by planer knives, joiner knives or saw blades. In the case of planer or joiner knives, these imperfections can be caused by nicks in the blades, improper knife settings, feeding the stock too rapidly or taking too deep of a cut in a single pass. In the case of saw blades, virtually all blades (with the possible exception of certain hollow-ground blades) produce mill marks.

Miter—A joint where the meeting angle of two pieces of stock is divided. For example, the 90° corner of a picture frame is usually created by cutting two mating 45° miters. This same 90° corner angle could also be divided and produced with a 60° cut and a 30° cut.

Molding—The process of creating decorative surfaces on workpieces using a molder accessory.

Mortise—A hollowed-out hole or recess that is usually rectangular in shape and formed to accept a matching tenon for joinery purposes. Mortises can be created with a mortising bit and chisel, a router bit, a series of overlapping drilled holes or an ordinary hand chisel. Mortising is the process of cutting such a hole or recess.

Pad Sanding—The process of stacking a number of identical workpieces and sanding the entire stack at one time with the disc sander, belt sander, drum sander or strip sander, or by hand. When performing this operation, all workpieces must be held firmly together with clamps, nails, screws or double-stick tape to ensure the accuracy of the operation.

Pad Sawing—The process of stacking a number of identical workpieces and sawing the entire stack at one time with a scroll saw, bandsaw, or jigsaw. When performing this operation, all workpieces must be held firmly together with clamps, nails, screws or double-stick tape to ensure the accuracy of the cuts.

Particleboard—An inexpensive, strong composite material formed by gluing wood chips and sawdust together under high pressure. Usually produced with non-waterproof glues and therefore easily damaged by dampness or direct contact with water. Readily available in thicknesses and sizes comparable to plywood.

Parting—A term used in lathe turning to signify the act of separating or cutting-away a completed workpiece from its adjoining scrap once the turning process is completed. Parting is usually performed with a parting tool.

Pattern—An established shape or design used as a model. When duplicating with the routing system, the pattern is the paper design used in laying-out the plywood or masonite template that guides your fixture blank during the fixture-making process.

Push Block—A flat, rubber-bottomed "paddle" with a handle on top that is used as a safety device when guiding a flat piece of stock through an operation on a power tool. Generally used when the wide surface of the workpiece rests flat on the table surface during operations. Can be used in combination with a push stick or feather board.

Push Stick—A 10" to 12" long, narrow stick with a notched end that is used as a safety device when guiding a piece of stock through an operation on a power tool. Can be used in combination with a push block or feather board.

Rabbet—An L-shaped cutout formed in the edge or end of a piece of stock, usually for joinery purposes. One common example of rabbets is the recessed cuts in the backs of picture frames. Although rabbets generally have 90° corners, angled rabbets are also used occasionally.

Resawing—The process of slicing a thick piece of stock into several thinner pieces. Although this operation is usually performed on a bandsaw, depending upon the thickness of the stock being cut, it can also be done on a table saw or scroll saw.

Rip Bevel—A bevel cut on the edge of a piece of stock that runs **with** the grain of the wood. Rip bevels are used most often for decorative purposes or for creating "invisible" joints where the sides of square, octagonal or other shaped posts, boxes or similar projects meet.

Rip Cut—A cut made **along** (or with) the direction of the grain of the wood.

Rounding—The first step in the turning process after a workpiece is mounted in the lathe. Rounding is performed at low speeds to eliminate sharp corners in preparation for the initial shaping operations.

Scraping—The easiest and safest of all lathe turning cuts in which the chisel is usually held perpendicular to the workpiece and fed slowly into the rotating stock. Although the gradual easing of the chisel into the stock during scraping produces the least gouges and errors, a finished turning that has been scraped will require more sanding than one that has been sheared.

Shaping—The process of creating a decorative edge on a workpiece. The term shaping can be applied to operations performed on a shaper, molder, lathe, router or virtually any tool used to create such an edge or surface.

Sharpening—The process of restoring a keen edge to cutting tools of any type. Sharpening is one of the most important skills for any woodworker to master, since sharp tools are more accurate and safer to use.

Shearing—In lathe turning, shearing is accomplished by holding the chisel at an angle and moving it parallel to the work to slice away a layer of wood from the surface of the stock. Shearing is the fastest cutting and most difficult of all lathe operations to master. If performed properly, shearing will produce super-clean cuts that seldom require sanding.

Sizing—In lathe turning, the process of making a series of initial cuts (usually with a parting tool) to the approximate final depth along the length of your turning. These sizing cuts are usually made for each bead or cove and serve as a "benchmark" or guideline to follow as you proceed with your shaping cuts.

Snipe—When planing or jointing stock, a snipe will occur if you allow the workpiece to "droop" because of improper setup when it is fed into or out of the planer or jointer. Snipes usually appear at the ends of the stock and can be prevented by keeping the workpiece parallel and flat on the table surface at all times. Properly adjusted roller stands at the infeed and outfeed sides of machines can also help to support the stock and prevent snipes.

Spacer—A block clamped or otherwise attached to the table saw rip fence to enable the safe crosscutting of several pieces of stock to an identical length. The use of such a block is necessary to keep the workpiece from being thrown by becoming wedged between the fence and blade.

Spindle Turning—The process of turning a project that is supported on both ends between centers on a lathe.

Spline—A thin wood strip that is set into mating grooves in two joined pieces of stock. The grain direction of the spline is perpendicular to the joint to strengthen the joint. Splines are most commonly used in mitered corners of picture frames and for joining stock together edge-to-edge for tabletops and similar projects.

Starter Pin—A small diameter pin that is inserted so it protrudes up from the shaper or router arm table surface and is used to rest the workpiece against when easing it into the rotating cutter. A starter pin is sometimes referred to as a "fulcrum" pin.

Stop Block—A block of wood attached to a fence, miter gauge, machine table or workpiece with the intended purpose of limiting the depth or length-of-cut during operations. Also used frequently in mass production situations to position workpieces for drilling or other operations with high level of repeatability.

Template—When performing duplication with the routing system, the plywood or masonite pattern that is attached to the bottom of the fixture blank and used to guide the cutting of the actual fixture.

Tenon—A protruding rectangular, square or round "tongue" on the end of one piece of stock that is cut to fit snugly into a mortise on a mating piece of stock.

Tongue And Groove—An extremely strong wood working joint that is formed by a tongue on the edge of one board that fits into a mating groove on another board. This method is often used when joining stock together for tabletops or other large project components and for tongue-and-groove paneling.

Under-Table—Routing operations performed with the router mounted in an inverted position under the table of the routing system.

V-Block—A shop-made, V-shaped woodworking aid that is most commonly used to support dowel rods, pipe, tubing or other cylindrical-shaped objects during drilling on the drill press.

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