Drill Press Primer

Anatomy and use of a woodworker's standby

by Bernie Maas

Using a metal rule, *Maas double checks each hole's edge distance for the series he bored with a machine-spur bit chucked in his drill press. A fence, clamped to the table with a hold-down, keeps the workpiece aligned while the machine's depth gauge (next to the feed lever) ensures that the holes are uniformly deep.*

If your solutions to boring holes have been a wrist-cracking brace and bit and an ear-straining electric drill, then you'll break into a smile when you crank up a drill press. Originally devised for metalworking, the drill press offers the same professional results for woodworking: consistently accurate holes. While the press is a premier hole maker, its name belies its ability to do other work, such as mortising. In contrast to most stationary machines, the press is a quick study, and it's quiet and fairly safe to use.

Basically, there are two types of drill presses: benchtop and floor standing. Bench models range in height from 22 in. to 46 in., while floor models can be anywhere from 52-in. to 76-in. tall. Drill-press capacity or throat size—the largest circular workpiece you can bore a central hole through and not hit the column with—is often expressed as *swing* or *diameter*. Bench models usually have a swing from 8 in. to 12 in. Floor models range from l0-in.-dia. machines up to 21-in.-dia. monster presses. I prefer the floor-standing models in the 11-in. to 16-in. range because they can be positioned in tight spots without occupying valuable bench space, and this size is ideal for most woodworking jobs.

Drill-press parts and their purposes

The drill press is made up of four basic parts (see the drawing on p. 57), which are clamped to a polished steel column. From the bottom up, there's a base (foot), a movable table, a safety collar, and a head. Both the table and base are usually cast iron and ribbed for strength and rigidity. The base is big enough to stabilize the machine, and usually features bolt-down holes. The table, adjustable up and down, has a smoothly machined flat top that's either square or circular. Commonly, there's a split ring and a screw handle to lock the table to the column. Some tables have slots to clamp fixtures; some tilt for angle work, but all have a central hole so that you won't easily run a bit into the metal top. The safety collar is locked to the column just beneath the head to support the head in case it accidentally slips. Finally, there's the head itself, a cast unit that houses the most important parts: the motor, pulleys, pinion shaft, quill and electricals. Most drill presses have sealed-bearing motors ranging from ¼ HP to ¾ HP. The drive belt is tensioned by shifting the motor on its bracket. When properly tensioned, the belt should flex about an inch midway between the motor and spindle pulleys.

The quill assembly—The heart of the head is the quill, which is the sleeve that contains the spindle. The quill allows the spindle shaft both to revolve (drill) and to reciprocate (press) simultaneously (see the drawing detail on p. 57). Ball bearings at each end retain the spindle within the quill and keep it centered and free to rotate. Rack-and-pinion gearing, controlled by the quill handle (feed lever), moves the quill up and down. Quills usually have a vertical stroke of 3 in. to 4 in., although some travel 6 in. An adjustable clock spring returns the quill

Selecting spindle speed

Heat is the enemy of bits; you need to get your bit in and out of a workpiece before friction heats it up. To do this, your drill press has to generate the correct number of RPMS. Most presses will run between 400 RPM and 5500 RPM. Speeds are adjusted by altering the position of the drive belt. The press will run fastest when the belt couples the smallest spindle pulley with the largest motor pulley. To help determine the best speed to use for the bit you've chosen, refer to the chart below. *—B.M.*

Bit type/size☆	Recommended speed (RPM)*
Machine spur	
1/8 - 5/8	3,600
over 5/8	1,800
Multi-Spur	
1/2 - 2	1,200
2 - 3	900
over 3	600
Forstner	
3/8 - 5/8	1,800 - 2,400
11/16 - 1	1,400 - 1,800
1 1/16 - 1 7/16	900 - 1,200
1 1/2 - 3	250 - 600
Spade†	
1/4 - 1 1/2	1,000 - 2,000
Powerbore†	
3/8 - 5/8	1,800 - 2,500
3/4 - 1	1,200 - 2,000
Twist	
1/16 - 3/16	2,400 - 4,700
1/4 - 7/16	1,250 - 2,400
1/2 - 3/4	700 - 1,250
Plug cutter	
Under 1/2	2,400
1/2 - 1	1,800

☆ Don't use long (over 6 in.) thin-shank bits over 1,000 RPM

* Slower RPMs (when range is given) are for hardwoods. Actual spindle speed will be influenced by step-pulley sizes and density variations within the wood. Generally, the larger the bit and the harder the material, the slower the speed.

† Speeds over 2,500 RPM will likely burn workpiece.

to its up position. From time to time, the spring and quill should be lubricated through their oil holes, but unless you're desperate for entertainment, don't try to take apart the spring assembly.

You can lock the quill or preset the depth to which it can advance. On the left of the head is the quill-lock handle. On the right is the depth gauge, usually a simple rod-and-nut arrangement. To set the depth gauge, lower and lock the quill at the desired depth, and snug the gauge's bottom stop nut against the lug on the head. Then unlock the quill, return it to the starting position, and lock the gauge's top nut against the bottom one.

The chuck—Fixed to the lower end of the quill is a three-jaw chuck, sometimes called a Jacob's chuck (after its inventor). While 3/4-in. and 3/8-in. chucks are not uncommon, most presses have 1/2-in. or 5/8-in. chucks. A chuck's size designates the maximum diameter shank that it will take; minimum capacity is usually 1/16 in. Some chucks have springs that automatically eject the key, so it can't be left it in the chuck accidentally. For the best grip possible, tighten all three of your chuck's key holes, especially when boring large holes (over 1 1/2 in.). Large bits exert considerable torque, sometimes stalling while the chuck continues to spin. This chews up the chuck and galls the bit shank so that it won't run true.

Drill-press safety

The drill press is not inherently dangerous, but it deserves respect and warrants some precautions. The greatest hazard is spinning work. Large bits muster enough torque to rip work from your grip, smacking it into your knuckles or worse—launching it at bystanders. Besides causing injury, a whirling piece of wood can bend a bit or the spindle. Boring a hole off center can also whip work around. Misalignment occurs when the bit grabs a hole's edge or when small or unwieldy stock dances out of line or becomes cocked due to vibration or table tilt. Chips and debris left on the table also can allow a piece to drift dangerously off center.

In order to avoid these hazards, always keep the floor around the press clear and the table clean and well lit. To prevent work from spinning when boring small holes, brace it against a clamped block or fence, and when using bits over 1/2 in., clamp the work down, In addition, you can use a hold-down (available from Enco Manufacturing Co., 5000 W. Bloomingdale, Chicago, Ill. 60639) to prevent work from lifting when you withdraw bits (see the photo on p. 55). Through the following good shop practices, you'll avoid other hazards, such as flying pieces, entanglement and cutter contact: Never leave the key in the chuck; wear eye protection; tie back long hair and don't wear jewelry or loosely hanging clothing. Remember that the chuck and bits revolve clockwise—keep your hands and body clear of them and anything else that might spin.

Feed rate, pressure and speed

When boring wood with a drill press, the spindle speed, feed rate and the pressure you apply determine the quality of the hole. Too much pressure on the feed lever causes rough cuts or jammed and broken bits. Too slow a feed rate can burn the work and overheat the bit. Feed steadily and evenly. A fast or choppy stroke can cause drift, thus elongating a hole. Boring at the correct rate and pressure produces uniform shavings, about 040-in.-thick. If you're coming up with dust, either the feed is too slow or the bit is dull. If your bit is advancing slowly but is requiring a lot of pressure, then your speed is too fast or your bit is dull. Refer to the chart at left for recommended speeds for bits. With a little practice, you'll know when you've found the best combination of feed rate, pressure and speed.

Boring with a drill press

Before you do any boring, cover the drill-press table with an auxiliary table of 3/4-in. plywood. The auxiliary table supports the fibers on the underside of your work and may save you from running an expensive bit into the cast-iron table. Additionally, if a bit slips as you're chucking it, it'll only drop a few inches onto plywood instead of diving 4 ft., point first, into the cast-iron base. A fence is another drill-press helper. I clamp a fence to the table to help keep the work from spinning and to align a series of holes, such as bracket holes for shelving. My fences are made from straight lengths of 1x2 hardwood with a 3/16-in. chamfer on the bottom edge. The chamfer acts as an escape hatch for chips, which otherwise will pack against the fence, throwing off its registration.

To bore a hole, put your auxiliary table down first, and then adjust the table to a comfortable height. After selecting the right bit for the job (see the sidebar on p. 59), mount it in the chuck and set the spindle speed for the size and type of bit you are using (see the sidebar at left). If the bit has a center lead point, ding a center hole in your work with an awl or punch. For plug cutters and Forstner bits, which don't have lead points, lay out the circumference of the hole with a circle template (found in most art-supply stores). If you're boring an angled hole, lay out the hole's upper limit (where the boring will begin). And remember, the perimeter of an angled hole is an ellipse.

Most holes will be shallower than your press's stroke, but if the hole depth exceeds the stroke of the machine, you can use a bit extension shaft or drill as deep as you can, and then raise the table or block up the work until you get to the depth you need. If the hole depth is less than the stroke and shallower than the thickness of the workpiece, adjust and lock your quill travel. Keep in mind that the chip ejectors for both Forstner and Multi-Spur bits work best in shallow holes. In deep holes, the chips wad up, making it tough to back out the bit. Avoid wadding by raising these bits periodically to evacuate the waste. But don't retract a Multi-Spur bit completely from the hole, and then feed the spinning bit back in again because the teeth will likely grab the hole's edge and ruin the face of your work. Instead, stop the machine and feed the bit back into the hole. Restart the motor and continue boring,

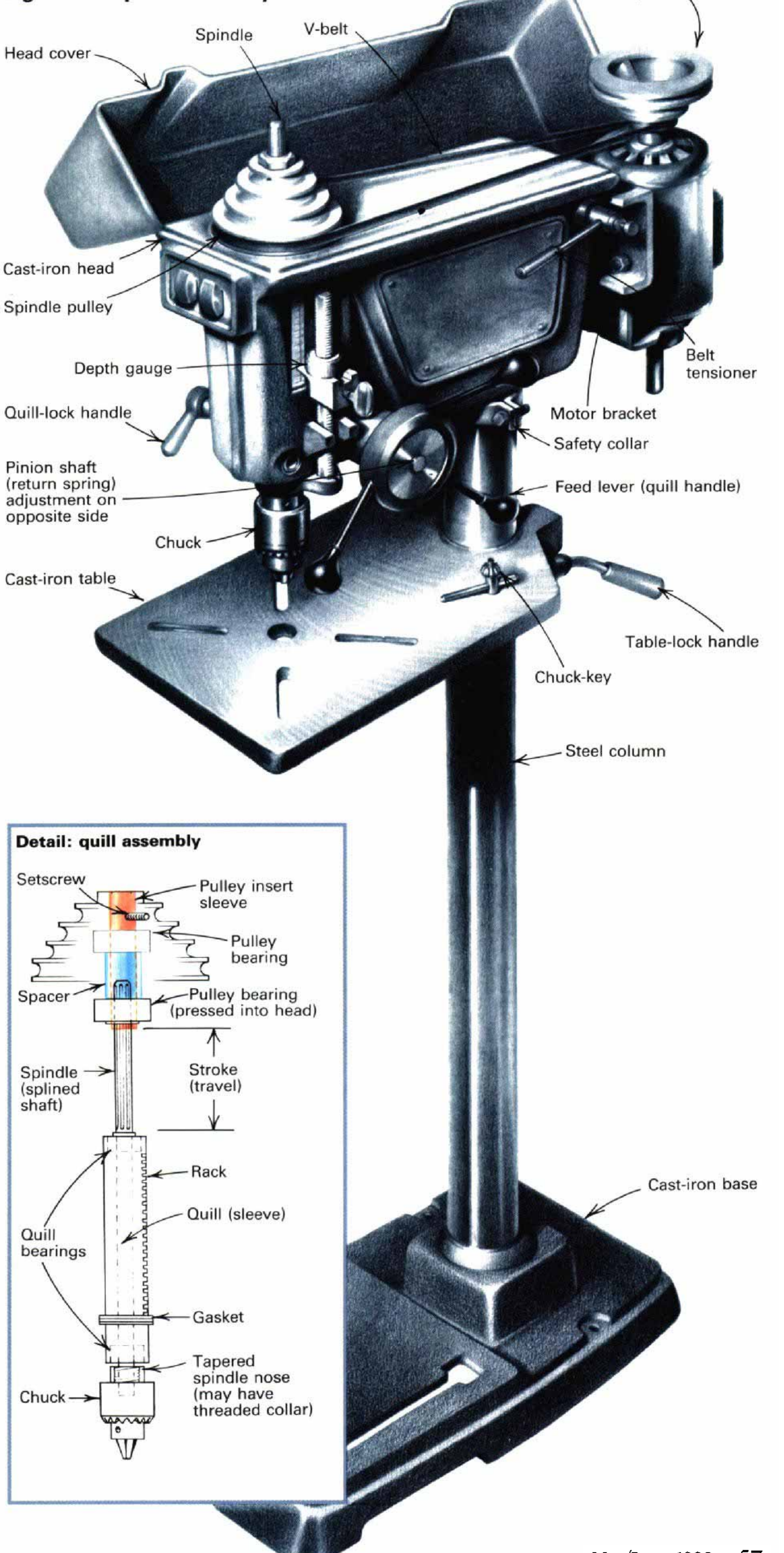
If you have to bore completely through the workpiece, there's a good chance you'll split the underside. You can avoid this by drilling only deep enough for the lead point to come through and then back drilling from the other side. To do this, first, lower the bit (with the motor off) and sink just the point into the auxiliary table. Lock the quill at this position and set the depth gauge to bore only this deep. Release the quill lock and fire up the machine. Get a good grip on your work or clamp it down, and bore until the depth stop bottoms out. Then turn the work over and look for the tiny pilot hole made by the point. If you back drill carefully, you'll wind up with a splinter-free hole. This method won't work with a Forstner bit because it doesn't have a lead point. So instead, set the depth stop to where the bit's rim barely brushes the underlayment. Then carefully bore down from the topside. Lower the bit gently until you feel the bit just break through.

To use a fence when boring a series of holes, first set the workpiece on the table. With the motor off, lightly tack your bit's point into a hole's center and lock the quill. You don't have to align the fence parallel to the table's edge because only one point—the bit's center—must be the correct distance from the fence. Snug the fence against the work (chamfered edge down and toward the bit), and clamp the fence to the table. Make sure the clamp pads are on a flat spot under the table, not against a rib where they might vibrate loose. Release the quill lock, start the motor and bore the first hole. Slide the work along the fence to bore the rest of the holes in a row, as shown in the photo on p. 55.

Fixtures and table vises

There are dozens of drill-press fixtures that you can make. A few that I like are a V-block

Fig. 1: Drill-press anatomy



Photos: Alec Waters

When boring angled holes *for splayed legs, Maas uses ramps like the pair in the foreground (above). A pocket-hole fixture (left, background) makes sloped (75°) holes for recessed screws. The steel vise (right, background) serves as a tilting table, which can precisely hold small pieces.*

A V-block cradles a dowel *being bored with a Forstner bit (left). To make the cradle, the author cut 45° chamfers on two edges of a foot-long 2x4, ripped the 2x4 in half and glued the halves together.*

(cradle), a pocket-hole fixture and a riser block (ramp). A V-block (see the photo above left) allows you to bore almost any cylindrical workpiece. If you try to bore a hole in a dowel freehand, the dowel will roll, and you will have a devil of a time getting the hole where you want it. But you can stabilize the dowel by cradling it in a V-block. To make a V-block, simply cut a 45° chamfer along two edges of a 1-ft. length of 2x4; then rip the piece in half, and glue the halves together to form a 90° cradle,

A pocket-hole fixture comes in handy when you need to make angled holes for screws that fasten an apron to a tabletop's underside or screws that join stiles to rails in a cabinet face frame. The fixture is L-shaped and like the V-block, forms a 90° cradle (see the photo above right). But a pocket holer tilts the workpiece at about a 75° angle. When using a pocket holer, always bore the large hole (land) that recesses the screw head first. Then bore the hole for the screw shank most of the way through before turning the work over to back drill. If you want your pocket holes in a neat line, add a fence to the setup.

You'll also need holes that are angled to the work surface when socketing splayed legs for a stool. If your press has a tilting table, you can bore the angled holes directly. Whenever I do this, however, my lumber, clamps and ruler end up on the floor. A good solution is to build a riser block or ramp, which is simply an inclined auxiliary table. To make a project-specific ramp, just cobble together some plywood scraps to form the table angle you need as well as a base with a clamping ear. A variation of this has a hinged table, so you can bore at almost any angle, much like a tilting table. The photo above right shows a couple of ramps that my students have made over the years.

A steel drill-press vise (see the photo above right), sometimes called a milling vise or an angle vise (also available from Enco), mimics a tilting table. But, because they have machined jaws with intersecting grooves to improve their grip, these vises let you precisely hold small objects, such as tubing and rods. They're also great finger savers. The more sophisticated vises have swiveling bases and cross slides, which allow you to hold odd-shaped pieces at very precise alignments to your drill-press spindle. Although some vises can be expensive, their accuracy and durability justifies the cost.

Other functions and accessories

The press can perform many secondary functions that are variations on boring, such as countersinking screw holes. You also can counterbore (superimpose a large hole over a smaller one) by clamping the work and using a Forstner or Multi-Spur bit. With a set of plug cutters (see the sidebar on the facing page) you can make cross-grain plugs for hiding counterbored screws, instead of using end-grain dowels. With a fence and a Forstner or Multi-Spur bit, you've got a basic mortiser; just bore interlocking holes and chisel the resulting slot square, A hollow-chisel mortising bit and a drill-press yoke will let you do both operations at once (see *FWW* #83, pp. 52-56).

For some drill-press users, a set of drum sanders for smoothing curved edges is also a must. But because drum sanding exerts substantial side pressure, you're likely to cause premature wear on the chuck, spindle or bearings. This is true for drill-press grinding and routing, too. Furthermore, drill-press routing isn't very effective because the press can generate only about one-fifth of the necessary speed. And without a guard and anti-kickback pawls, the procedure is dangerous. For these reasons, I leave sanding, grinding and routing to the tools designed specifically for those functions and save the drill press for the boring operations that it does so well. □

Bernie Maas is an associate professor of woodworking at Edinboro University of Pennsylvania.

Sources of supply

Information on sharpening methods and recommended speeds for bits is furnished by the following bit manufacturers.

Machine spur and Multi-Spur:
Forrest City Tool Co. (a division of Textron Corp), 620 23rd St. N. W, Hickory, NC 28601.

Forstner:
CONVALCO, 102 Washington St., PO Box 1957, New Britain, CT 06050

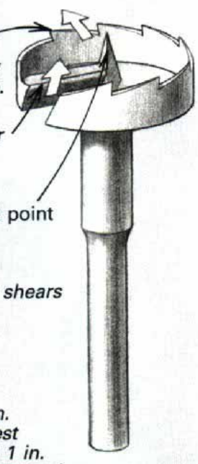
Spade:
Irwin Co., 92 Grant St., Wilmington, OH 45177

Powerbore:
Stanley Tools (a division of Stanley Works), 600 Myrtle St., New Britain, CT 06050

Twist drills and plug cutters:
Vermont American Tool Co., PO Box 340, Lincolnton, NC 28093.

Common woodworking bits

Multi-Spur



File relief of tooth at factory angles; avoid shifting its tip.

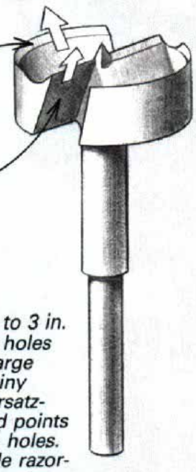
File lifter's upper face rather than the lower clearance angle.

Brad point

If properly sharpened, lifter shears after tip cuts hole's edge.

Multi-spur bits come in ⅜ in. to 4 in. dia. and are your best choice for holes larger than 1 in. They have brad points to seat and lead them into wood. They use saw-like teeth arranged in a circle to cut the outside of the hole and recessed lifter tips, which shear off and eject the wood chips. Bits can start holes at almost any angle, bore overlapping holes (good for mortises and rabbets) and start holes on curved surfaces or cylindrical workpieces.

Forstner

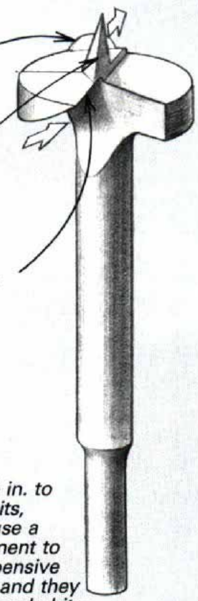


File inside of cutting rim out toward edge.

File angle (upper face) of lifter.

Forstner bits come in ¼ in. to 3 in. dia. They make flat-bottom holes with glass-smooth walls. Large Forstner bits usually have tiny cone-shaped lead points. Ersatz-Forstner bits have long lead points but won't make flat-bottom holes. The bits combine an outside razor-edged circular band, which cuts wood fibers with an interior pair of lifters that hog out material. Because lifters and cutters act on the same plane, these bits are increasingly grabby with size. Bits can bore angled holes, overlapping holes and holes on curved surfaces.

Powerbore



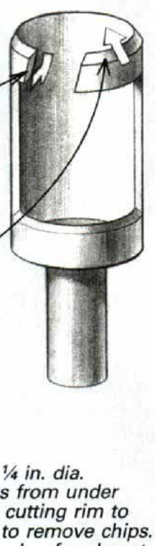
Sharpen spur similar to machine spur tip (below).

File brad point at angle towards tip.

File scraper edge outward, following factory angles.

Powerbore bits come in ⅜ in. to 1 in. dia. and, like spade bits, they cut holes fast. They use a spur and scraper arrangement to cut holes. They're less expensive than other brad-point bits and they make cleaner holes than spade bits.

Plug cutter

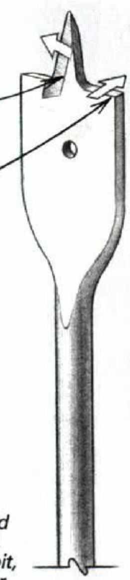


File upper angle of lifter.

File outside of rim toward cutting edge.

Plug cutters come in sizes from ¼ in. dia. to 2 in. dia., and come in lengths from under an inch to over 3 in. They use a cutting rim to scribe a hole's edge and a lifter to remove chips. Plug cutters can make a custom plug for almost any counterbored hole, whether to cover a screw head or to inlay some decoration.

Spade



Grind both edges of lead point.

Set tool rest to grind scraper edge(s) at a 5° to 10° rake angle.

Spade bits come in ¼ in. to 1½ in. dia. They're made for quick, rough holes. They have long, sharp-edged lead points, and either one or two scrapers. Bits work well in endgrain, and if you need a hole with a different-shaped bottom, just grind the spade to the profile you need. If you need an in-between sized bit, you can grind its outside diameter down to size.

Machine spur

Brad point

File relief and flute lifter (avoid "belly").

File spur toward tip from inside.

Machine-spur (brad-point) bits come in ¹⁄₁₆ in. to 1¼ in. dia. These are the best all-around hole makers for wood. They have two perimeter spurs that sever wood fibers, and lifters scrape out the interior of the hole. Brad (diamond) point starts and leads the bit into the wood.

Choose the right bit and keep it sharp

Many of us have chucked twist bits in a drill press because they're cheap and handy. While twist drills can make holes in wood, they're really designed to cut metal. In contrast, screw-tipped bits, although made for wood (like augers designed for slow hand-boring), should never be used in a drill press. An auger in a press feeds itself too aggressively. The result is a torn-up hole or an undamped workpiece whipping out of control. Luckily, there are better bit alternatives for boring crisp, precise holes in wood.

When I'm boring holes with a drill press, I usually use one of three bit types: machine spur (or brad point), Multi-Spur or Forstner. And although I don't use them as often—spade, Powerbore and plug-cutting—are three other bits that come in handy. All six types (shown in the drawing above) are designed to cut wood, so they are available from most woodworking-supply stores.

Basic bit care: Only run bits at their recommended speed, and don't toss them in a drawer. Instead, store them in an index, a cloth pouch, a rack or a compartmented wooden case. Also, douse bits with WD-40 every so often to discourage rust, and polish the bit's flutes and spirals with steel wool to keep them running cool. To keep carbon steel bits surgically sharp, touch up their edges with auger-bit flies. Don't worry about wire burrs left from filing; they'll be stropped away as you bore holes. For hardened-steel edges, like those on most spade bits, use a grindstone. If you want to sharpen your twist drills, see Ken Donnell's article in *Fine Woodworking* #82, pp. 72-74. Finally, if you think a bit has been used or honed beyond reason, don't despair, and don't toss it out. For a nominal fee, most bit makers will restore bits to their factory specs.—*B.M.*

Drawing this page: Bob La Pointe