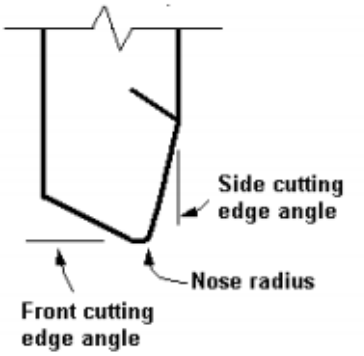
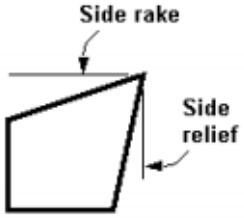
Grinding Tool Bits

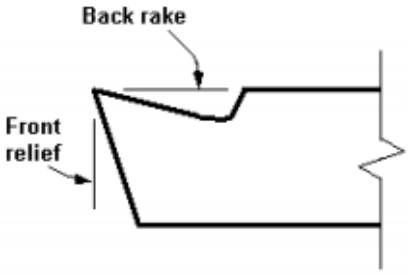
When you purchase a new lathe tool bit, it might have an angle on the end, but it is not properly sharpened for turning. Grinding lathe tool bits is a bit of an art. It takes some practice to get good at it.



You need to create a cutting edge that is sharp, extends out so that the cutting edge and not the side of the tool contacts the work, but that still has enough support to maintain sufficient strength to cut metal.

Before diving in, there are some terms you need to understand. The illustration below shows these terms.





First, notice that there are two cutting edges on the tool bit. There is a cutting edge on the end of the tool bit called the front cutting edge. There is also a cutting edge on the side of the tool. Between these cutting edges is a rounded section of cutting edge called the nose.

Side Cutting Edge	The side cutting edge does most of the cutting. As the tool bit moves along the work piece the side cutting edge removes most of the material.
Front Cutting Edge	The front cutting edge cuts when the tool is advanced into the work.
Nose	The nose is a critical part of the cutting edge, because it produces the surface finish of the work piece.
Side Rake	The side rake produces the side cutting edge that cuts into the work piece.
Side Relief	Side relief provides clearance for the side cutting edge. Without side relief, the side of the tool bit would hit the work piece and not allow the cutting edge to penetrate the work piece.
Back Rake	The back rake produces the front cutting edge that cuts into the work piece.
Front Relief	Front relieve provides clearance for the front cutting edge. Without front relief, the front of the tool bit would hit the work piece and not allow the cutting edge to penetrate the work piece.

How to Grind Tool Bits

Use a bench grinder to sharpen your tool bits. Even an inexpensive bench grinder can do a good job grinding lathe tool bits. In some cases, you might want to purchase a higher quality fine grit wheel.

Keep a small cup of water near your grinder. Grinding generates heat, which can cause two problems. The tool bit will become too hot to hold. Overheating can also affect the heat treatment of the tool bit, leaving the cutting edge soft.

Use a protractor to measure the angles. They are not super-critical, but you should try to stay within one degree of the recommendations.

Grind the Front Relief

The first step in creating a tool bit is to grind the front relief. For most work, a relief angle of 10° works well.

While you are grinding the front relief, you are also creating the front cutting edge angle. Make this angle about 10° also, so that the corner formed by the front cutting edge and the side cutting edge is less than 90°.

Grind the Left Side Relief

Form the left side relief next. Again, create about a 10° angle. You don't need to form a side cutting angle. The side cutting edge can be parallel to the side of the tool blank.

Grind the Top Rake

The top of the tool bit is ground at an angle that combines the back rake and the side rake. The side rake is most important, because the side cutting edge does most of the work. For cutting steel and aluminum, the side rake should be about 12° and the back rake should be about 8°. For cutting brass, the rake angles should be much less, or even 0°.

Round the Nose

A small nose radius allows you to turn into tight corners. A large nose radius produces better surface finishes. Create a nose radius that is appropriate for the tool bit you are creating.

Relief and Rake Angles for Cutting Common Metals

Material	Side Relief	Front Relief	Side Rake	Back Rake
Aluminum	12°	8°	15°	35°
Brass	10°	8°	5° to -4°	0°
Bronze	10°	8°	5° to -4°	0°
Cast iron	10°	8°	12°	5°
Copper	12°	10°	20°	16°
Machine Steel	10° to 12°	8°	12° to 18°	8° to 15°
Tool Steel	10°	8°	12°	8°
Stainless Steel	10°	8°	15° to 20°	8°

When working around grinders it is an absolute necessity to wear EYE PROTECTION. Grinding debris is thrown out at high velocities and can damage not only eyes, but also expensive glasses. Wear safety glasses or a full face shield.

If you've never sharpened a tool, take a close look at how ours are sharpened. Let's duplicate the right hand tool on the opposite end of the blank. Be careful you don't cut yourself on the blank or the sharpened end while working with it.

First dress the wheel by taking the dresser and setting it on the tool support square with the wheel and while applying a light pressure move the dresser back and forth with the grinder running. Unless the wheel is in bad shape, it should be ready to use in a few passes.

Grinding side 1 of the tool

Turn off the grinder and set the tool support for approximately 7° if you haven't done it yet. If you're not good at guessing at angles use a presharpened Sherline tool to set the angle. Metal cutting tools are very tolerant on angles. I've always found wood cutting tools more difficult to sharpen. Too little angle and the "heel" of the tool will rub, too much angle will cause the tool to "dig in" and chatter.

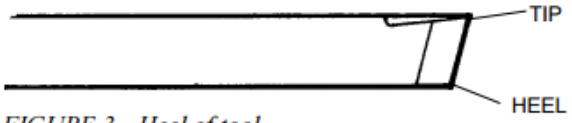


FIGURE 3—Heel of tool.

Have a cup of water handy to cool the tool with and set the blank on the tool rest and start grinding side 1.

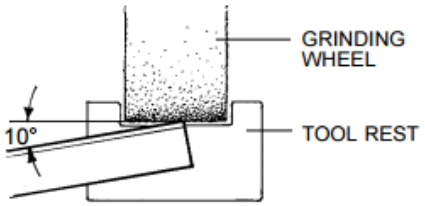


FIGURE 4—Grinding Side 1.

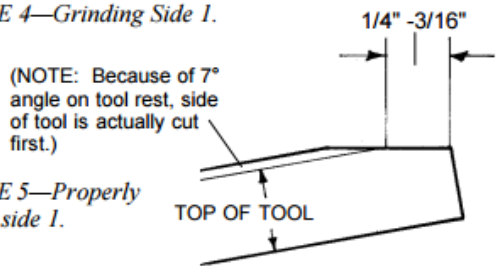


FIGURE 5—Properly ground side 1.

Move the blank back and forth across the face of the wheel until you have ground a 10° angle on approximately 3/16" (4mm) of side 1.

This is where the "positive approach" comes in. Unless you push the tool into the wheel with enough pressure, the tool will bounce around and you'll never get a good flat cutting surface. It isn't necessary to worry about getting the tool too hot. Modern day tool steels don't anneal and a little discoloration doesn't effect the tool life in tool room use. What you should worry about is not burning yourself or grinding the tips of your fingers off! Concentrate on holding the 10° angle while moving back and forth. We'll give this edge a final sharpening later; it's time for side 2.

Grinding side 2 of the tool

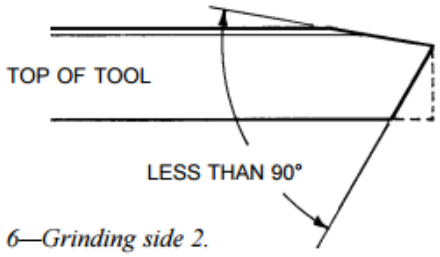


FIGURE 6—Grinding side 2.

The reason angle B is ground less than 90° is to allow the tool to get into corners.

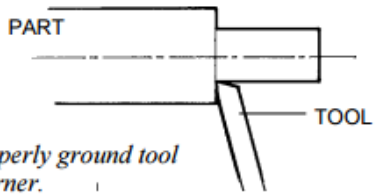
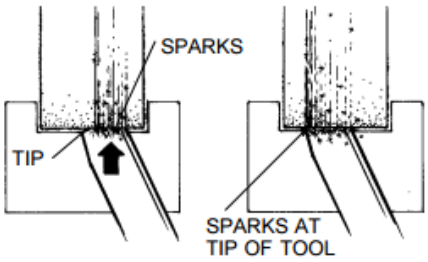


FIGURE 7—Properly ground tool cutting into a corner.

Side 2 is ground the same way as side 1, moving the tool back and forth until you have a point. After you get side 2 ground, cool the tool in the cup of water.

Now I want you to learn another aspect of tool grinding. It's important to know when you have ground the surface up to the cutting edge, especially when resharpening lathe tools. Take the tool you just ground and bring it up to the wheel at a slightly different angle than you just ground for this experiment. Watch the point that touches the wheel first and you will notice that the sparks will bounce off the cutting edge only where the wheel has ground from top to bottom.



FIGURES 8A—Tip not yet ground flat and 8B, Tool ground flat all the way to the tip.

This tells you when the tool has been sharpened without taking it away to look which allows you to grind flat and true surfaces. If you sharpen a tool for a Sherline lathe, use a 1/4" square tool blank and keep the cutting edge up to the top of the blank; the tool will come out on center without shims.

You will have to be precise grinding the third side to accomplish this.

Grinding side 3

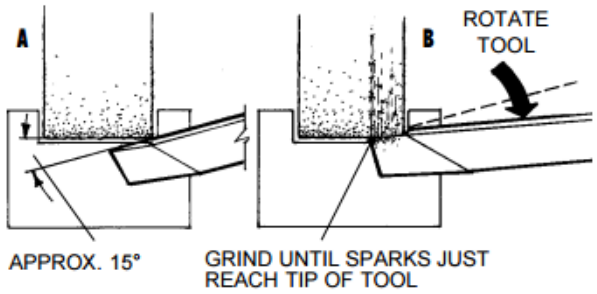
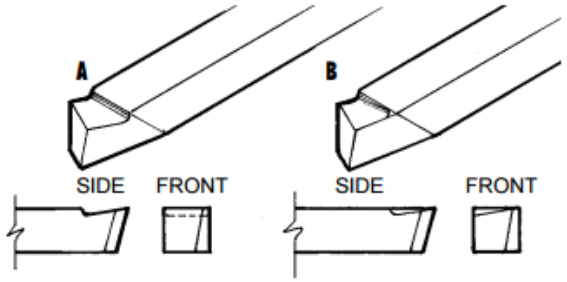


FIGURE 9—Grinding the "Hook" into side 3.

Use the skill you have developed grinding the second side now. Set the blank on the support with the 10° (side 1) up. The tool has to be brought up to the grinding wheel with a slight angle so you don't grind the tip below center. With the tool setting on the rest, move the tool in and grind until you see sparks bouncing off the cutting edge where the corner of the wheel is lined up with the back part of the 10° face. When this happens, slowly decrease the angle without pushing the tool in any more until sparks bounce all the way to the tip. Stop as soon as this happens. You may inspect it, and the surface should be entirely ground. The recommended way is to put more "hook" on the tool than I have suggested, but I have found that the slight increase in performance is offset by the problems encountered resharpening these tools.



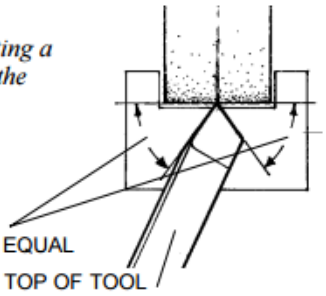
FIGURES 10A—Normally recommended "hook" ground into tool and 10B, Simpler method suggested for Sherline tools.

To put the finishing touches on your tool, you have to "kiss off" sides 1 and 2 again. You must carefully line up side 1 with the wheel and bring it to the wheel in a positive manner with very little pressure; watch for the sparks on the cutting edge. What you're trying to accomplish is to make the tool set against the wheel on the same plane as when you first ground side 1. If the tool is held too rigid, it will not align itself, too loose and it will bounce around.

"Breaking" the point

Use the same method on side 2. The tool should be ready to use except for the point. I always put about a .010 (.2mm) "break" on the point by holding the tool with the point aimed at the wheel face. Because two angles converge at the point, the angle in relation to the sides is greater. Think about it!

FIGURE 11—Putting a .010" "Break" on the tip of the tool.



This means that if you set the tool flat on the tool rest the tool rest angle would have to be increased to get an even flat. This wouldn't be worth the effort, so the easy way is to free hand it. I always start by touching the heel of the tool first, and then change the angle until a slight flat is put on the tip. Of course, the angle you're holding it at has to be close when starting to get desired results.

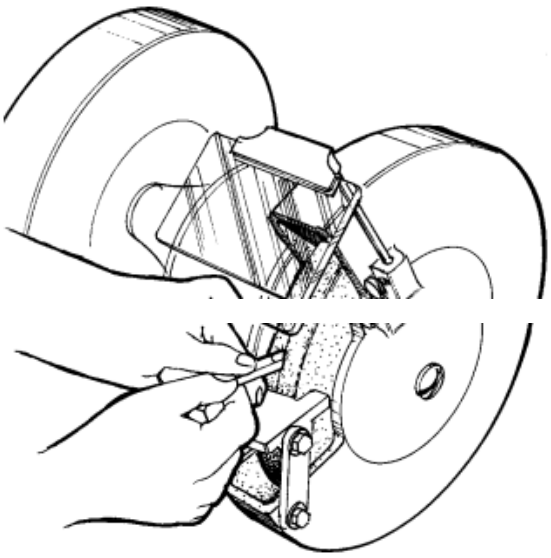


FIGURE 12—Handholding the tool to "Break" the point saves resetting the angle on the tool rest.

The purpose of this flat is to improve finish and tool life. I don't recommend a large radius on the tip of tools used on small machines. These machines are not rigid enough to get the desired results from this practice and cause "chatter" problems.

The finished product should be a right handed tool, have flat cutting surfaces (except for the radius caused by the wheel), have a slight flat on the tip, and a tip angle of less than 90°.

Tools used on lathes such as the Sherline will do all their cutting at the tip of the tool because they don't have the horsepower for 1/4" (6mm) cuts.

I don't recommend using oil stones to improve the edges. After a few minutes use with an occasional dab of cutting oil a properly sharpened tool will hone itself in.