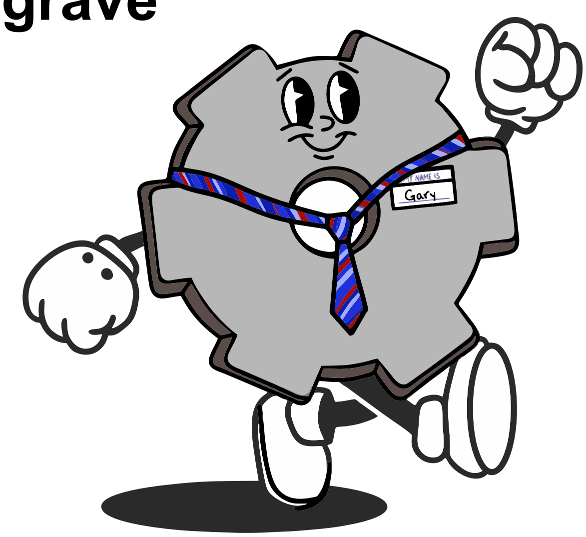
WARDCO

ENGRAVING SYSTEMS

Rotary Engraving Basics & “how to”

- Z axis anatomy
- Types of cutters
- Spindle and XY speeds
- Zeroing and setting cutters
- “How to engrave”



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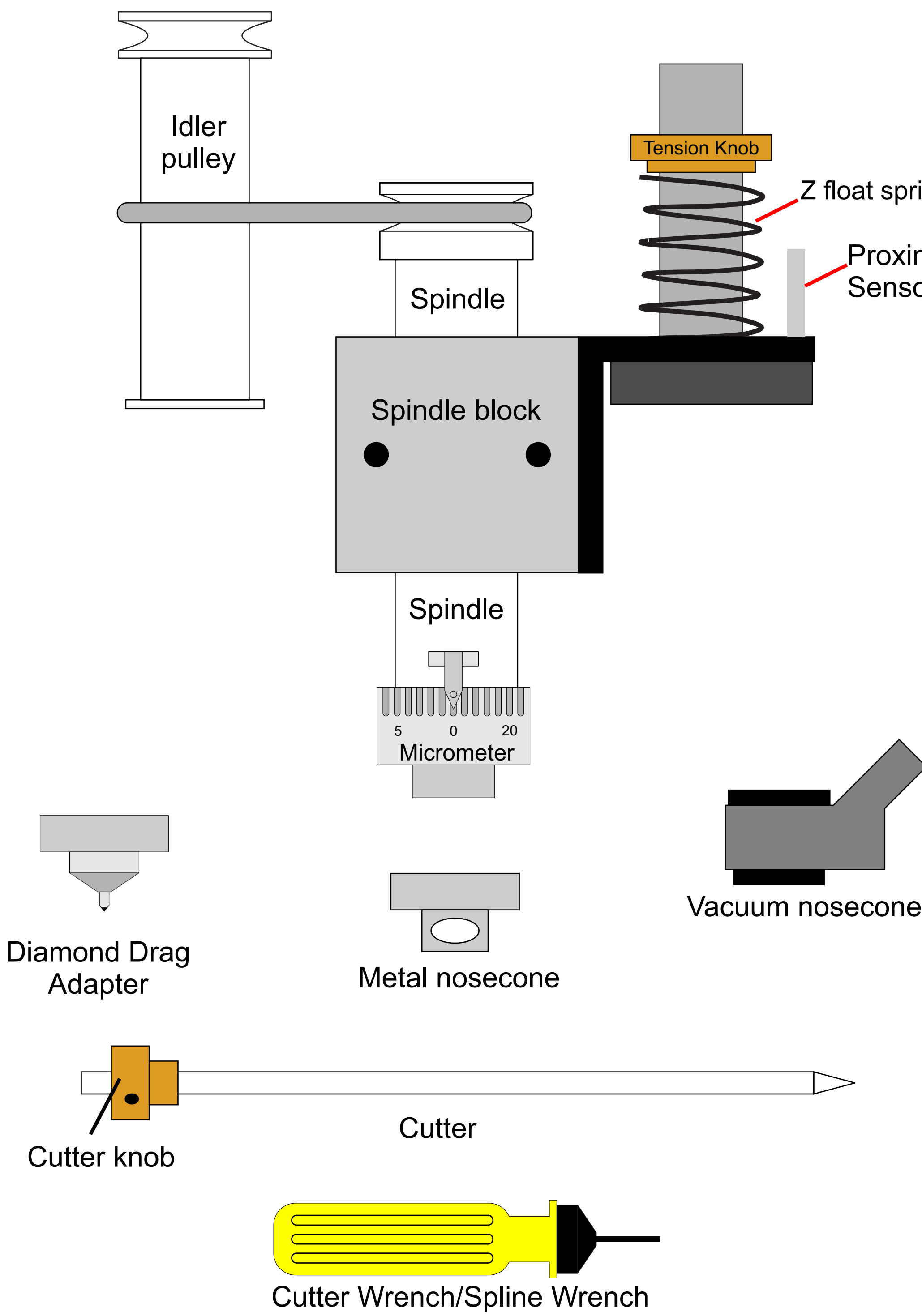
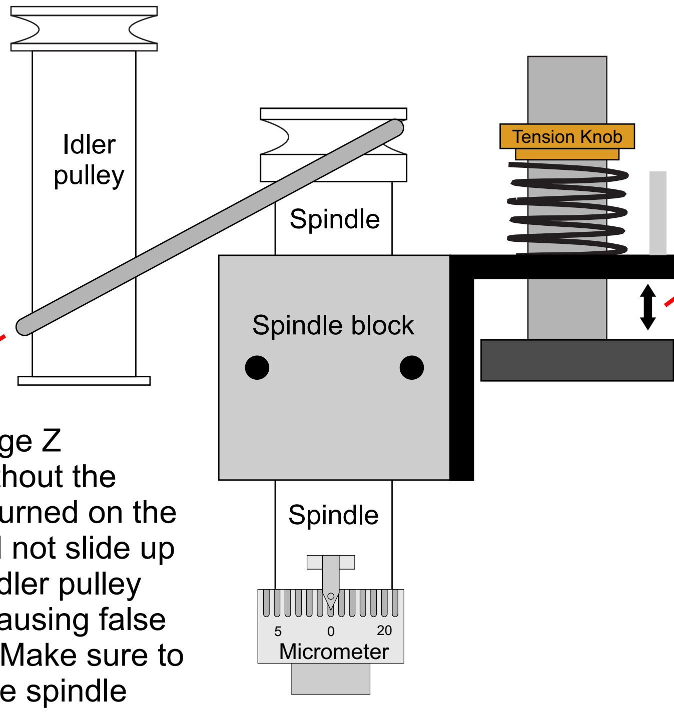
Anatomy of an engraving machine Z axis

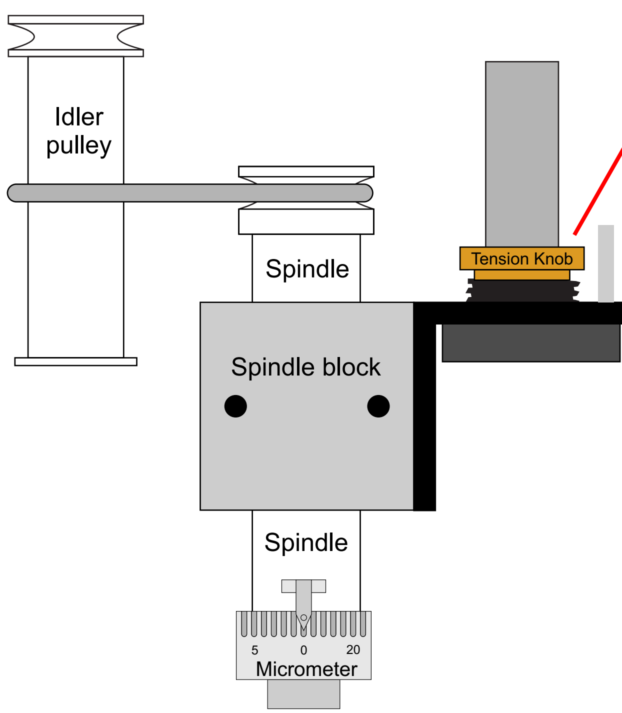


Anatomy of an engraving machine Z cont.



If you make large Z movements without the spindle motor turned on the spindle belt will not slide up and down the idler pulley and can bind causing false prox readings. Make sure to always have the spindle motor set to Auto or On when making Z movements of a 1/2” or more.

As soon as the foot or nosecone hits the material, the spindle stops moving down while the rest of the assembly continues. The separation of the bracket that the prox sensor is mounted to from the plate below triggers the prox sensor telling the electronics that the surface has been detected.



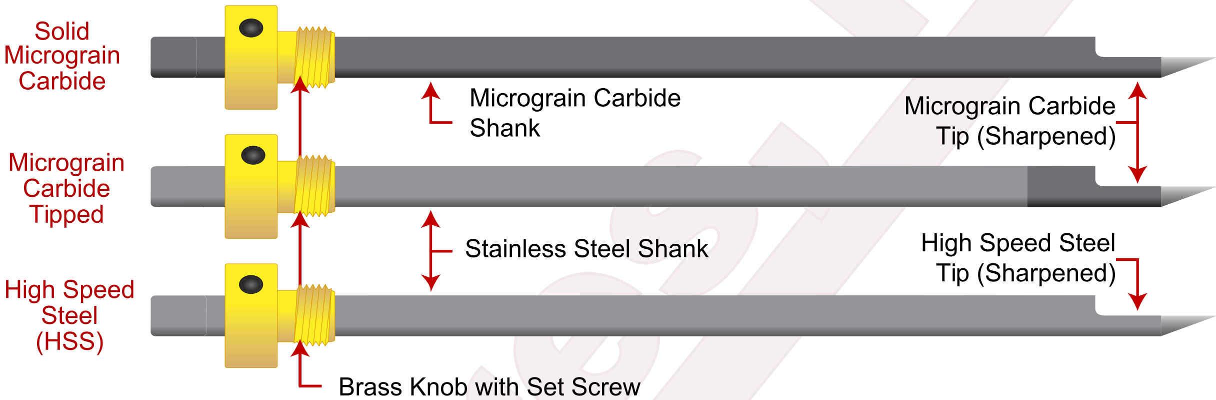
When routing or milling materials and a nosecone is not an option it is best to lock the Z float by tightening the tension knob all the way down. This will prevent the Z from bouncing or “chattering”.

If the Tension knob is down and the machine is set to full automatic, the Z will drive down till it is touching the material then the Z motor will grind, trying to push down further to trigger the prox.

Anatomy of an Engraving Cutter

Cutters is an all-inclusive term used to describe the rotating cutting tools used in the engraving operation. Cutters can be manufactured from high speed steel or carbide and are available in a variety of configurations for specific applications.

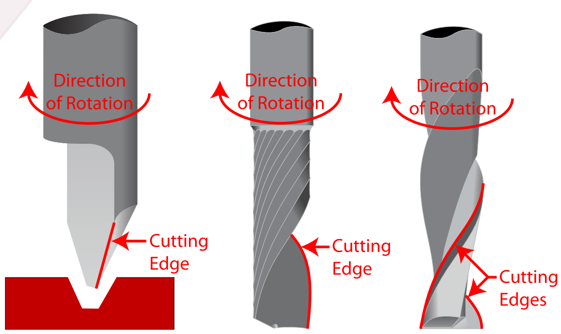
Most standard cutters are available with either a stainless steel shaft or a micrograin carbide shaft (see below). The stainless steel shank is less expensive than the solid carbide shaft. The solid carbide shaft provides more rigidity and is better for engraving in harder materials such as stainless steel. Both of these types of cutters have micrograin carbide tips. Therefore, the cutting edge is of the same quality. All of these cutters are available with a threaded brass knob for top-loading engraving machines. The knob has a set screw to allow adjustment of the vertical position of the cutter and to hold it in place.



Typically, engraving cutters are single-flute tools.

This means they have only one cutting edge. The cutting edge is edge created between the split on the flat of the tool and the cutting angle (highlighted in the picture at right). Note the direction of rotation of the cutter.

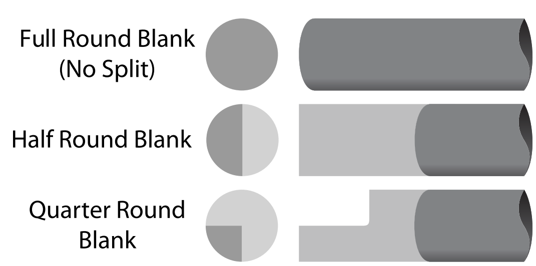
Router tools may have one or multiple cutting edges. The cutting edges are the edges created by the flute and the clearance grind. All of Antares tools are bottom cutting, so the bottom edge of the tool cuts as well.

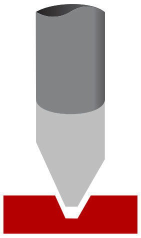


Cutters can be classified as half-rounds or quarter-rounds. This refers to how the blank carbide shafts are split during the manufacturing process.

Half-round cutters are made from blanks that have been “split” or “halved” approximately on center through a grinding process. This tool has a cross-section that is half of a cylinder and is the choice for most engraving cutter applications.

Quarter-round tools are half-round tools that have a secondary split at 90 degrees to the original flat producing a tool that has a cross-section that is one quarter of a cylinder.

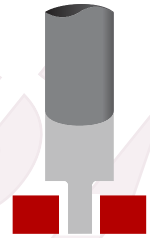




While there is a seemingly infinite number of cutter sizes and shapes, engraving tools fall into two basic categories - conical and parallel.

Conical cutters have an angled cutting edge and produce a “vee” shaped, flat-bottomed cut.

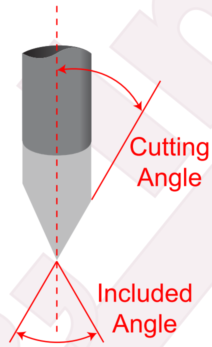
Parallel cutters have a straight cutting edge that is parallel to the cutter’s axis of rotation and produce a cut with straight walls and a flat bottom. The width of the cut can be as large as the diameter of the shaft (i.e. 11/64” parallel tool can be made to cut up to .171” wide)

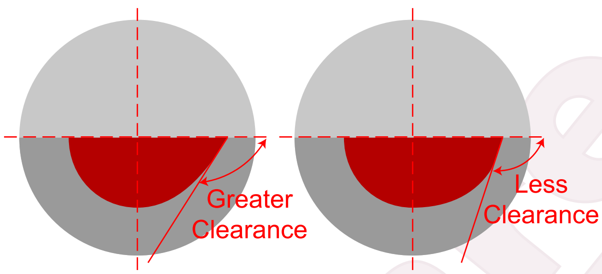


Cutting Angle and Included Angle

The **cutting angle** is the angle formed between the cutter's axis of rotation and its cutting edge. This determines the "V" shape of the groove produced by conical cutters.

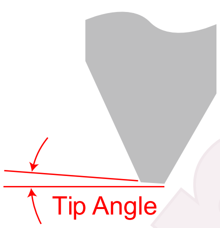
The **included angle** is double the cutting angle.





Clearance Angle

The **clearance angle** refers to the angle of the cutting edge with respect to the face of the cutter. This angle allows for chip clearance, determines how fine the cutting edge is and is selected based on material properties.

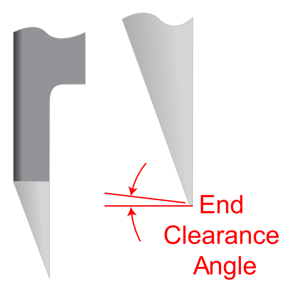


Tip Angle

The **tip angle** is the angle at the tip of the cutter. Sometimes called the tip-off. Determines the width of the flat at the bottom of the cut.

End Clearance Angle

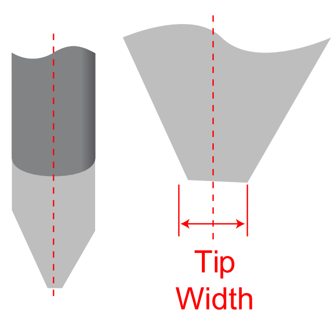
The **end clearance angle** is the angle on the back side of the tip that provide clearance for the tip.



Tip-Off or Tip Width

The **tip-off** refers to the flat on the tip of an engraving cutter that determines how wide the cutter will cut. When we refer to tip width or tip size, we are describing the width the cutter produces at the bottom of the cut.

Tip widths are most accurately measured by doubling the dimension from the cutter's centerline to the cutting edge. In the sharpening process, material is removed from the back of the tool to provide clearance, therefore the dimension across the tip will be smaller than the cut produced. For example, a .030” cutter for flexible engraving stock will only measure about .025”.



Types of Engraving Cutters

Diamond Gravers - The most common engraving tool used in the trophy and awards industry is the diamond graver which is a non-rotating, diamond-tipped tool that is used to scratch lettering into metal - usually brass or aluminum. It consists of a steel shank which has a diamond set in one end that is ground and lapped to a conical point. It is used without a depth nose and, as downward spindle pressure is applied, the point penetrates the surface of the metal and scribes a fine line as the character is formed. Diamond gravers are not available in different tip sizes so we are limited to a rather fine, delicate line of about ten thousandths (.010) in width.

Rotary Cutters - Rotary engraving is a term that is commonly applied to the type of engraving done on plastics and metals where we cut into the surface of the material. As the name implies, it is done with a rotating cutting tool in a motorized spindle. The rotary cutter is generally a single-flute tool (one with only one cutting edge) that works much like a router bit and produces a cut of specified depth and width. Depending upon how they are made and sharpened, rotary cutters can be used to engrave a wide variety of materials with plastic and metal being the most common.

Burnishers - Burnishing is a method of engraving on metals that tends to bridge the gap between scratch engraving and rotary engraving. It is capable of producing wider line widths than a diamond graver without having to rout deeply into the metal. It is a surface marking technique that is generally done on coated metals. It is most commonly used to produce decorative effects on trophy and plaque plates.

The tool used for burnishing is called a “burnisher” which is a rotating tool that is used in a motorized spindle. It is usually a carbide or carbide tipped-tool that is ground with four facets that form a cutting edge to the desired tip size. A burnisher is not a cutter. Its function is to remove the surface coating from the material and expose the bare metal.

Parallel Cutters - Cutters whose cutting edge is parallel to the shank of the tool. They produce a straight cut and are used for cutting out shapes or making cut-outs in panels.

Profiling Cutters - Cutters that have a narrow angle and are used for cutting through material in similar applications to the parallel cutter, but produce a slight bevel on the edge of the material.

Ballnose Cutters - Have a radius at the tip rather than a flat. They produce a cut with a rounded bottom and are typically used for reverse engraving.

Types of Engraving Cutters

Dovetail Cutters - Produce a cut that has a reverse bevel and are used for making signs that have removable legend strips.

Quarter-Round Cutters - Provide more clearance than half-round cutters.

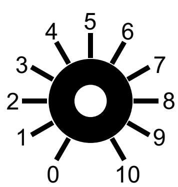
Rotating Diamonds - Faceted diamond tools that are used in rotating spindles to engrave glass.

Rubber Stamp, Seal, Pens - These are variations of standard cutters that are manufactured and sharpened for specific applications such as engraving rubber stamp matrix, notary seals, coated pens, etc.

CUTTER TYPE	MATERIAL
ACR	Acrylic
FLX	Soft Plastics and flexible engraving stock
PHN	Phenolic and rigid plastics
BAL	Brass, Aluminum and other soft metals
SSS	Stainless steel, steel, and other hard metals

Spindle speeds

The spindle speed on a standard Xenetech machine is 20K rpm max. The 1-10 numbers on the MSC knob are translated below.



1 = 2K rpm	6 = 12K rpm
2 = 4K rpm	7 = 14K rpm
3 = 6K rpm	8 = 16K rpm
4 = 8k rpm	9 = 18k rpm
5= 10k rpm	10 = 20k rpm

Spindle speed recomendations by: *Antares, Inc*.

	Cutter Size						
Material	**.015”**	**.030”**	**.060”**	**.090”**	**.125”**	**.171”**	**.250”**
Plastic Engravers Stock	20K rpm		15K rpm			12K rpm	10K rpm
Engravers Brass	15K rpm			13K rpm	9K rpm	7K rpm	5K rpm
Free Cutting Aluminum	20K rpm		15K rpm		9K rpm	7K rpm	5K rpm
Mild Steel	15K rpm	10K rpm	5K rpm	4K rpm	3K rpm	2K rpm	1K rpm
Hard Steel/Stainless Steel	12K rpm	6K rpm	3K rpm	2K rpm	1.5K rpm	1K rpm	750 rpm
Wood	20K rpm						

Note: While engraving a material you may notice noise or“vibration”. You can adjust the spindle speed up or down slightly to smooth it out.

Feed Rate (X,Y, Speed)

Feed rate should be proportionate to cutter speed and is dictated by material properties, horsepower, and torque. At a given cutter speed, a slow feed will produce more, smaller cuts and finer finishes. A higher feed rate will produce fewer, larger cuts and rougher finishes. Due to its single-lip design, an engraving cutter makes an "interrupted cut" which means the cutting edge is not continually engaged in the material. At each rotation, the cutting edge hits the material as it starts the cut. On harder materials, the shock created by this impact can damage the cutter and quickly destroy its edge, thus slower feed rates are dictated.

While the above situation not as dramatic and detrimental when involving softer materials, a cutter still needs time to cut. Too high a feed rate tends to tear the material rather than cut it cleanly, resulting in rough, burred cuts. As a rule-of-thumb, the feed rate should be adjusted to allow maximum engraving speed without sacrificing the quality of the finished cut.

On softer, free-cutting materials like flexible engraving stock, one pass is generally sufficient to produce a good, smooth cut. On harder materials such as steel, brass and even acrylic, two or more passes are recommended. The first does most of the cutting, while the second cleans out the chips and removes the burrs.

One problem inherent to some machines common to the awards and engraving industry is their lack of power and torque at lower speeds. If the cutter speed is reduced appropriately for harder materials, there is insufficient power to produce a quality cut. Engraving machines are not milling machines and care must be taken to not exceed their capabilities.

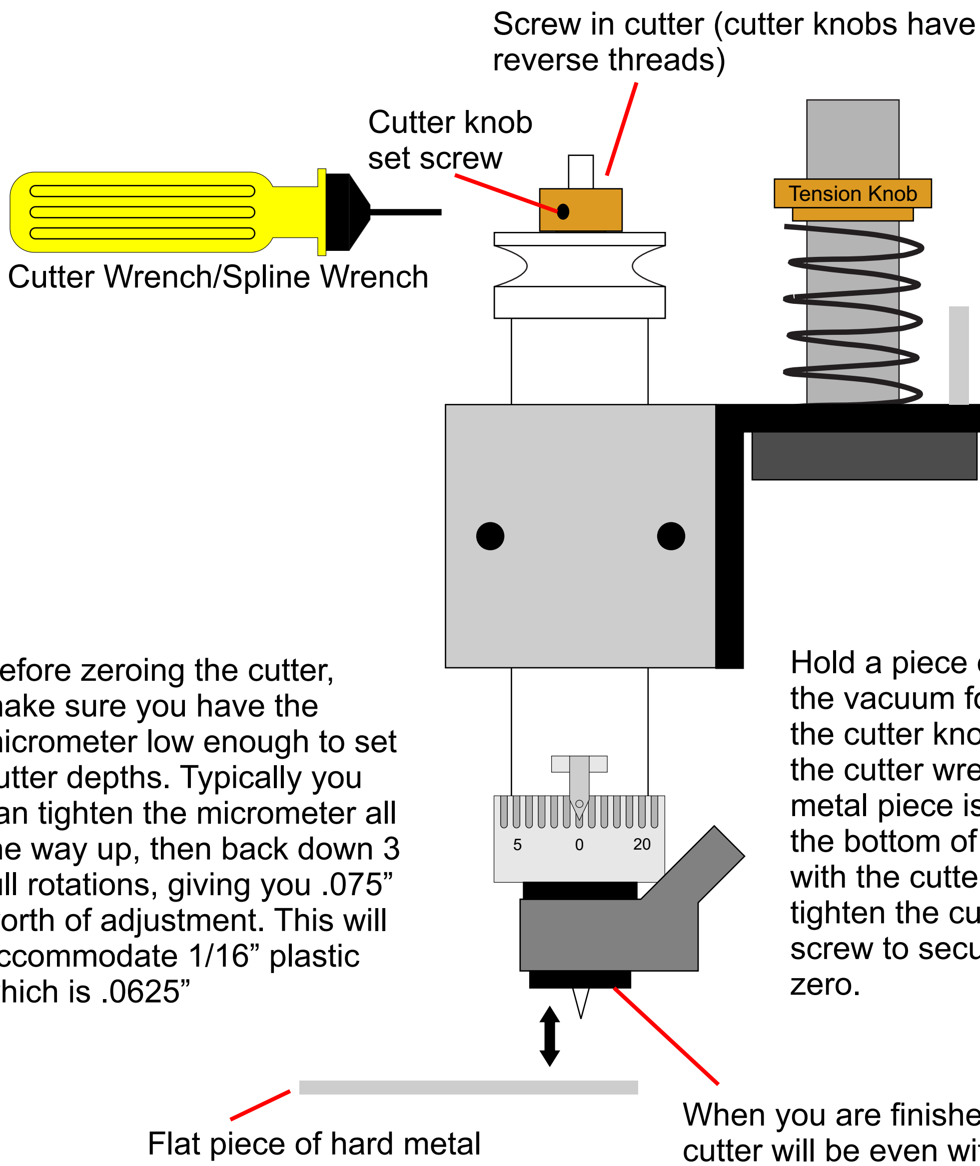
Cutting Fluids

Many of the materials common to the awards and engraving industry can be cut effectively without the use of cutting oils or lubricants. Flexible engraving stock, phenolic, engravers brass, and aluminum all fall into this category. There are many other materials, however, that must be cut with a cutting fluid to achieve satisfactory results and maintain reasonable cutter life. Cutting fluids keep the cutter cool and prevent chips from adhering to the cutting edge.

The subject of cutting oils is very specific and complex, but the following are generalizations that may be helpful as guidelines.

All steels should be engraved using an appropriate cutting fluid to improve the cut and extend tool life. Soft aluminum that is not "free-machining" can usually be engraved effectively using kerosene or a tapping fluid specifically formulated for aluminum.

How to zero a cutter

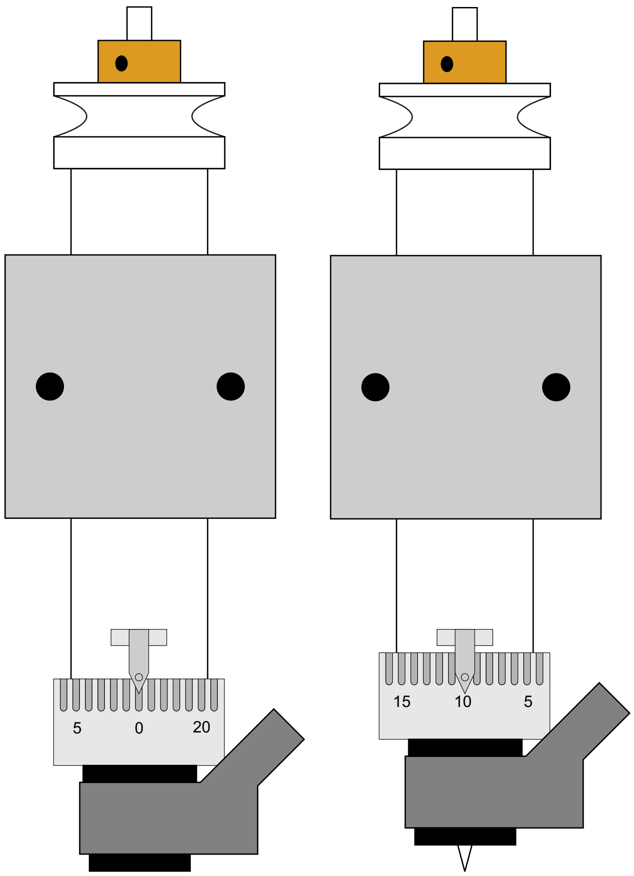


Before zeroing the cutter, make sure you have the micrometer low enough to set cutter depths. Typically you can tighten the micrometer all the way up, then back down 3 full rotations, giving you .075” worth of adjustment. This will accommodate 1/16” plastic which is .0625”

Hold a piece of metal under the vacuum foot, then loosen the cutter knob set screw with the cutter wrench. Once the metal piece is flush agains the bottom of the vacuum foot with the cutter tip resting on it, tighten the cutter knob set screw to secure the cutter at zero.

When you are finished the tip of the cutter will be even with the bottom of the vacuum foot not sticking down below it like shown here.

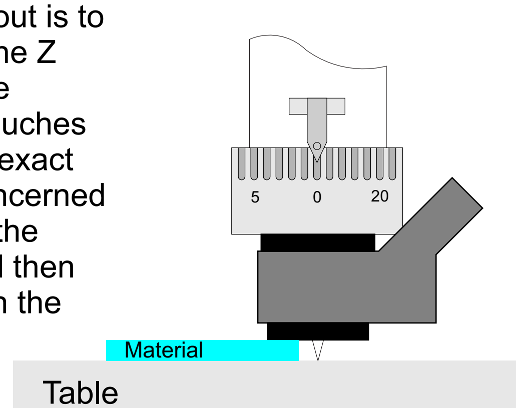
How to set cutter depth



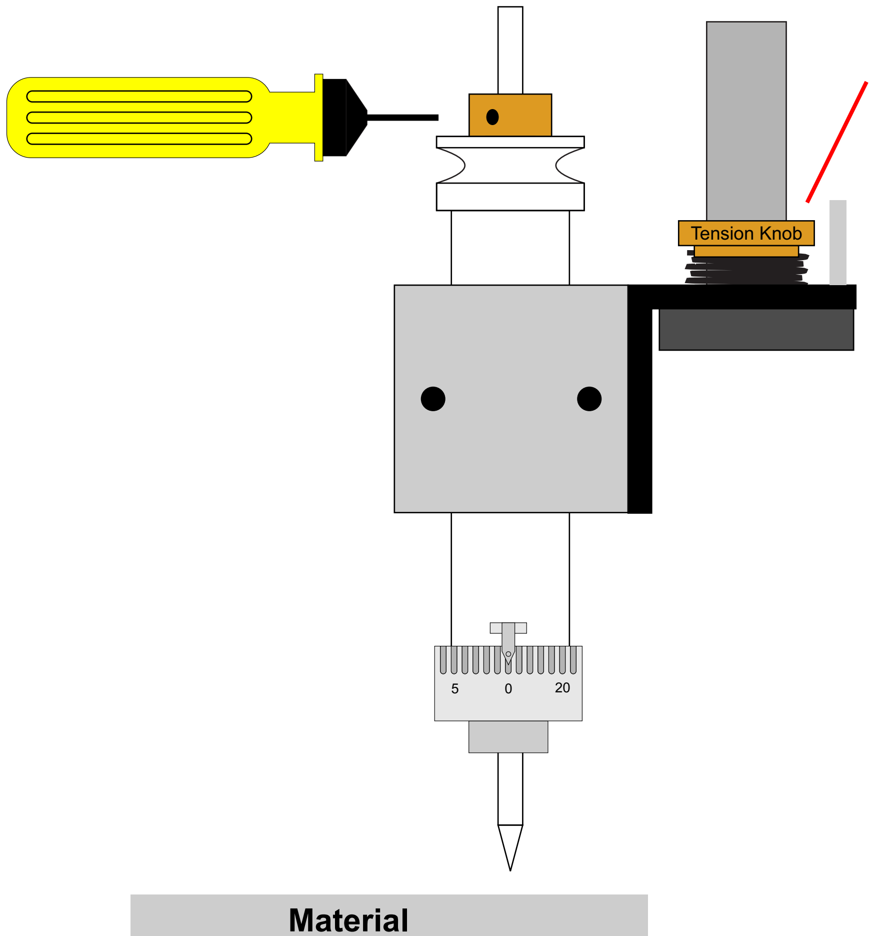
When you are adjusting the cutter depth you first need to have the cutter zeroed as is shown on the left.

The illustration on the right shows a very exaggerated view of setting cutter depth. The micrometer has 25 notches, clicks which is 25 thousandths or .025”. This illustration is exaggerated for effect. There is no way for us to know the actual depth by looking at the micrometer. It is clearly more than .010” but could be .035” or .060”. We come to this conclusion because each full rotation is .025” then we add the .010” indicated. This why it is important to keep track of where your micrometer is set at all times.

Another way to set cutter depth for cutout is to place the material on the table, lower the Z until the foot is touching the edge of the material, then lower the cutter until it touches the table. This will set the cutter at the exact thickness of the material. If you are concerned about engraving into the table, loosen the micrometer 1 or 2 clicks. The cutter will then be set either .001” or .002” shorter than the thickness of the material.



Manual Cutter Set
(No Float)

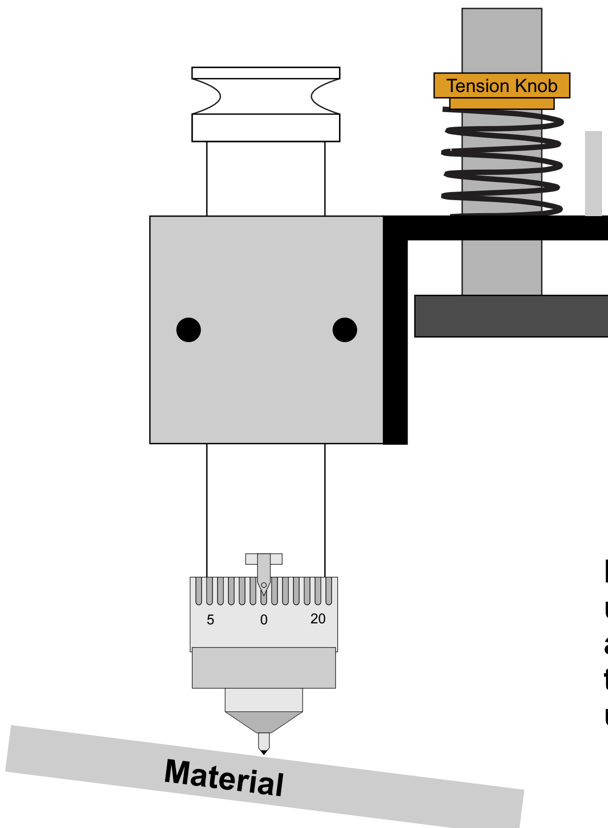


If routing/milling material and a nosecone or vacuum foot can not be used, it is recommended to lock the Z float by tightening the tension knob all the way down.

Manual Cutter Set (Without Z float)
In the settings dialog of the Carpathia EDI, set the “Engrave Type” to “Route”, then set the “Cutter Mode” to “Manual”. Press the play button to start the job. the job the spindle motor will turn on, then the engraving head will jog out to the location of the first object to engrave and wait. With the pendant use the green Z down arrow to lower the cutter close to the material (about 1/8” above). Turn off the spindle motor using the green spindle on/off button on the pendant. Loosen the set screw in the cutter knob using the cutter wrench. Let the cutter slide down and touch the surface of the material. Tighten the set screw in the cutter knob. Press the set cutter set button on the pendant. The Z axis will lift by the amount of “cutter lift” set in the Carpathia EDI settings dialog. Press the play button and the job will begin.

Note: After you have done a manual cutter set, the controller will remember that Z height until you do another manual cutter set. You can continue to use this Z location by using the “No Cutter Set” selection in the “Cutter Mode” dialog.

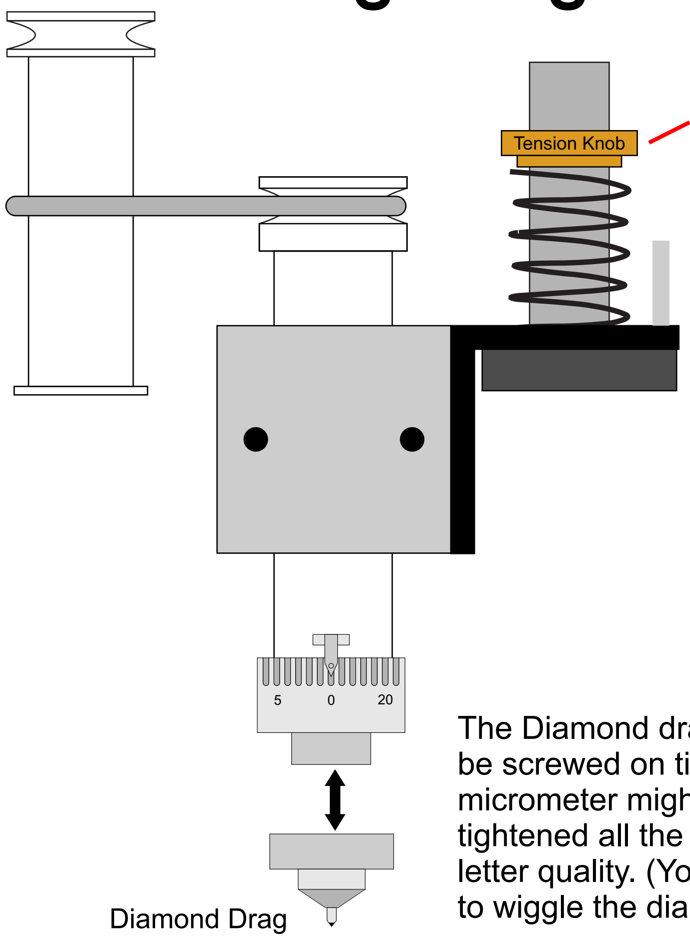
Manual Cutter Set
(With Z Float)



For this example we are using a diamond drag adapter using the Z float to accommodate an uneven surface.

Manual Cutter Set (With Z float)
In the settings dialog of the Carpathia EDI, set the “Engrave Type” to “Drag”, then set the “Cutter Mode” to “Manual”. Press the play button and the spindle motor will turn on, then the engraving head will jog out to the location of the first object to engrave and wait. With the pendant use the green Z down arrow to lower the cutter close to the material (about 1/8” above). Turn off the spindle motor using the green spindle on/off button on the pendant. In the example above we lower the Z compressing the Z float spring enough to compensate for the lower slope of the material and we have enough spring left to accommodate the higher slope of the material. If we were setting our “cutter set” at the lowest part of the material we would just touch the diamond to it. If we were setting the “Cutter Set” at the highest point we would lower till we almost compress the spring into the tension knob. Once you have the desired cutter set location press the “cutter set” button on the pendant. The Z axis will lift by the amount of “cutter lift” set in the Carpathia EDI settings dialog. (Needs to be very high for this application) Press the play button and the job will begin.

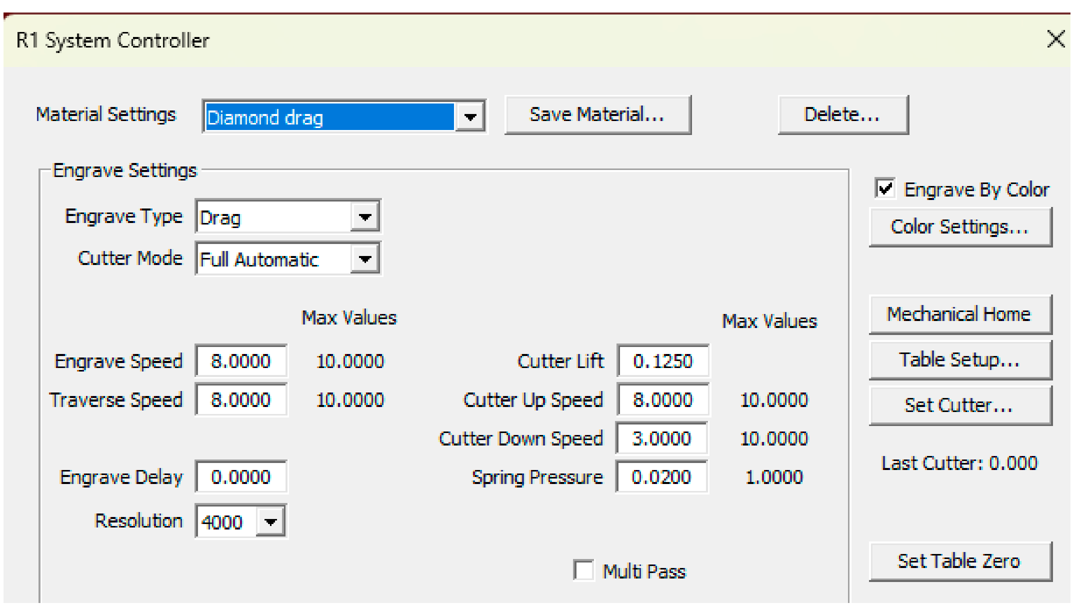
Diamond Drag Engraving



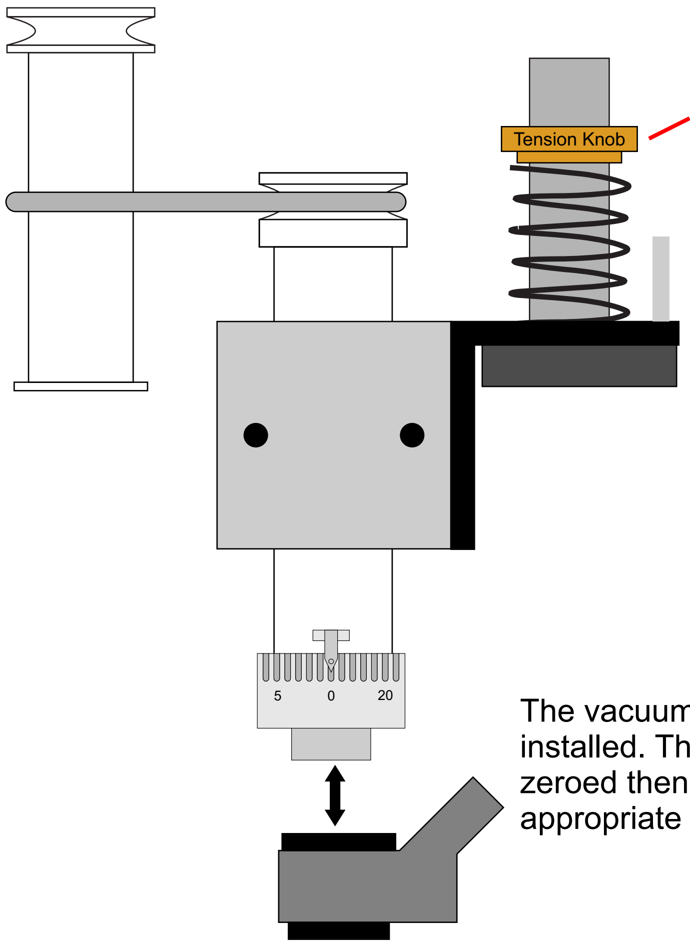
Tension knob needs to be set so there is float. The lower the knob the more pressure and deeper the diamond will engrave.

The Diamond drag adapter needs to be screwed on tight and the micrometer might need to be tightened all the way to prevent bad letter quality. (You should not be able to wiggle the diamond tip at all.)

Diamond Drag Adapter



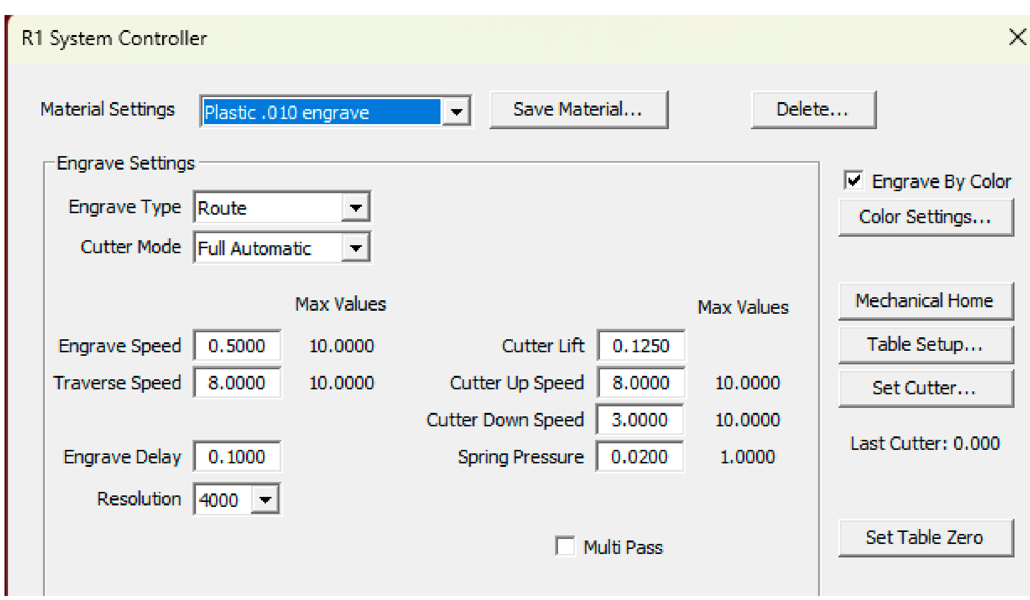
Plastic Engraving



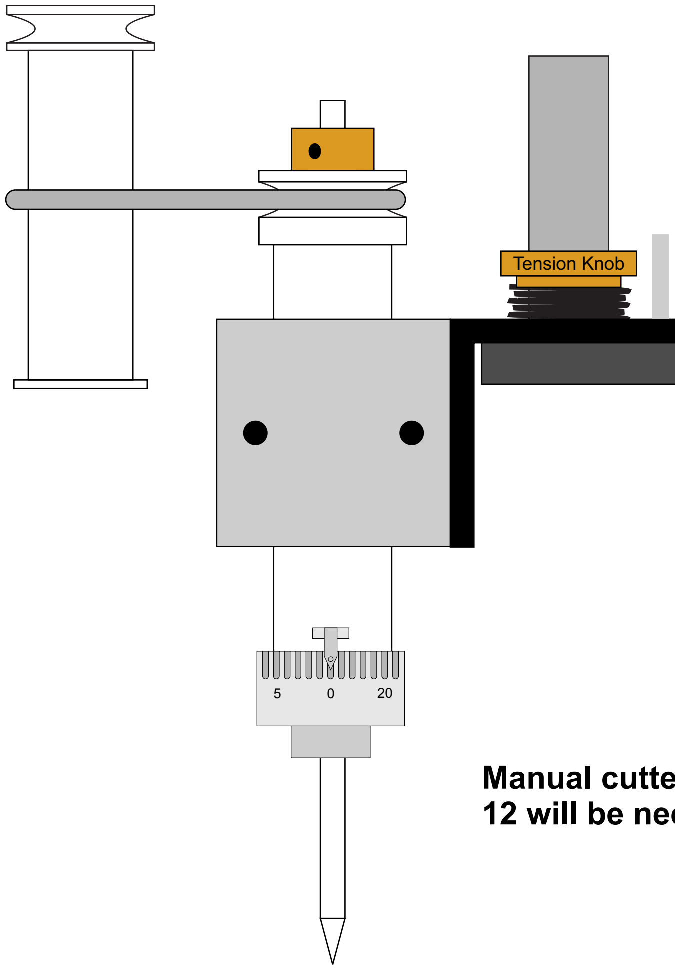
Tension knob needs to be set so there is float. The lower the knob the more pressure and the more uneven a surface it can accommodate.

The vacuum nosecone needs to be installed. The cutter needs to be zeroed then the micrometer set for the appropriate depth.

Vacuum nosecone



Metal Routing and Milling



Deep routing and milling can require multiple passes. For example if you are milling aluminum, .015" might be the max depth you want for each pass. If you need to route .125" deep, multi pass mode will be necessary.

The Tension knob needs to be all the way down "locking" the Z to prevent bouncing or "chattering".

Manual cutter set as shown on page 12 will be needed for this application.