Bridgeport Mill & Horizontal Bandsaw

Safety – Bridgeport Mill

Mandatory Eye Protection

Recommended Hearing Protection

No loose clothing. Recommend short sleeves. If long sleeves, should be tight to arms.

Tie back long hair.

Recommend no rings, watches, jewelry, necklaces, or other items that could be caught by rotating tools.

No gloves.

Workpieces must always be clamped securely. Never held by hand.

Metal chips coming off your workpiece are hot and sharp. Never use your hand to clear metal chips.

Cutting tools are sharp. Hold by non-cutting surfaces or use something between your hand and the cutter. Never grab or hold a moving cutting tool.

Change the speed belt carefully to prevent pinched fingers. Do not allow fingers to be positioned between the pulleys and the belt. Never change the belt with the motor running. Always replace the pulley/belt guards after moving the belt.

Take your time. Do not hurry.

If you do not understand what you are doing, ask for help. Send an email to boss.machine@xerocraft.org.

Safety – Horizontal Bandsaw

Safety items under the Bridgeport mill above are also applicable to the horizontal bandsaw.

Be aware of the moving bandsaw blade and keep body parts away from the moving blade.

The horizonal bandsaw is mounted on wheels such that it can be pulled out to support access for operation. The bandsaw is heavy. Be aware of the weight as you move it. When done using the saw, move it back against the wall.

The bandsaw mechanism can be listed into a vertical position to allow access for workpiece clamping. The bandsaw mechanism is heavy. Be careful when raising the bandsaw mechanism.

The workpiece must be clamped securely when cutting.

If using the bandsaw vise with a workpiece shorter than the vise width, equivalent packing must be used on the end of the vise opposite of the workpiece.

House Keeping and Maintenance

No one like to start a new job with a DIRTY machine or shop. Please respect the next person using the machine.

When you have completed your job **PLEASE** clean and return all tools, clamps, measuring tools, etc to their normal location.

Clean the Machine and immediate work area of all chips and oils. You can us a brush, compressed air (be careful of flying chips).

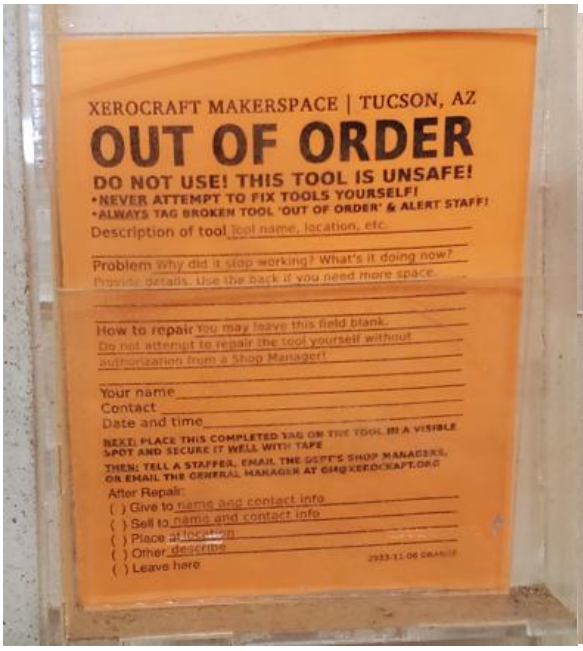
In addition, sweep or vacuum the floor and clean chips from toolbox and bench surfaces. The mill can fling chips a significant distance in all directions.

Wipe down machine with rag or paper towel.

Note: General Rule – Leave the shop in better condition than you found it.

Basic oil procedures can be found in the Bridgeport Manual.

If you find that something on the Machine is not working correctly or broken, notify a volunteer staff, send an email to boss.machine@xerocraft.org, attach a machine issue tag to the machine (picture below), attach a tool problem tag (picture below) to the machine, or leave a note at the front desk.



Basic Operation of the Horizontal Bandsaw

The horizontal bandsaw can be used to cutting raw material and work pieces to approximate size before machining on the lathe or mill.

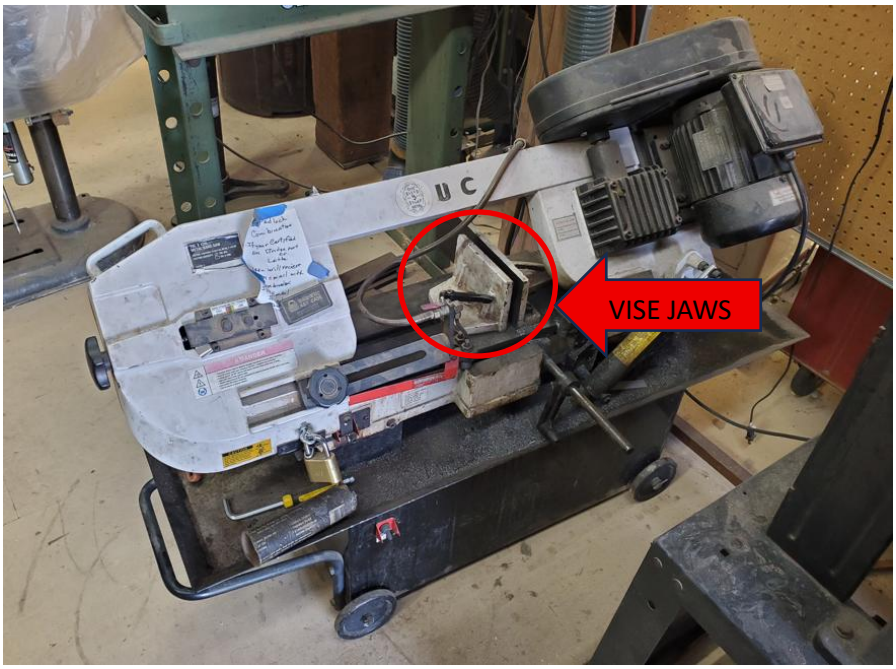
Note: The horizontal bandsaw in the Xerocraft machine shop shall only be used on mild steel, aluminum, brass, and other soft materials. Do NOT use the horizontal bandsaw to cut hard or hardened materials. If in doubt, do NOT cut you material and ask for help.

Start by lifting the saw mechanism to the vertical position.

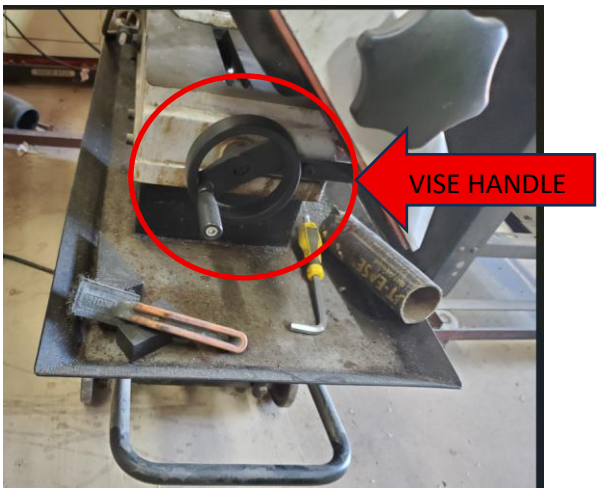
Note: Lift the saw mechanism carefully. The saw mechanism is heavy and changes the balance of the saw.

The material must be secured to the bandsaw prior to cutting. Typically, the material is held in the onboard vise shown in the phot below, but can also be clamped in an alternate secure manner.

Material clamped in the vise must be clamped in the middle of the vise such that the vise jaws are parallel. If your workpiece is short and clamps on the end of the vise jaw, suitable packing material must be used on the other end of the vise jaw. This is similar to guidelines for clamping work in the mill vise discussed latter in this document.

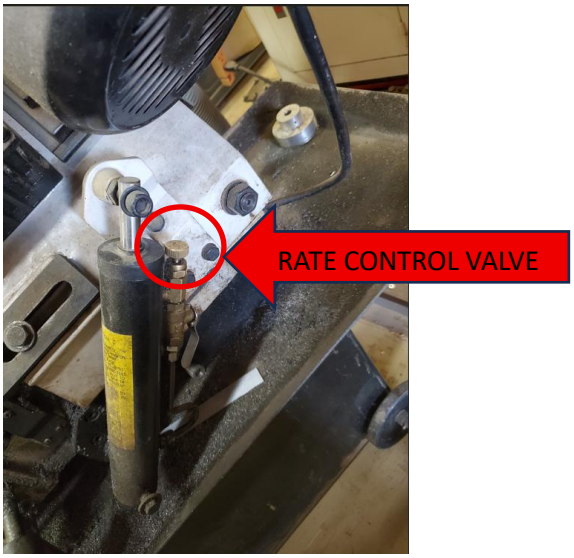


The vise is operated by manually pulling the moveable jaw back to create space for your workpiece. The work piece is secured by clamping using the vise handle at the front of the machine as shown in the photo below.



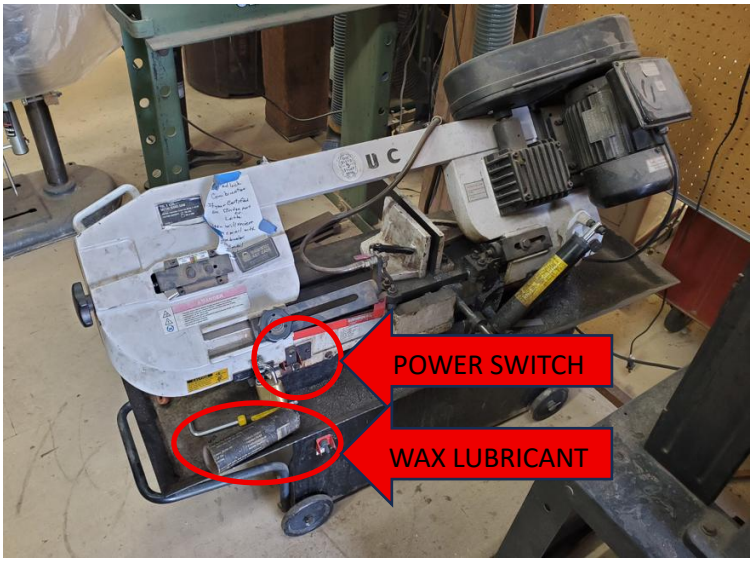
Once the material is secured, lower the saw mechanism towards the material. The rate of lowering is controlled by the valve shown in the photo below. When the saw mechanism is slightly above the workpiece, close the valve to hold the saw mechanism until ready to start the cut.

Note: Do NOT start the cut with the saw blade in contact with the workpiece.



Turn on the saw with the power switch as shown in the photo below. The switch should turn off automatically when the cut is complete.

Note: When powered, a significant portion of the blade is exposed. Keep hands and other body parts clear of the blade. ALWAYS turn power OFF before working near the blade.



Gently press the wax lubricant stick as seen in photo above to the moving blade for a moment before starting the cut.

There is a flood coolant option available on the horizontal bandsaw. Use of the flood coolant creates a major mess on the bandsaw as well as the surrounding floor. If choosing to use the flood coolant, you must completely clean up the mess. If the bandsaw is not cleaned up, the coolant option will be removed.

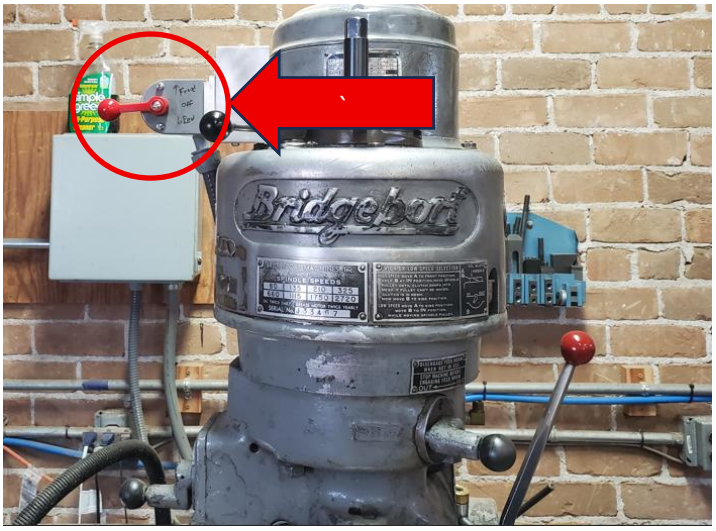
If you have need of the coolant, please contact the shop managers at boss.machine@xerocraft.org for a briefing.

Open the rate control valve until the blade starts moving slowly downward to make the cut.

Basic Operation of Mill

Locate the ON/OFF switch shown in the picture below. This switch controls the Electric Motor and it's direction of Rotation. Move the lever up when the machine is in high gear. Move the lever down when the machine is in low (back) gear. The spindle should always rotate in the clockwise direction.

Note: the direction of Spindle Rotation will depend on the selection of Normal or Back Gear and the position of the power switch.

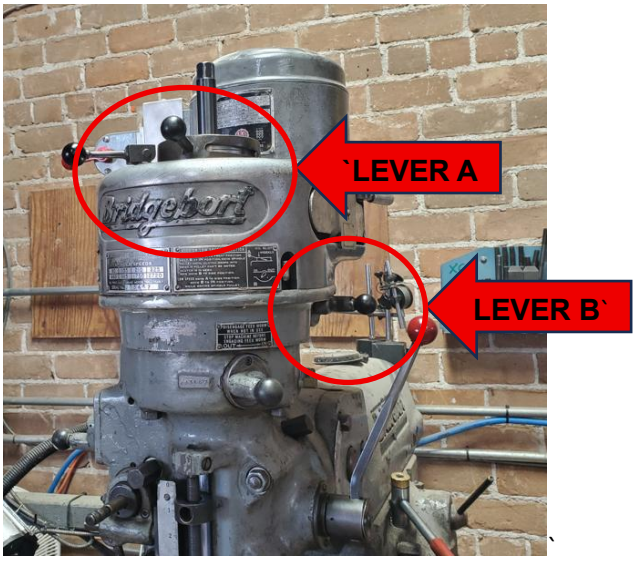


Locate the gear selection levers A & B as shown in the picture below.

Gear selection is via levers A & B. Gear changing directions are on the front of the gear housing and shown in the picture below.

Simple memory aid: When both levers are set to the inward position the mill is in low gear. When both levers are set to the outward position the mill is in high gear.

Note: Make certain when switching from High to Low / Low to High gear, that the internal gears are fully engaged before switching ON the motor. Test by rotating the Spindle by hand before switching the motor ON.



Spindle Speed is set by the gear chosen and the belt location on the pulleys. High and Low Spindle speed ranges are selected via the Gear levers discussed above. The Step Belt pulley system provides various spindle speeds in two ranges. The speeds are shown on a speed table on the front of the mill as seen in the picture below, The upper speed table row showing the four speeds (80, 135, 210, and 325 RPM) are selected by the low speed (back) gear. The lower speed table row showing the four speeds (660, 1115, 1750, and 2720 RPM) are selected by the high speed gear.

The largest pulley on the motor is for the highest speed in each speed range. The smallest pulley on the motor is for the lowest speed in each speed range.

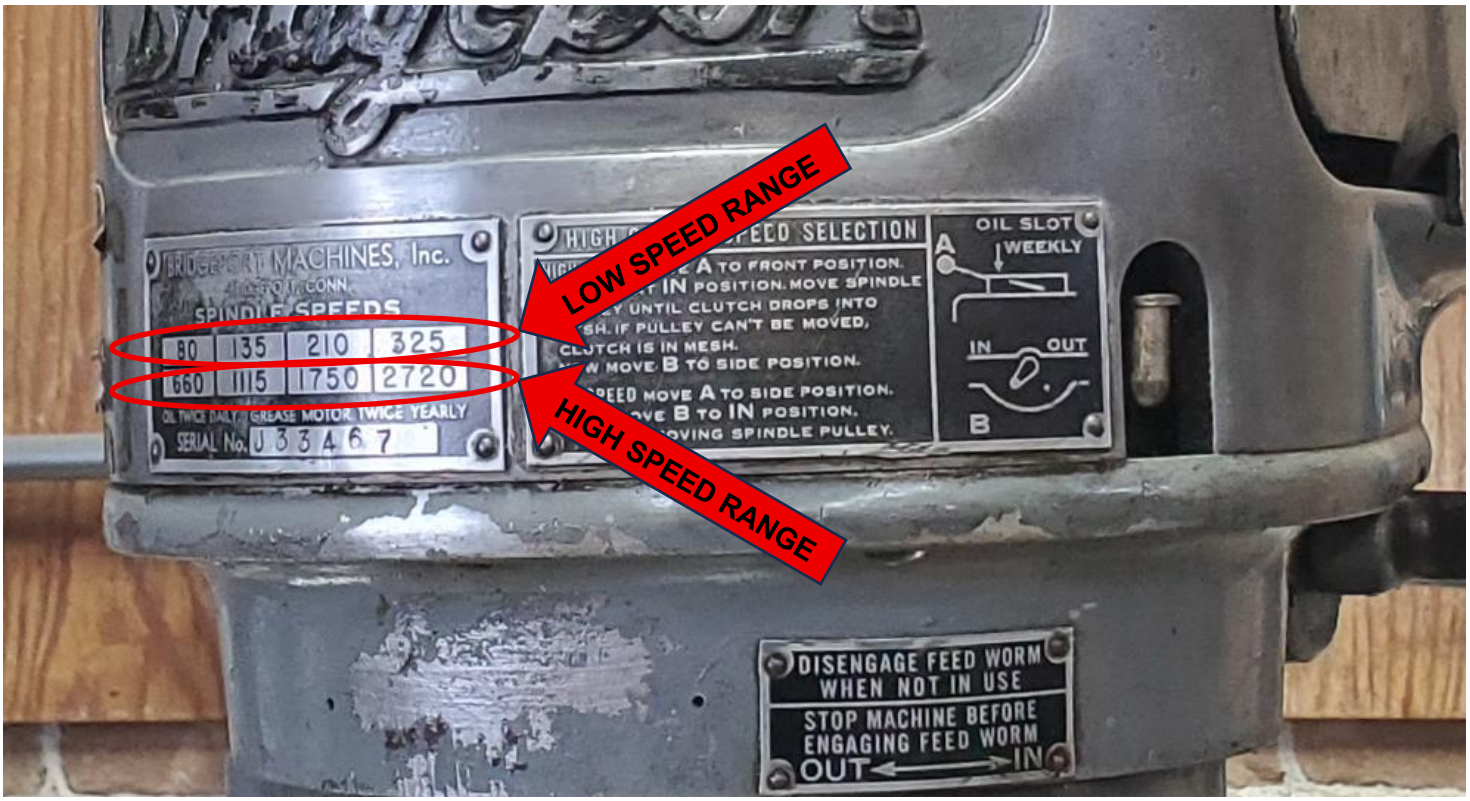
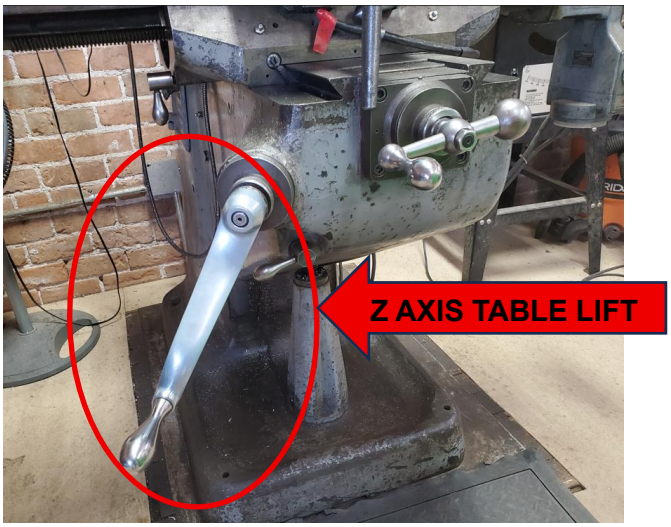


Table Axis

The Table X & Y axis handles are shown below. The X & Y axis lock handles are also shown below.

The Z axis is controlled by 2 separate methods both of which can be used to control cutting depths.

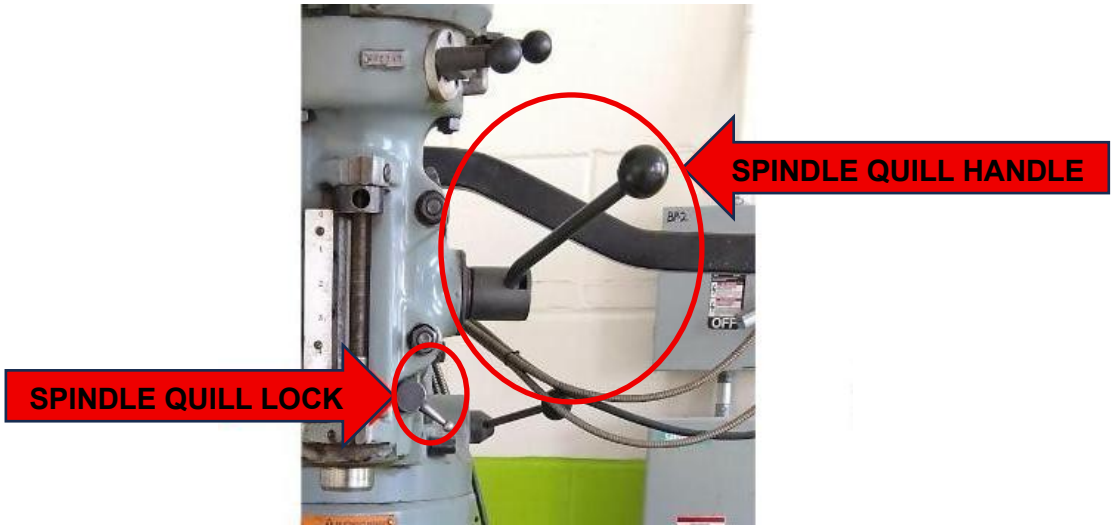
The Table lift is used to lift the whole X-Y table into position as shown in the photo below.



The Spindle / Quill, up / down motion is controlled by the lever adjacent the spindle as shown in the photo below. The spindle locking lever is also shown in the photo below.

The spindle/quill depth stop can be used to cut to a specific depth.

Spindle motion can also be controlled via the power feed option. Ask for help if you have a job that needs quill power feed.



Cutting Tools and Tool Holders

Various tool holding options are available.

The mill spindle is equipped with an R8 locking taper and requires tool holders with a matching R8 shank.

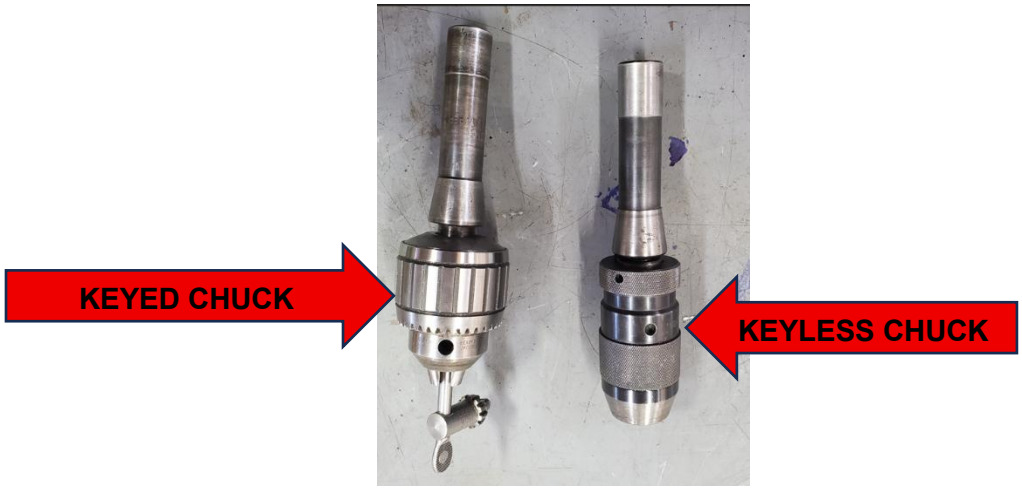
R8 Collets as shown below can be used for drills or endmills. They typically are available in 1/16” inch increments.

Note: R8 collets are designed to hold tools of the same shank size as the collet size. Installing tools with larger or smaller diameters than the collet size will permanently damage the collet.

Standard Drill chucks shown in the photo below can be used for drilling.

Note: Keyless chucks should not be used with drill diameters greater than the maximum chuck opening size. Use a keyed chuck for larger diameter drills.

Note: Drill chucks can only be used for axial drilling. No side cutting (END MILL) allowed.



Solid tool holders as shown in the photo below are available for larger sized cutters. The tool holders are designed for specific shank diameters and require cutters with Weldon shanks.

A Weldon shank has a ground flat spot as shown in the photo below.

The cutter with a Weldon shank is inserted into the holder in an orientation and to a depth such that flat spot on the shank aligns with the set screw in the tool holder. The set screw is then secured to hold the cutter in the holder and prevent rotation of the cutter in the holder.

Loading & Changing Tool Holders

To remove a tool from a machine, move the quill to the highest position and lock it in place with the quill lock. Engage the spindle break by pushing or pulling with your hand so it cannot spin as seen in photo below. Place the Drawbar Wrench on the Drawbar on the top of the milling head and loosen as seen in the photo below.

Note: Do not fully loosen Draw bar.

Note: Hold whatever is in the collet (endmill, drill chuck, etc.) If you do not hold on to the collet and cutter, they may fall out and can be damaged.

Turn the wrench counterclockwise to loosen it. You will feel the spindle loosening and opening. This loosens the collet and allows the cutter to be removed from the collet.

To get the collet and cutter free you may need to tap the top of the Drawbar with the back of the Drawbar wrench.

Note: The drawbar should be loosened no more than 1-2 turns if it needs to be tapped with the drawbar wrench. Tapping with the drawbar loosened too much may damage the Drawbar.

To remove the collect, while supporting the collet so it does not drop, continue to loosen the drawbar until the collet can be removed.

Drill chucks and tool holders are removed in the same manner as collets.

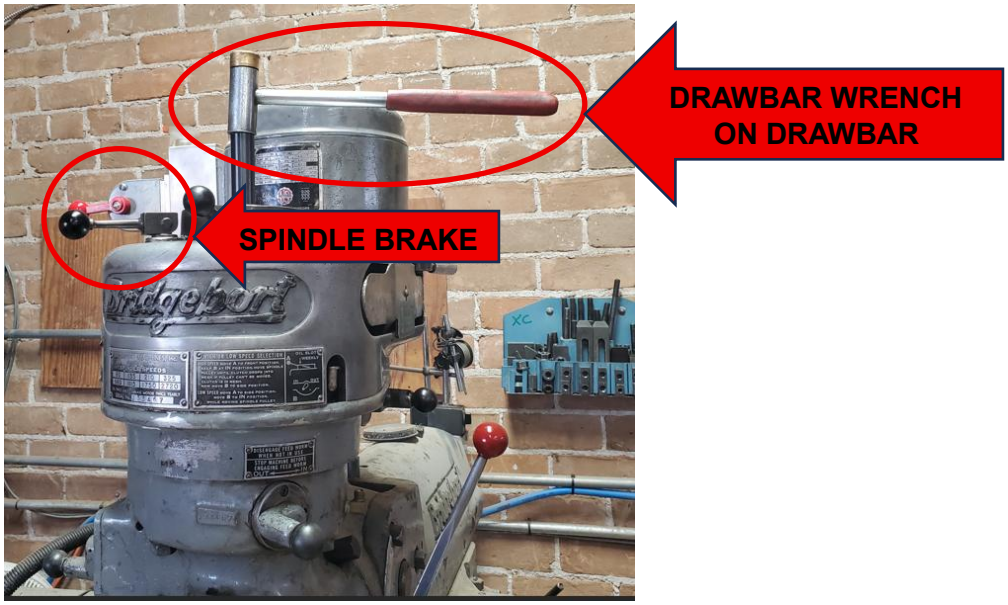
To load a collet, insure the outside of the collets is clean and free of chips or other debris. Insure the inside of the spindle is clean and free of debris. Hold the collet in the spindle bore and turn the drawbar clockwise until the collet is held in place.

Note: Do not tighten the collet completely until the tool is load into the collet.

To load a tool in the collet, slip the smooth shank of the tool into the collet such that most of the shank is in the collet. Continue to tighten the drawbar in the clockwise direction until finger tight. Stop the spindle rotation by holding the spindle brake and use the drawbar wrench to finish tightening the collet.

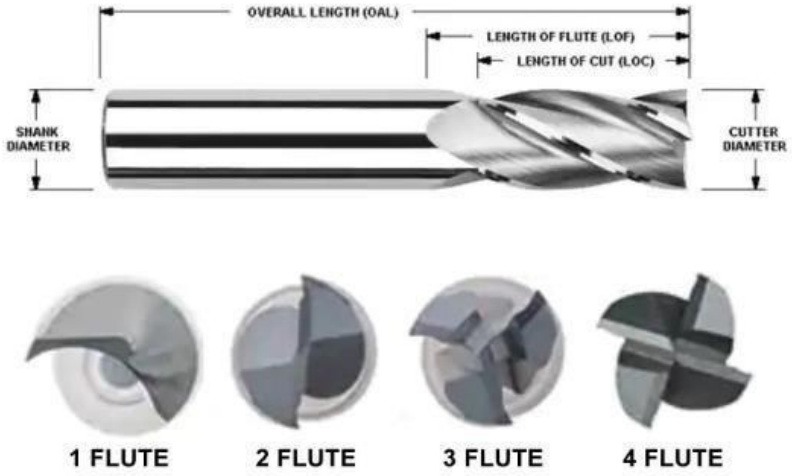
Note: Hold whatever is in the collet (endmill, drill chuck, etc.) If you do not hold on to the collet and cutter, they may fall out and can be damaged.

Loading drill chucks and tool holders is done in the same manner as collets except tightening the drawer bar is independent of the cutting tool installation.



Cutting Tools

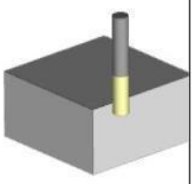
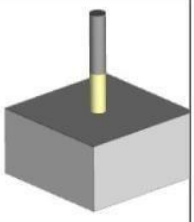
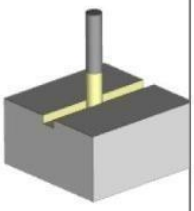
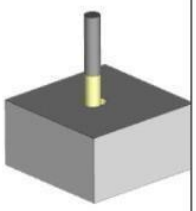
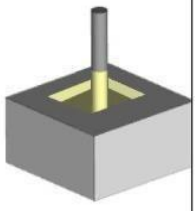
Standard drills, Endmills, Face mills, Boring Heads, and other specialized cutting tools such as those in the photos below can be used in the mill.



Common applications for end mills are shown in the photo below.

Note: Plunge milling requires a center cutting end mill and most end mills are not center cutting.

Applications for End Mills

Side Milling	Face Milling	Slot Milling	Plunge Milling	Pocket MIlling
				
Machining of an edge surface on the part.	Machining of a top face on the part.	Machining linearly between two points.	Axial feeding into a part along the Z axis.	Axial feeding along the X and Y axis to remove a region of material

Cutting Speed

Use of proper cutting speed yields a part with the most accurate dimensions, best surface finishes, and minimizes wear and damage to the tooling.

The proper cutting speed should be determined for each application and the nearest available speed set on the mill.

As a general rule use higher RPM for small tools and softer material and slower RPM for larger tools and harder materials.

As a general rule, carbide tooling can be run at higher RPM than high speed steel (HSS) tools.

Each workpiece material and tool material combination has a recommended Surface Feet per Minute (SFPM) number. The SFPM number can be found in the Machinery's Handbook, online, or in other machining references.

The SFPM is used to determine the appropriate machine RPM for the operation.

A quick Spindle RPM calculation is:

$$\frac{\textbf{4 x Cutting Speed (SFPM)}}{\textbf{Cutter Diameter}}$$

Examples Drilling a ½ " dia. hole in mild Steel

Cutting speed for mild steel with HSS drill 90 SFPM

Cutter diameter 0.5 " dia

(4 x 90) / 0.5 = 720 RPM

Endmill ¼ " dia. Carbide in Aluminum

Cutting speed Carbide with aluminum 300 SFPM

Cutter Dia. 0.25 " dia

(4 x 300) /0.25 = 4800 RPM

Cutter Feed Rate

The Bridgeport mill is all manual you will have to control Feed rate by feel.

Hand feeding too FAST you may overload the machine, break a cutter, or move your work.

Start slow and easy into the work piece.

Cutting Lubricants help to keep the tool cool, lubricate the cutting action and help with chip removal.

Climb milling vs Conventional milling

NOTE: Climb milling vs. Conventual milling is a critical concept for cutting with the milling machine. Lack of understanding of this concept will result in damaged cutters as well as your workpiece.

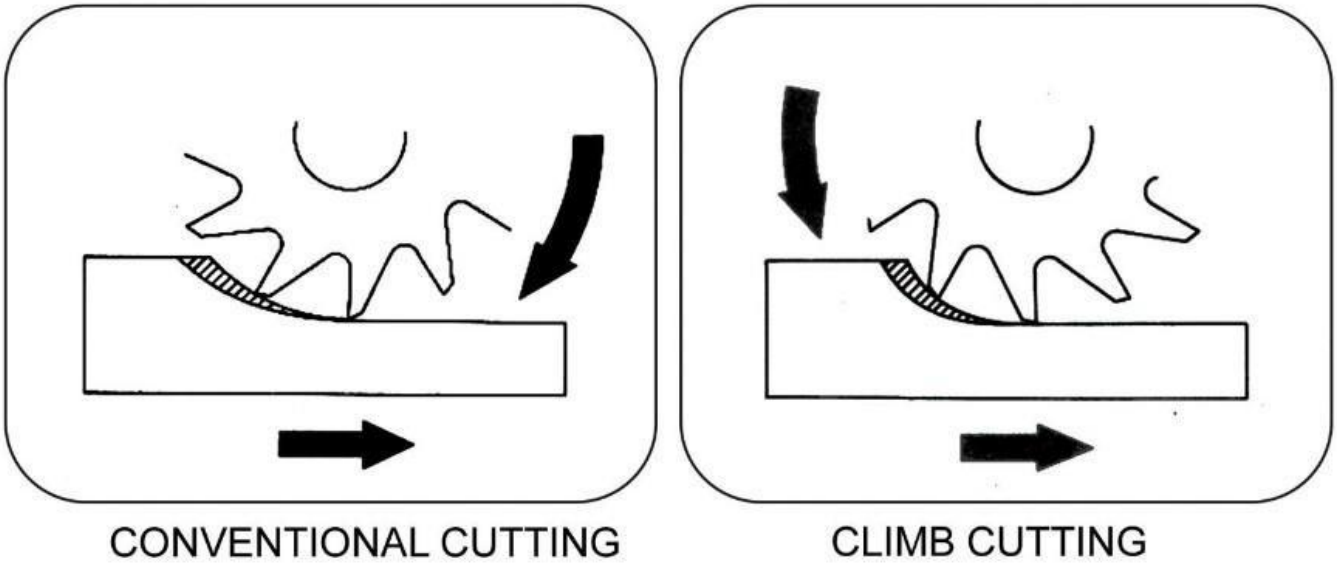
Refer to the figure below for the difference in CLIMB vs. Conventional milling.

In conventional milling, the workpiece is fed into the rotation of the cutter. This type of cut requires lower forces and is preferred for most milling cuts.

In climb milling, the work moves in the direction of rotation of the cutter. There are special applications where climb milling is used; however, typically on low backlash CNC mills.

It is imperative to understand the difference between climb and conventional milling.

NOTE: Climb milling is NOT recommended for this milling machine. Our Bridgeport mill has significant backlash which will cause the table to jump if climb milling. You WILL damage the cutter and your work piece.



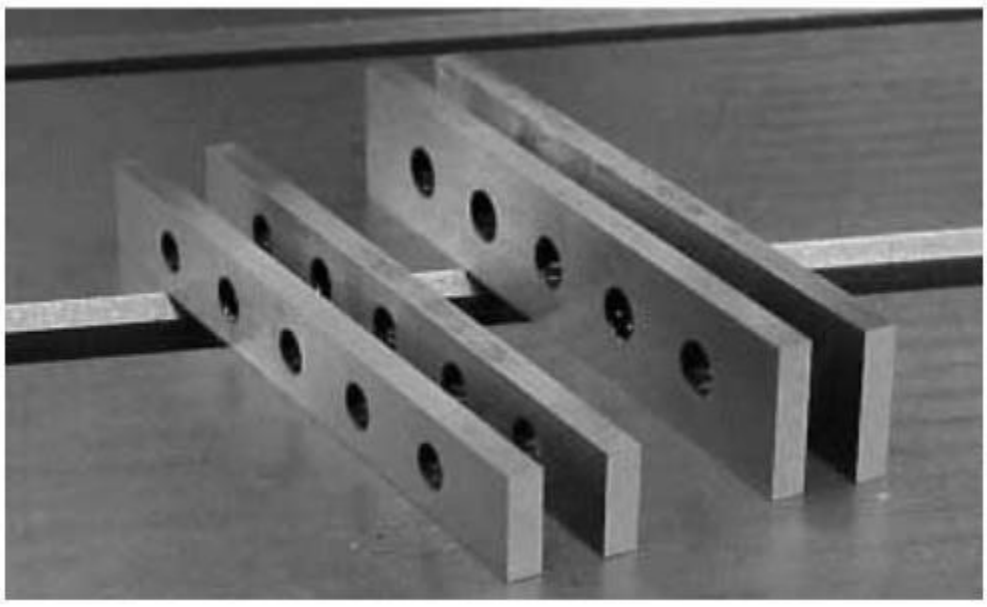
Work holding

NOTE: NEVER HAND HOLD your work piece while cutting. A rotating work piece is like a guillotine!

Many work holding options are available. Examples are: Table mounted Vice, Edge Clamping work to table, and Rotary Table.

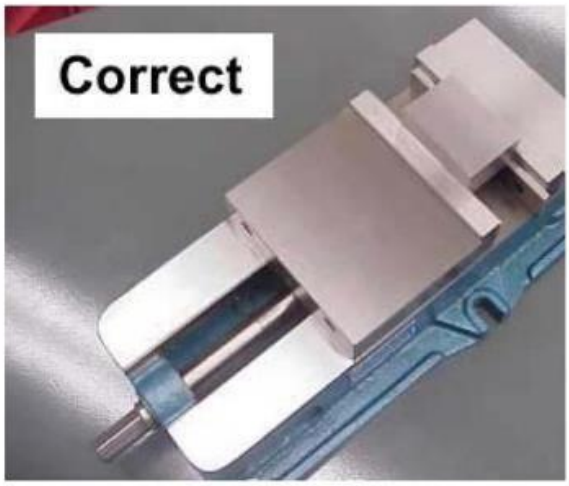
Note: If you mount your work piece directly to the table, always use parallels or a sacrificial scrap under the work piece to insure you do not cut into the table.

The photo below is an example of parallels.

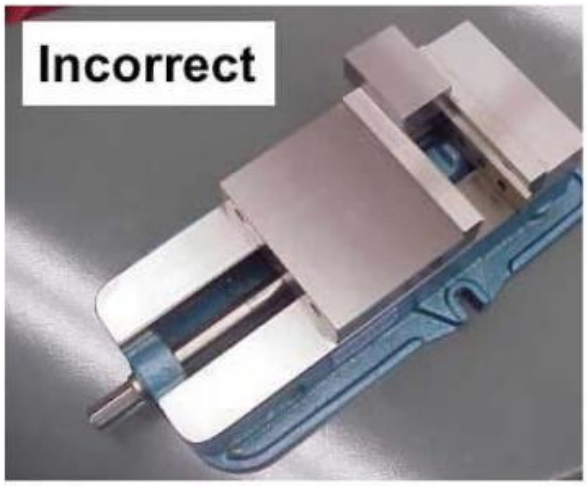


Guidelines to using a table vice are below.

The Vice and Clamping a Workpiece



Locate the part in the center of the vise. This equalizes the pressure on the vise jaws.

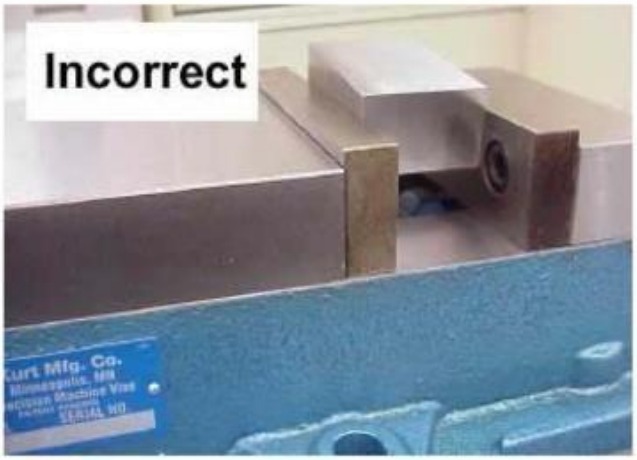


Holding the workpiece off center puts unequal pressure on the vise jaws. This can cause the piece to loosen up.

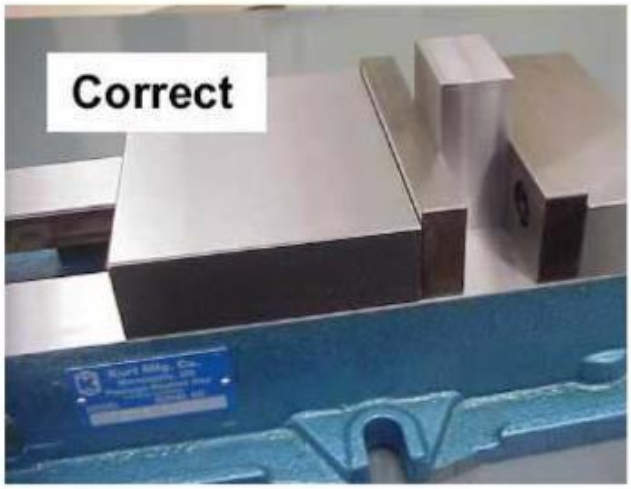
Note: Holding a workpiece as shown in the incorrect picture above may also damage the vise.

Note: If necessary to hold the workpiece at the edge of the vise as shown on the incorrect picture above, equivalent width packing must be added to the opposite edge of the vise to provide balanced clamping pressure.

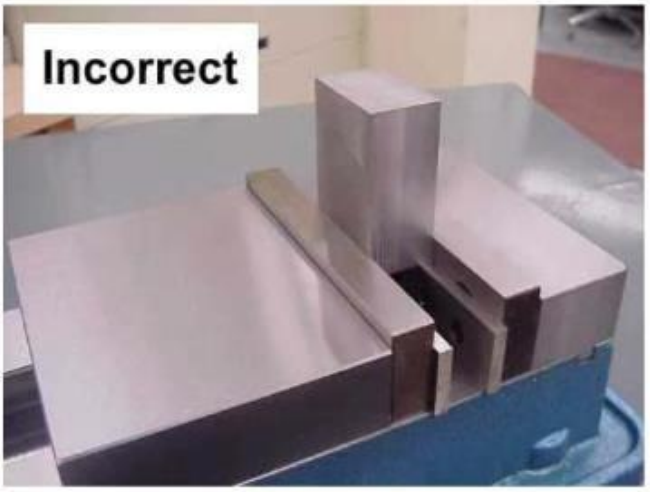
The workpiece should always be supported by the bottom of the vise or by parallels.



Work pieces that are not supported will move under the pressure of the cutting forces.



Keep the workpiece as low in the vise as possible.



Work that extends out of the vise has a greater chance of loosening up under cutting conditions.

Work piece alignment.

To accurately locate and machine you work piece you will need to align your work holding device and/or your work piece. This can be accomplished with a dial indicator. See photo below. By moving the X axis the dial indicator will indicate if the vice is parallel with the x axis.

Digital readout (DRO)

The DRO will provide many digital measurement options. Allow precision placement of drilled hole on your work piece. Accurate end milling. Drill a hole pattern.

Initially you will have to align / calibrate the DRO to your work piece. The method will be determined by the level of accuracy that you require. An edge finder is a quick and easy method of “zeroing” the DRO to your workpiece X & Y axis.