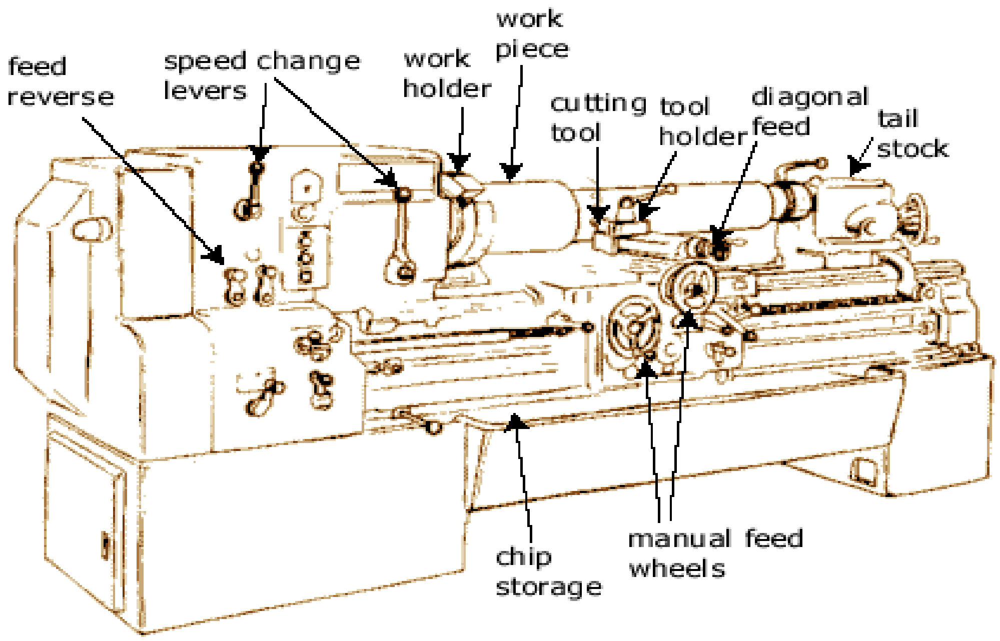
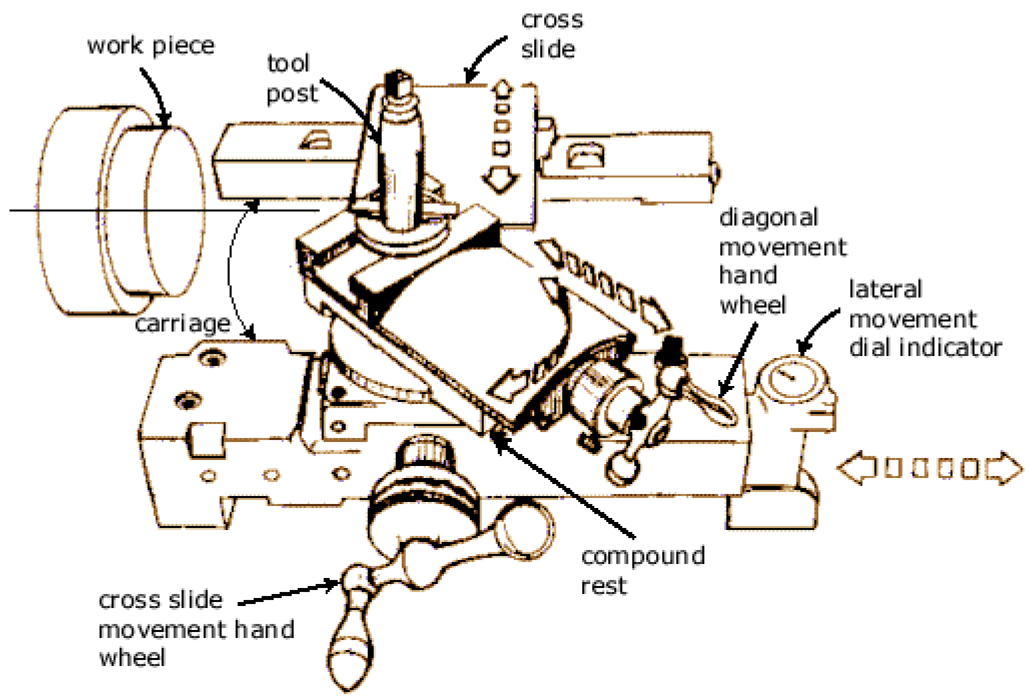
Turning: Engine Lathe Detail



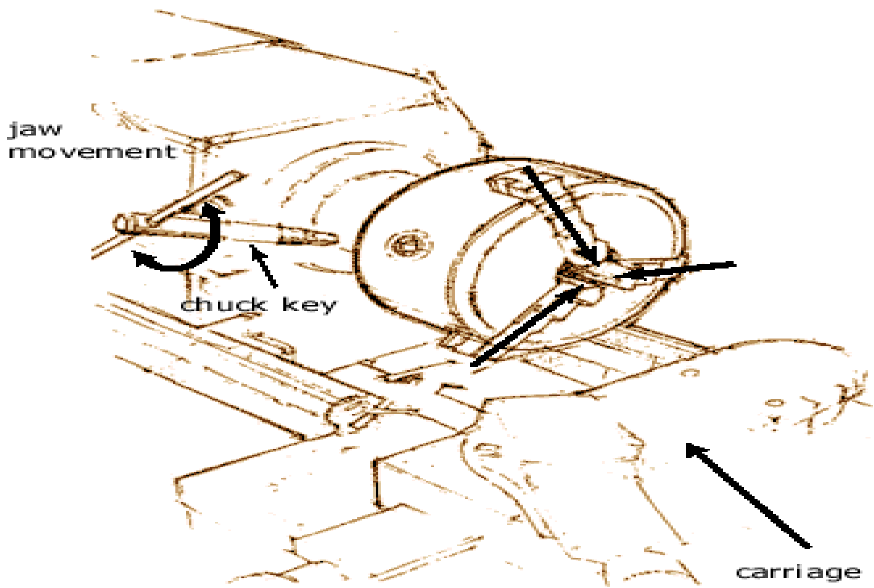
Engine Lathe Carriage

The figure below illustrates the carriage of an engine lathe. The carriage allows cross-feed and diagonal movements in addition to axial movement.



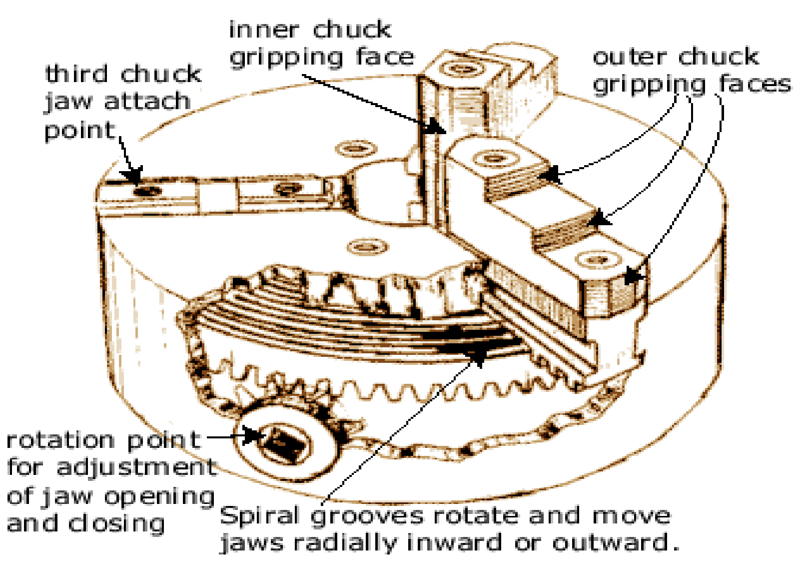
Turning: Chucks

The chuck is integral to a lathe's functioning because it fixtures the part to the spindle axis of the machine. Below is shown a three-jaw chuck with jaws that are all driven by the same chuck key. This arrangement provides convenience in that parts can be mounted and dismounted quickly.



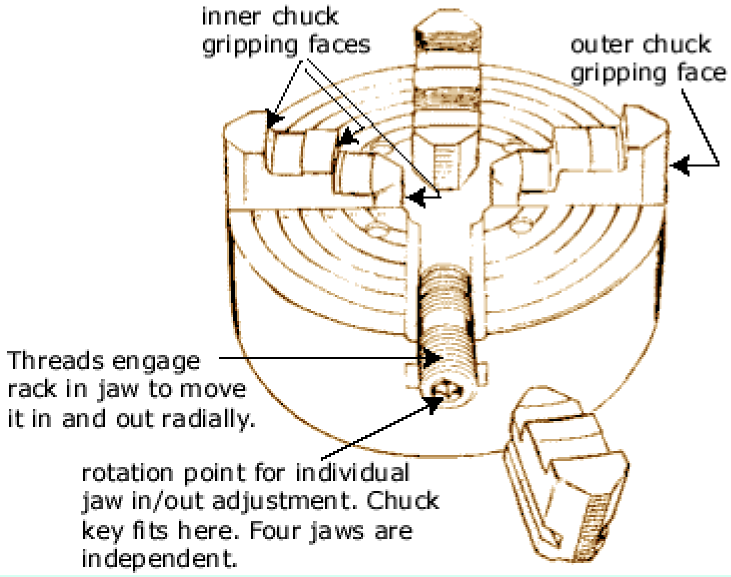
Three-Jaw Chuck

The inner construction of the three-jaw chuck is shown below. A spiral gear meshes with cog teeth on the jaws to move all three jaws in or out simultaneously. Parts can be fixtured on outer or inner surfaces since there are gripping surfaces on the inner and outer surfaces of the chuck jaws.



Four-Jaw Chuck

If the part needs to be off center or is not a solid of revolution (axially symmetric), a four-jaw chuck with independently-actuated jaws needs to be used. Such a chuck is depicted below.



Lathe Construction

The five main parts of the lathe are: the bed, the headstock, the carriage, the tailstock, and the gearbox. Below are illustrations of different lathes and lathe parts. Study these parts and be ready to answer questions concerning their names and locations.

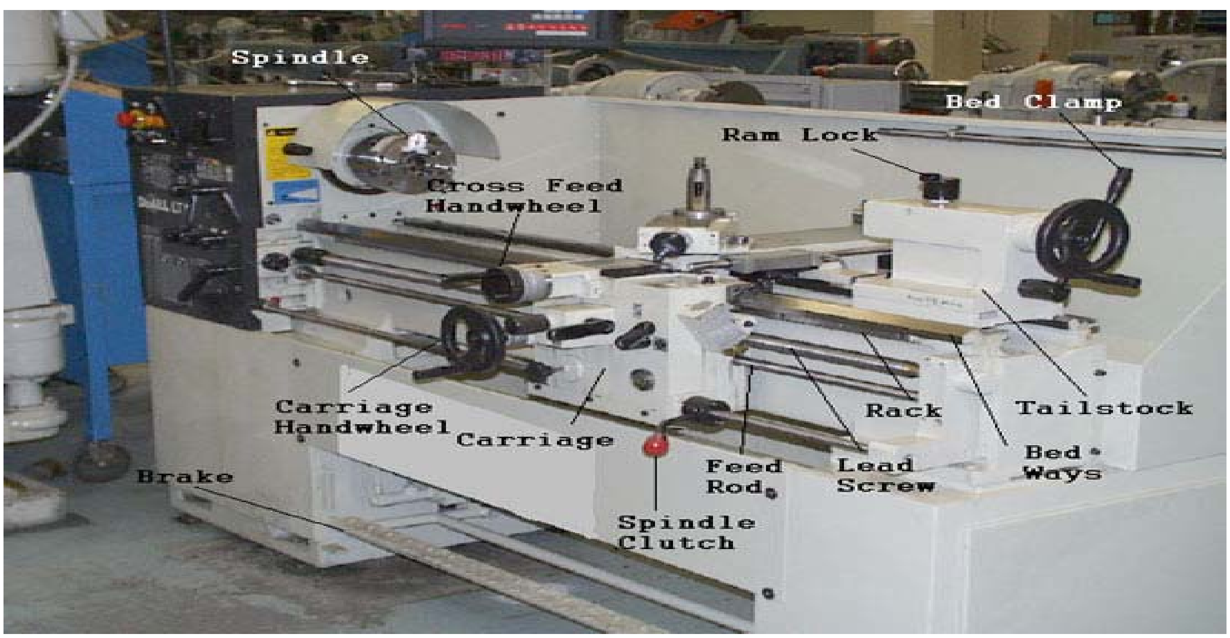


Figure 1 Engine lathe parts

Figure 1: Engine Lathe Part Descriptions

Spindle	The spindle holds and drives the workpiece.
Cross Feed Handwheel	The cross feed handwheel is used to manually position and/or hand feed the compound rest in the X axis.
Carriage Handwheel	The carriage handwheel is used to manually position and/or hand feed the carriage in the longitudinal or Z axis.
Carriage	The carriage houses the saddle, the cross slide, and the apron. The main function of the carriage is to position the tool along the lathe bed.
Spindle Clutch Lever	This lever controls the spindle’s rotation and direction.
Brake	This type of spindle brake uses the foot pedal. The foot pedal type of brake is found on many types of lathes. When the foot pedal is actuated, the spindle will stop regardless of the position of the spindle clutch lever.
Feed Rod	The feed rod transmits power from the headstock to the carriage for feeding operations.
Lead Screw	The lead screw transmits power from the headstock to the carriage for screw thread cutting operations. On some lesser types of lathes the feed rod and the lead screw are used for both the feed and the screw cutting power transmission.
Rack	The rack or gear rack, as it is sometimes referred to, links with the carriage handwheel to make longitudinal movement of the carriage possible.
Bed Ways	The bed ways align the components of the lathe. The bed is the back bone of the machine.
Tailstock	The tailstock is used to support the right end of the work. The tailstock is also used for tool-holding for machining operations, such as drilling, reaming, and tapping.

Figure 2 - Lathe Parts Descriptions

Headstock	The headstock houses the spindle and the components which drive the spindle and the feed gears.
Spindle Speed Selector	The spindle speed selector allows the operator to adjust the spindle speed of the machine.
Emergency Stop Button	The emergency stop button turns off the power to the machine.

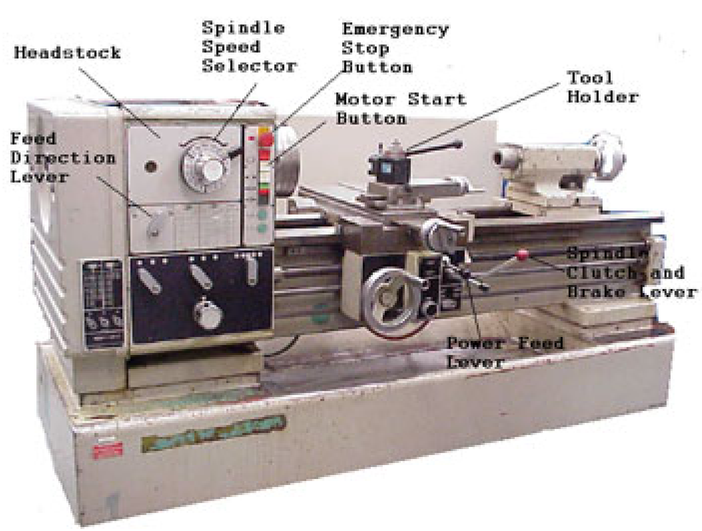


Figure 2 Lathe parts

Motor Start	The motor start button starts the electric drive motor for the machine. The motor

Button	start button does not control the spindle; however, it does supply the power.
Spindle Clutch and Brake Lever	This lever controls the spindle rotation. Through the use of this lever, the operator controls the spindle direction, spindle on, and spindle off. On some machines, when the spindle is turned off, a magnetic spindle brake is applied. The other type of spindle brake is the foot pedal. The foot pedal type of brake is found on many other types of machines.

Figure 3 - Lathe Carriage Parts Descriptions

Power Feed Lever	The power feed lever controls the automatic movement of the axes. The two axes of movement associated with the lathe are the Z and X axes. The Z axis is the longitudinal axis, while the X axis is the cross slide axis.
Tool Holder	The tool holder holds the cutting tool.
Feed Direction Lever	The feed direction lever or feed reverse lever controls the direction of automatic feed on the lathe.
Half Nut Lever	The half nut lever engages the carriage directly to the lead screw. The half nut lever is used only for threading. The half nut lever will only engage when the feed is set in the neutral position.

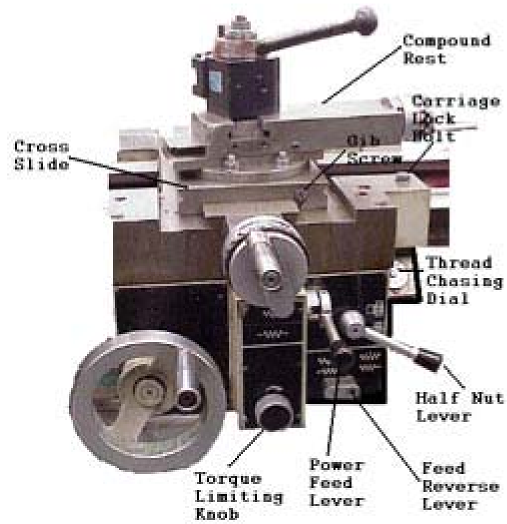


Figure 3 Lathe carriage parts

Thread Chasing Dial	The thread chasing dial is used for threading. The thread chasing dial works off the leadscrew and is used as a tracking device. The dial tells you when to engage the half nut lever so the tool follows the same thread groove every time.
Cross Slide	The cross slide allows for tool travel 90 degrees to the bed of the lathe. The cross slide makes up the X axis of the machine. The X axis of the machine controls the diameter of your work.
Compound Rest	The compound rest is mounted on the cross slide and can be swiveled to any angle. The compound is typically used for cutting chamfers or tapers, but must also be used when cutting threads. The compound rest can only be fed by hand. There is no power to the compound rest.
Carriage Lock Bolt	The carriage lock bolt tightens the carriage to the bed of the machine. The carriage lock is typically used during facing, grooving, or parting operations.
Gib Screw	The gib screw is used to take up clearance between the gib and the dovetail. Clearance between the gib and the dovetail will occur normally due to wear.

Engine Lathes

All turning machines can trace their existence back to the "Engine Lathe". The original engine lathes where powered by reciprocating steam engines. Through the use of pulleys, shafts and clutches, one steam engine may have powered several lathes as well as other machines within the factory. Today turning machines are powered by individual electric motors, but the original style of turning machines is still known today as an engine lathe (Figure 1).

Figure 1: **Engine Lathe**

The engine lathe is a simple style of turning machines. The design of the engine lathe is not meant for high production, but more for versatility. The engine lathe, when operated by an experienced operator, can produce parts to exacting tolerances.

CNC Turning Center

When many duplicate turned parts are required, the CNC turning center may be used (Figure 2).

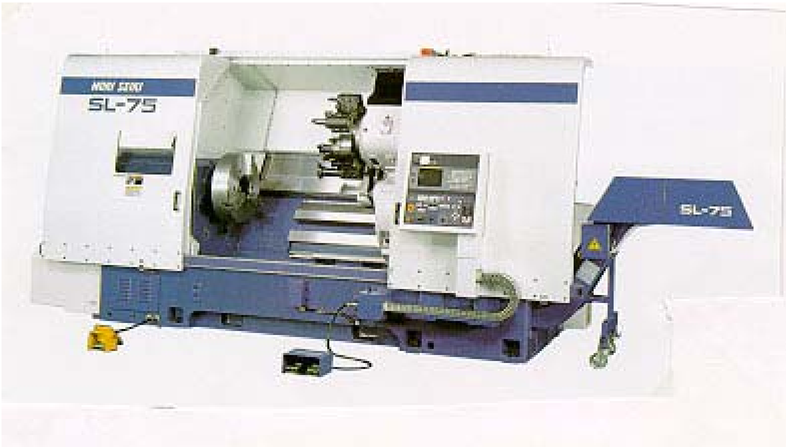


Figure 2: **Slant Bed Turning Center**

The CNC turning center employs a tool turret that allows the operator to change cutting tools automatically with great speed and accuracy (Figure 3).

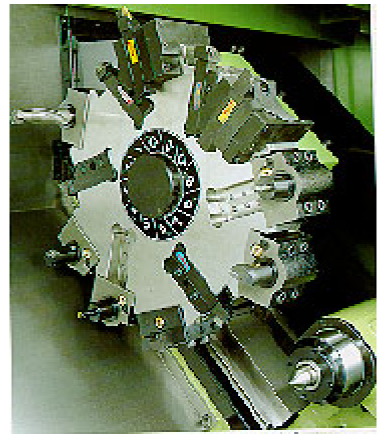


Figure 3: Turning Center Turret

Figure 4: Slant Bed

The bed of the turning center will typically lie at a slant to accommodate chip removal (Figure 4).

CNC Lathe

The CNC lathe is also a production turning machine (Figure 5). The CNC lathe differs from the turning center in that it does not employ an automatic tool changing mechanism.

Figure 5: CNC Lathe

The bed of CNC lathe will typically lie in a flat position much like the typical engine lathe. CNC lathes come in all sizes. Small CNC lathes are usually used in low production job shops or maintenance facilities. Large CNC lathes are employed where long roll turning applications exist (Figure 6).

Vertical Turning Machines

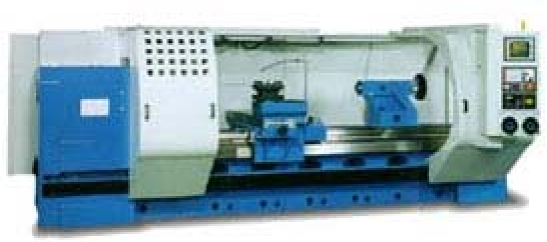


Figure 6: Large CNC Lathe

Vertical lathes are turning machines that are used in a vertical position (Figure 6). The vertical lathe has a circular chuck like an engine lathe, but the work-holding surface is horizontal. The horizontal work-holding surface allows large circular pieces to be

Positioned and held more easily than in conventional methods of lathe work holding. A Vertical lathe is commonly referred to as a Vertical-boring mill (Figure 7). Many vertical boring mills are equipped with a tool turret. In this case the machine would be referred to as a vertical turret lathe or VTL.

The VTL can be a manually operated machine or in production situations can be coupled with a CNC control and an automatic tool turret.

Figure 7: Vertical Boring Mill

Lathe Accessories - Tool Holding

A lathe without the accessories would be a fairly useless machine tool. It is the many accessories that go along with the lathe that expands the uses. This section on accessories is entitled Tool Holding.

Toolposts/Toolholders

Two basic types of toolholders are used on engine lathes: the standard tool post and the quick change tool post (Figure 1).

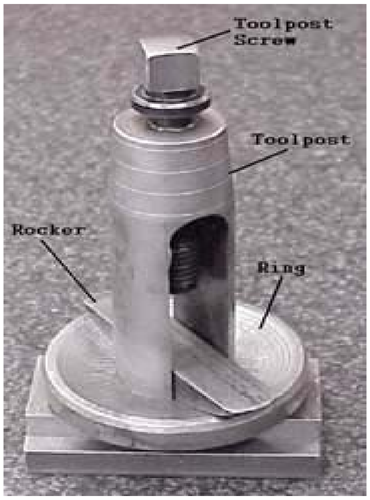


Figure 1 Standard tool post

The standard tool post is used in conjunction with high speed steel tooling. This type of tool post can only be used where cutting forces are kept low because they have a tendency to move around under heavy cutting pressure. The standard tool post uses a toolpost clamp screw to hold the tool holder down onto the rocker. The rocker is used to adjust the tool height to the center of the spindle. The standard tool holders which accompany this toolpost are shown in Figure 2.

Figure 2 Right hand, Straight, and left hand tool holders

Figure 2 Quick change tool post

The quick change tool post is used primarily with carbide cutting tools. The dovetail slide construction of the quick change tool post makes it much faster, more accurate, and more rigid than a standard tool post.

The quick change tool post uses a clamp actuated by the large handle you see in Figure 2 to wedge the dovetails on the tool posts and the tool holders together. There are a wide variety of tool holders which can be purchased for the quick change tool post (Figure 3). Knurling, boring, cutoff and turning tool holders are only a few of the different types of tool holders available.

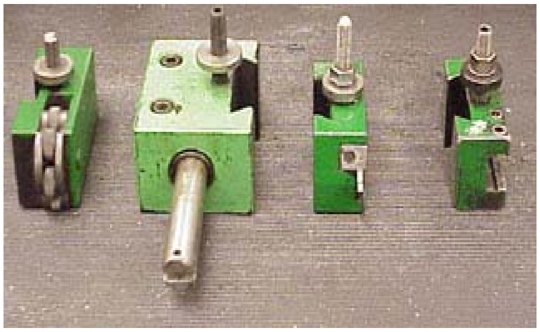


Figure 3 Quick change tool holders

There are a variety of cutoff and parting tool holders which are associated with both standard and quick change style toolposts (Figure 4).The tool holders are equipped with a knurled stud called an adjustment collar. This collar is used to adjust the tool height.

Figure 4 Parting tool holders

Boring is a very common operation associated with the lathe. In the following figures you will see assorted types of boring tool holders.

Figure 5 Light duty boring bar holder

This type of light duty boring bar holder is used with the standard style of toolpost. The clamp type boring bar holder shown in Figure 6 is used for heavier type boring operations. This clamp style of boring bar holder is also used in conjunction with the standard style of toolpost. Clamp style boring bar holders come in single size and adjustable configurations.

Figure 6 Clamp style boring bar holder (single size)

Figure 7 Clamp style boring bar holder (adjustable)

Quick change style boring tool holders create a rigid set up for carbide tooling, but are not as versatile in their size accommodations as some other types of boring tool holders (Figure 8).

Figure 8 Quick change boring bar holder

Tailstock Tool Holders

A self-holding taper has an angle of only 2 or 3 degrees. The tailstock of the lathe is equipped with a self-holding taper called a Morse taper. The taper shank of a tool with a Morse taper seats so firmly that there is a large amount of friction to keep the tool from spinning. There are many lathe accessories available with Morse tapers. The drill chuck, equipped with a Morse taper, is one of the most common tool holders associated with the lathe tailstock (Figure 10).

Figure 10 Drill chuck equipped with a Morse taper

The drill sleeve is another common tool holder associated with the tailstock of the lathe (Figure 11). The drill sleeve (or just sleeve) is used to increase the diameter of the tapered shank of the tool to match the size of the tailstock spindle of the lathe. Some of the more common tools using sleeves are tapered shank drills and tapered shank reamers.

Figure 11 Sleeve

Tools with taper shanks bigger than the tailstock spindle of the lathe can be accommodated using a socket (Figure 12). Drill sockets allow you to use large drills and reams in smaller machines.

Figure 12 Drill socket

The drill driver provides another method of holding a large taper shank tool in a tailstock spindle (Figure 13). The drill driver not only holds the tool , but also keeps the drill from spinning through the use of the drive handle. The drive handle is placed against the toolpost to absorb the cutting forces.

Figure 13 Drill driver

There will be times when you will need to ream a hole on the lathe. Because the tailstock on the lathe is not in a fixed position and the tailstock base is susceptible to wear, the center of the tailstock spindle is not perfectly aligned with the headstock spindle. If you try to ream a hole on a lathe and the tailstock and the headstock are not in perfect alignment, the hole will be cut oversize. By using a floating reamer holder, the ream will float to the center of the drilled hole (Figure 14)and the hole size produced will be much more accurate.

Figure 14

Taper shank floating

reamer holder

Lathe Cutting Tools - Cutting Tool Shapes

There are many high speed steel cutting tools used for turning operations. Most of the cutting tool used in industry employ some type of carbide as a base material. It is when we need odd or different shape cutting tools that you will see high speed steel single-point cutting tool being ground in industry. Regardless of the shape of the single-point cutting tool, it must have the correct relief and rake angles to cut correctly. This lesson deals mainly with the different shapes of high speed steel single-point cutting tools. The relief and rake angles are covered in another unit. Some typical shapes of single-point cutting tools are shown in the up-coming figures. Study their shapes and uses.

The tool in Figure A is used to turn to a semi-square shoulder. This tool, because of the square side cutting edge angle, directs the cutting force straight back, opposite the cutting direction. It can be used for roughing if there is sufficient material behind the cutting edge.

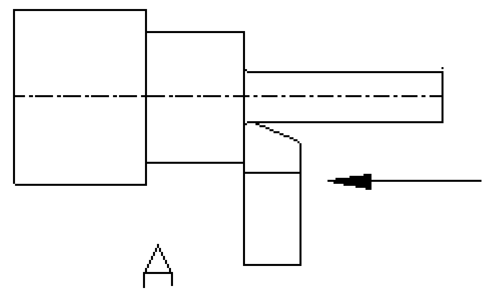


Figure A

The tool in Figure B is a standard turning tool with a lead angle. The lead angle allows for heavy roughing cuts. You can also turn the tool to accomplish a semi-square shoulder.

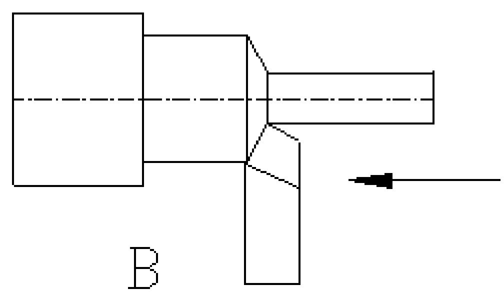


Figure B

The turning tool in Figure C has a very large nose radius. The large nose radius will allow for fine finishes on either light or heavy cuts. This tool can also be used with varying radii to form a corner radius.

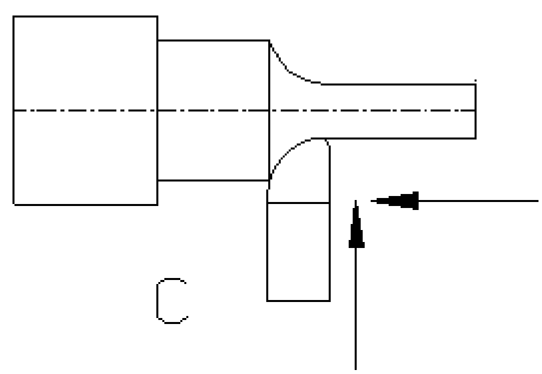
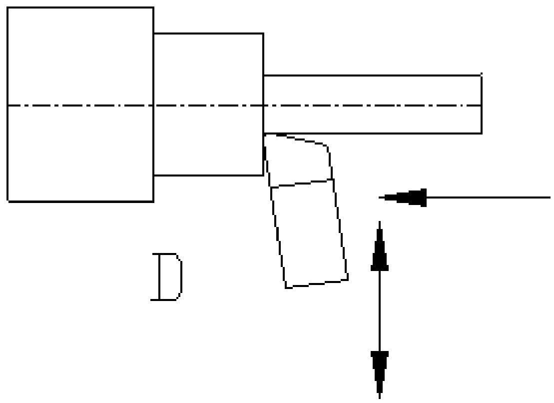


Figure C



The tool at Figure D has the nose leading the side cutting edge. In this position, the tool is set to take light finishing cuts on the diameter and the face of the shoulder.

Figure D

The tool in Figure E is a form tool. The form that is ground into the tool is reproduced on the part.

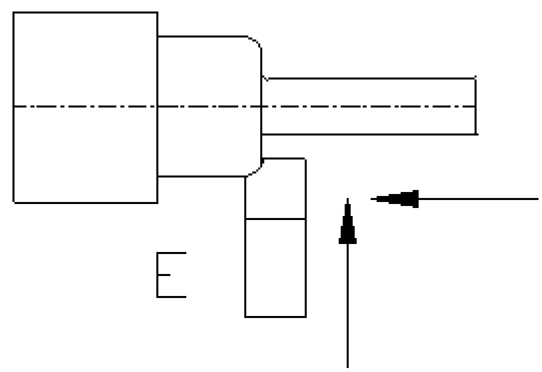


Figure E

The tool at Figure F is a facing tool. The tool can be used to face the end of the workpiece held by a half-center. A half center is a solid tailstock center that has half of the tip ground away for tool clearance.

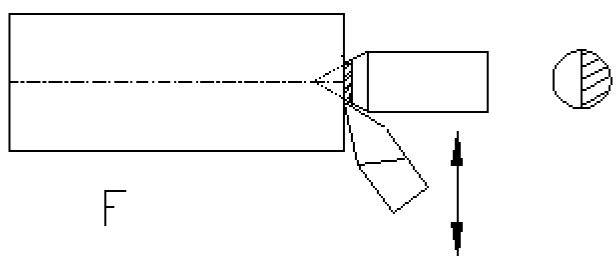
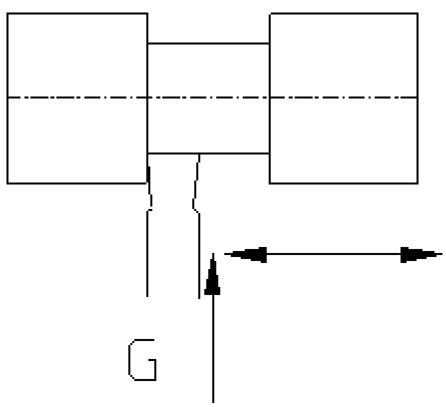


Figure F



The tool in Figure G is called an under-cutting or grooving tool. It is used to cut grooves as shown in the figure. With the proper clearances, the tool can plunge, or cut to left or to the right.

Figure G

The tool in Figure H is a cut-off or parting tool. This tool is used to cut off stock to finished length while the part is being held in a chuck. This parting tool employs a preformed blade and holder.

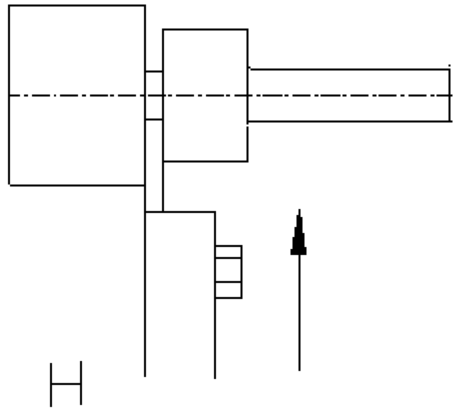


Figure H

The tool in Figure I is a 60-degree threading tool. The threading tool is another type of form tool.

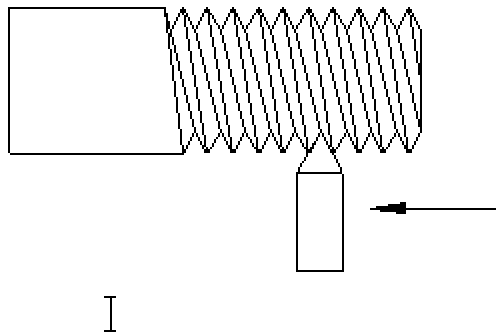


Figure I

Cutting Tools - Thread Cutting Tools

The secret to cutting good threads is to have a good threading tool. Threading tools must have the proper shape to cut an accurately shaped thread, but the clearance and relief angles must be correct to produce a clean thread. The shape of the thread corresponds directly with the form of the thread to be cut (**Figure 1**).

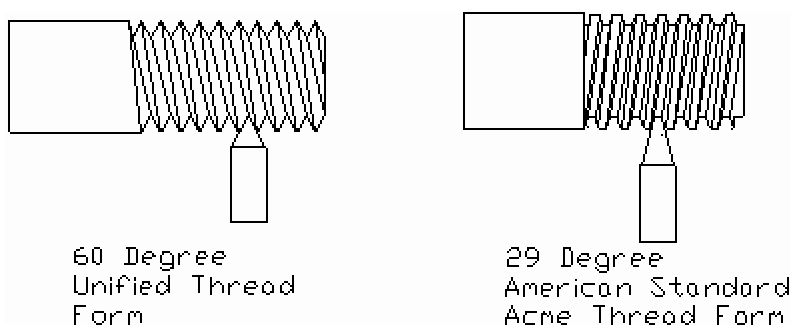


Figure 1

Grinding a thread cutting tool on a pedestal grinder is not that difficult, but you need to inspect the tool carefully. Accuracy in the tool is of great importance to the outcome of the thread. The design of the high-speed, steel cutting tool for cutting 60-degree unified threads is shown in **Figure 2**.

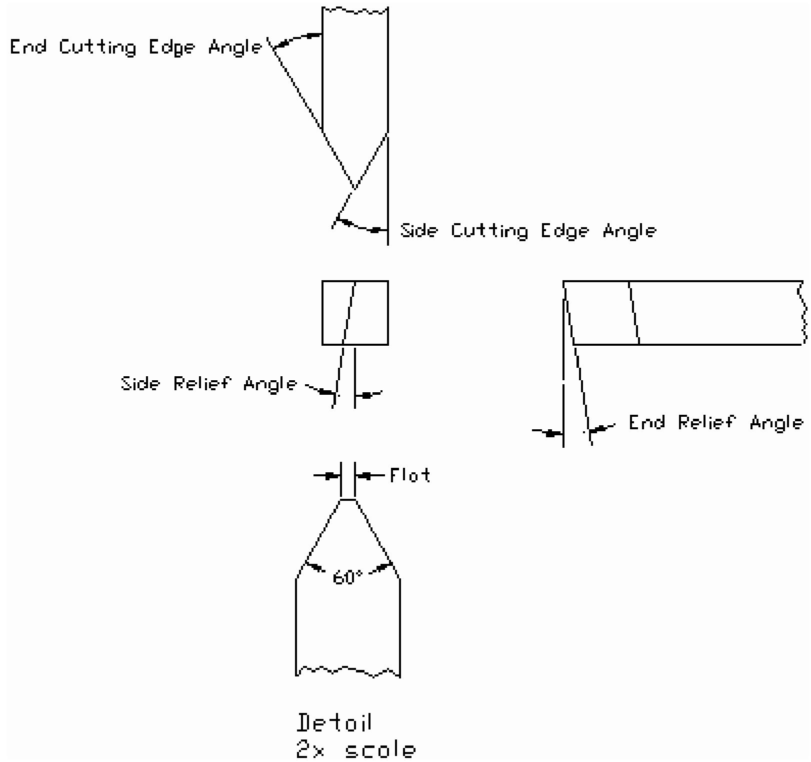


Figure 2

This tool has a 60-degree included angle and a flat on the tip which corresponds to the pitch of the thread to be cut. The larger the thread pitch, the larger the flat. The pitch is defined as the distance from a point on one thread to the same point on the next thread (**Figure 3**).

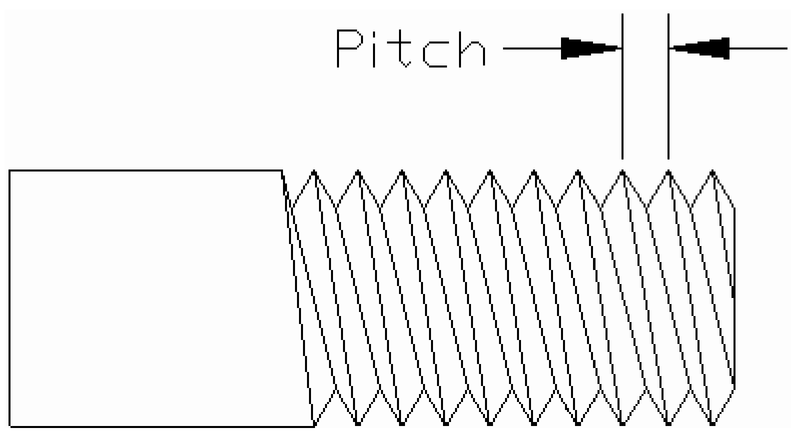


Figure 3

The thread pitch can be calculated by dividing the number of threads per inch into 1, or 1 over the number of threads per inch. An easy-to-understand example of this is a part with 8 threads per inch. Place the number 1 over 8 and you get 1/8. The decimal equivalent of 1/8 is .125. Therefore, the pitch of this thread is .125. The flat on the tip of the threading tool is derived from the pitch of the thread. The flat width is equal to the pitch of the thread divided by the constant of 8. For the part with 8 threads per inch and a pitch of .125, the flat width would be .125 divided by 8, or .015. The flat on the tool to cut 8 threads per inch should be 0.015. The side relief angle should have 10 to 12 degrees of clearance, much like a standard turning tool. Remember, the location of the side cutting edge angle is on the opposite side when cutting left hand threads. The front end relief will be 10-17 degrees depending on the tool holder and the hardness of the material being cut. The harder the material, the more support you want under the tool tip. If the tool tip keeps breaking off, you may have too much front clearance. There really isn't any top rake ground into a threading tool. The top rake is usually produced by the high speed steel tool holder. If you are using a neutral holder, you may want to grind a slight amount of top rake into your tool. See your instructor concerning neutral tool holders and threading. Now, let's go over the procedure for grinding a 60-degree, right-hand, threading tool.

The first step in preparing to grind a tool is to dress the wheel. Wheel dressing is done to keep the wheel face straight, sharp, and true. A dull grinding wheel can cause heat to get built up in the tool, especially a sharp-pointed threading tool. Heat buildup in the tool is not good because it may make the cutting tool softer, and when we go to cut with it, the tool dulls prematurely. Start the wheel on the pedestal grinder. Always stand to the side when starting a grinder. Let the machine come up to speed and run for at least 30 seconds. Place the wheel dresser on the tool rest. Grip the handle with both hands. Slightly raise the handle. Bring the dresser up to the wheel. Move the dresser back and forth to get rid of the groove in the middle of the wheel face. Look down between the tool rest and the wheel to make sure that the wheel face is flat. Check the distance between the tool rest and the wheel. There should be no more than 1/8" clearance between them.

Before you begin grinding the tool, make sure that there is an ample supply of water or coolant available near the grinder. You are going to need to dip the tool into the water or coolant occasionally. Again, this is to avoid heat building up in the tool.

Line the side cutting edge layout line parallel with the face of the *rough* grinding wheel. Bring the tool into light contact with the wheel. Now take and roll the bottom of the tool into the grinding wheel to achieve the 10-degree side relief angle. Run the tool back and forth across the face of the wheel to avoid grooving the middle of the wheel. If you are doing this correctly, the bottom of the tool will be ground more than the top. As the side cutting edge angle becomes larger, you should see the side relief angle forming. We want to keep this relief at about 10 degrees. But, when you do this for the first time, you are better off having too much angle rather than not enough. Remember to cool the tool off before the layout dye burns off. The layout dye will be a good indicator of heat buildup in the tool.

As you approach completion of the side cutting edge angle, look for the sparks hitting the top of the tool. When the sparks are hitting the top of the tool, it is a good indicator that you are getting a smooth, one-facet, grind.

When we have completed the side cutting edge angle, the next portion of the tool we will need to grind is the end cutting edge angle.

The end cutting edge angle helps form the thread and prevents the end of the tool from rubbing on the work. Line the end cutting edge layout line parallel with the face of the grinding wheel. Bring the tool into light contact with the wheel. Don’t roll the bottom of the tool into the grinding wheel. Hold it flat or parallel with the side relief angle, which was ground previously. If you are doing this properly, the top of the tool will come in contact with the wheel first. Remember to cool the tool off before the layout dye burns off. As you approach completion of the end cutting edge angle, look for the sparks hitting the top of the tool. When the sparks are hitting the top of the tool and the end cutting edge angle meets the side cutting edge angle, you are finished with the rough grind.

Inspect the tool for the condition of the ground surfaces and use the center to gage the accuracy of the angles. Move to the finish grinding wheel. Lightly grind the side cutting edge angle making any minor modifications to the 60-degree angle. The need for these modifications may have become apparent when checking the tool with the center gage. Remember to roll the bottom of the tool into the grinding wheel to achieve the 10-degree side relief angle. As you approach completion of the side cutting edge angle look for the sparks hitting the top of the tool. This is a good indicator that you are getting a smooth, one facet, grind.

When we have completed the side cutting edge angle, the next portion of the tool we will need to finish grind is the end cutting edge angle.

Bring the tool into light contact with the wheel. Don’t roll the bottom of the tool into the grinding wheel. Just hold it flat or parallel with the side relief angle which was ground on previously. When you have completed the end cutting edge angle, inspect the tool for the condition of the ground surfaces, and using the center, gage the accuracy of the angles. Depending on the width of the flat, you may want to hold the tool lightly on the finishing wheel, or you can hone the flat on the cutting tool. Finally, lightly hone the cutting edges of the tool to remove any burrs that may have formed on the tool during grinding.

"Milling Machine"

Milling Machine Types

Milling machines are a very versatile machine tool. Milling machines are capable of machining one or two pieces as well as large volume production runs. The milling machine can produce a variety of surfaces by using a circular cutter with multiple teeth that progressively produce chips as the cutter rotates (Figure 1).

Figure 1. Carbide face mill used on a vertical milling machine.

The advantage of having a circular milling cutter with multiple teeth has led to the design of a large variety of milling machine types. These different milling machine types can be classified as Knee and Column, Fixed Bed, Bridge Type, and Special. All of these classifications can have either a vertical or horizontal spindle configuration. Further classifications of milling machines are made on the basis of the type of computer numerical control the machine uses.

Knee and Column Type Milling Machines

The knee and column type milling machine is a very versatile machine (Figure 2). This type of milling machine is found primarily in job shops and tool and die shops.

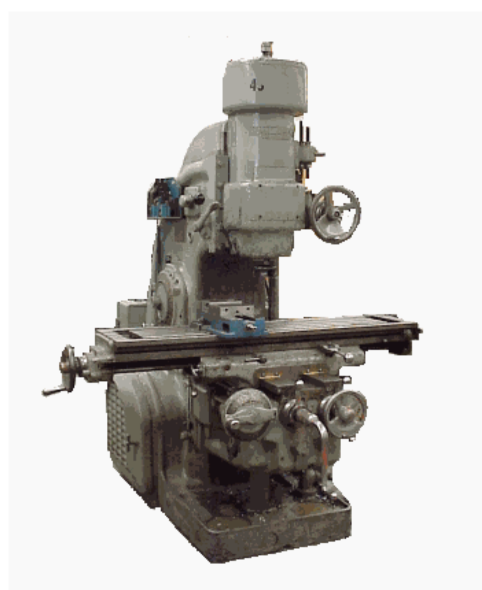


Figure 2. Vertical Knee and Column type milling machine.

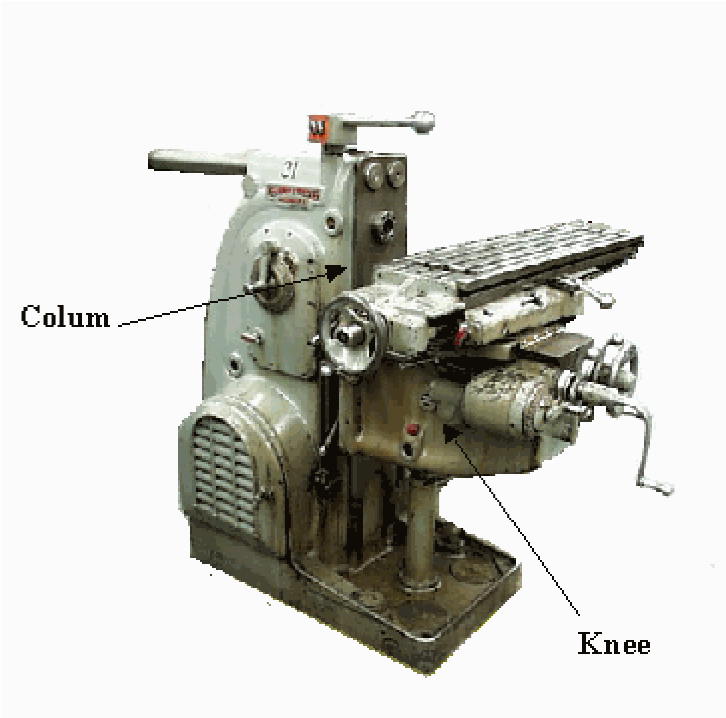


Figure 3. Horizontal Knee and Column type milling machine.

The most distinguishing characteristic of this type of machine is the knee and column configuration (Figure 3).

This type of milling machine is unique in that the table can be moved in all three directions.

The table can be moved longitudinally in the X-axis as well as in and out on the Y-axis. Since the table rides on top of the knee, the table can be moved up and down on the Z-axis. There are several different types of knee and column type milling machines, but they all have the same characteristic. The knee slides up and down on the column face.

Universal Knee and Column Milling Machine

The universal knee and column milling is very similar to the plain knee and column milling machine. The largest difference being the swiveling table housing. The swiveling table housing allows the table to be swiveled at an angle to the axis of the spindle (Figure 4).

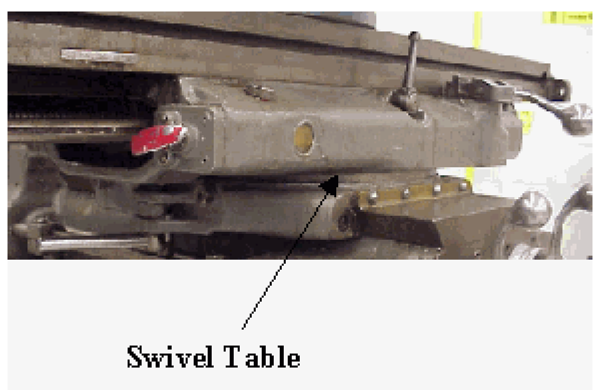


Figure 4. Universal Horizontal Knee and Column Milling Machine with the swivel table.

Vertical Knee and Column Type Milling Machine

A vertical type knee and column milling machine has the spindle located vertically, parallel to the face of the column, and perpendicular to the top of the table.

The ram style knee and column type milling machine is a light duty milling machine (Figure 5). This type of machine is well suited for a variety of tool room work as well as other light duty operations. The head is mounted on a ram that can be swiveled or brought forward. This allows the head to be brought into an operating position over most of the table.

Figure 5. Ram Style Knee and Column Type Vertical Milling Machine.

Fixed Bed Type Milling Machines

The most distinguishing aspect of the fixed bed type milling machine is the absence of the knee (Figure 6).

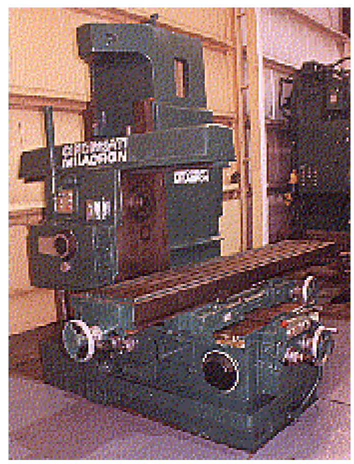


Figure 6. Fixed Bed Horizontal Milling Machine.

Figure 7. CNC Vertical Spindle Bed-Type Milling Machine.

The fixed bed construction of this style of milling machine minimizes deflection and allows very heavy cuts to be taken. Fixed bed style milling machines can be used for general purpose work although many people look upon them as high production machines. The table can move in a longitudinal and a transverse direction. The vertical position of the spindle, with respect to the work table, is obtained by moving the head up and down along the column of the machine (Figure 7).

Bridge Type Milling Machines

The construction of the Bridge Type milling machine resembles that of a bridge (Figure 8).

The table is mounted on the bed. On either side of the bed are two vertical columns connected at the top by a brace. A cross rail is mounted on the brace. The cross rail houses the spindle head. Bridge type milling machines are typically used to machine large pieces such as castings, machine tables and housings.

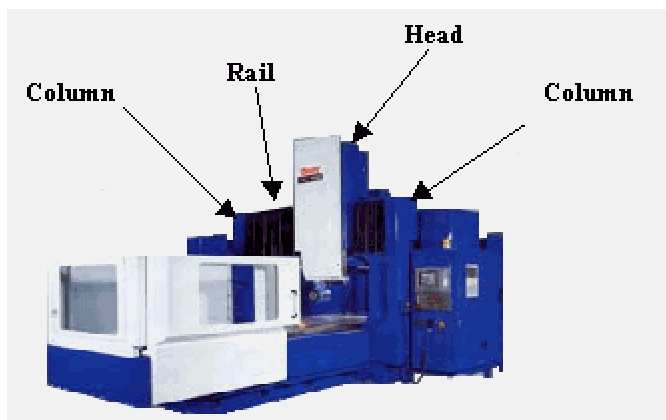


Figure 8. CNC Vertical Bridge-Type Milling Machine.

Special Milling Machines

There are a number of types of special milling machines. Special milling machines are designed specifically for one particular part or family of similar parts. Specialty milling machines are used extensively in the automotive and aeronautics industry. The specialty milling machine in Figure 9 is used to mill screws used in large extruding machines.

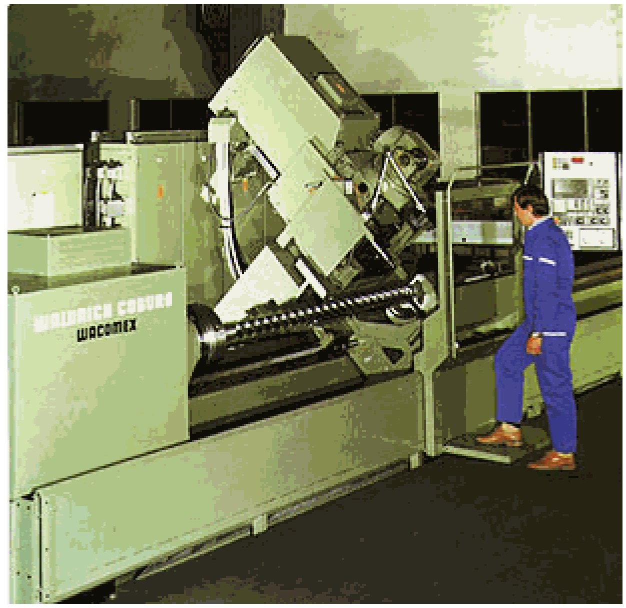


Figure 9. Extrusion Screw milling Machine.

"Types of Milling Machines"
Work Holding

Before we can begin to start making chips on the milling machine, the workpiece must somehow be securely fastened to the machine table. On most jobs that require milling, setting up the workpiece is the most difficult part of the job. Setups require critical thinking because not only does that part have to be fastened to the table, but the part must be positioned so that the proper surfaces can be machined using the correct features of the workpiece for positioning. If the setup is not properly planned and the accuracy is not insured in the setup, the part will probably end up as scrap. To insure a good setup, the operator must become aware of the types and proper uses of the work holding devices associated with milling machines.

Milling Machine Vises

The milling machine vise is the most common type of work holding devise used on the milling machine (Figure 1).

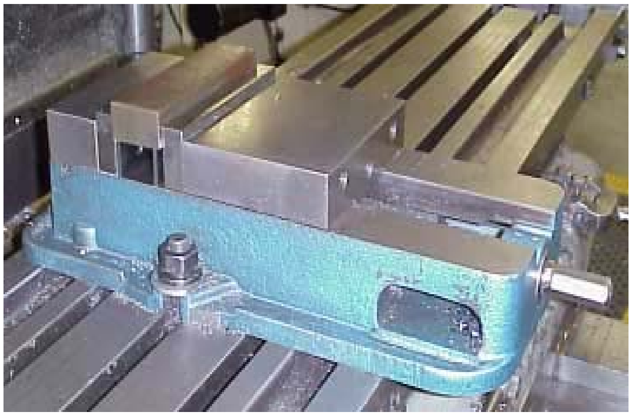
 The plain milling machine vise is used for holding work which has parallel sides. The vise is bolted directly to the table using the T-slots in the machine table. The plain vise can be accompanied by a swivel base (Figure 2).

Figure 1: Plain Milling Machine Vise

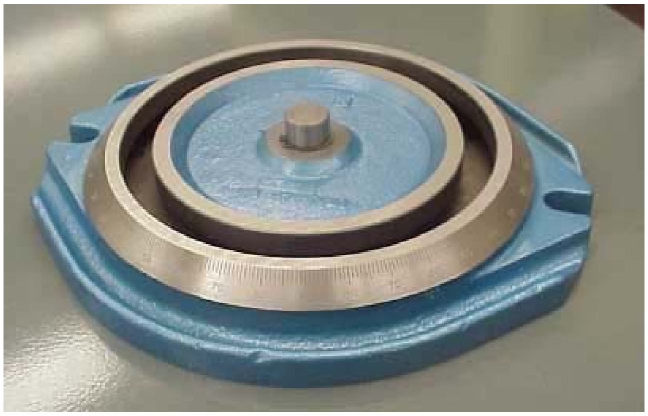


Figure 2: Swivel Base

Figure 3: Swivel Base and Vise

The swivel base is graduated in degrees and allows the vise to swivel in the horizontal plane. The swivel base gives the vise a greater degree of versatility, but should be avoided when doing heavy rough cutting operations because it reduces the rigidity of the setup.

For machining operations involving compound angles, a universal vise is commonly used (Figure 4).

The universal vise allows the operator to tilt the workpiece 90 degrees in the vertical plane as well as swivel it 360 degrees in the horizontal plane.

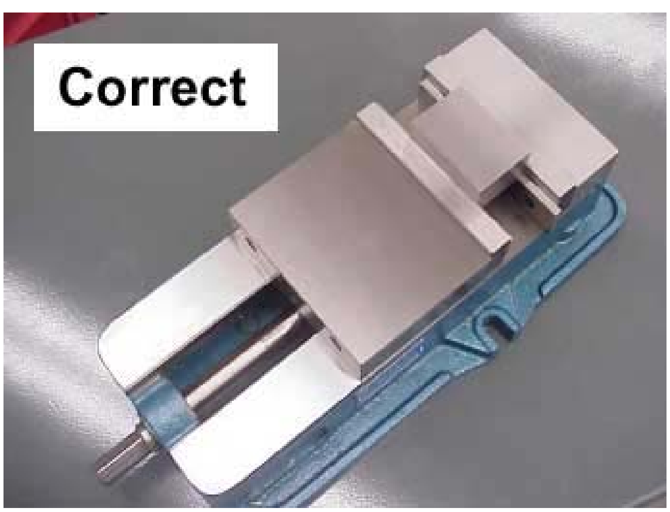
Figure 4: Universal Angle Milling Vise

In high production situations an air or hydraulically actuated vise may be used. These types of vises are quick acting. They also maintain consistent clamping pressures from one part to the next. However, on most manual type milling machines the vise is opened or closed using a handle. When tightening a plain type milling machine vise it is **not** necessary to strike the handle of the vise (Figure 5).

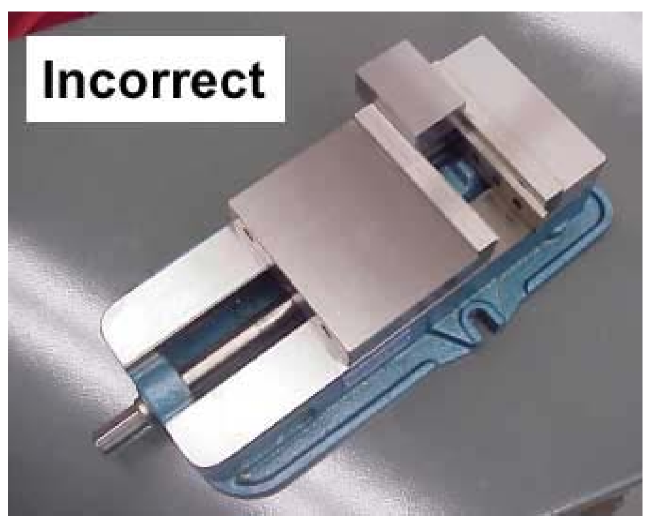
Figure 5

Striking the vise handle with a hammer can either cause the vise to become over-tightened or cause the vise handle to break. If it becomes apparent that the vise is not holding properly, check with your instructor for other possible causes to the problem.

In Figure 6 please study the correct and incorrect vise clamping practices.

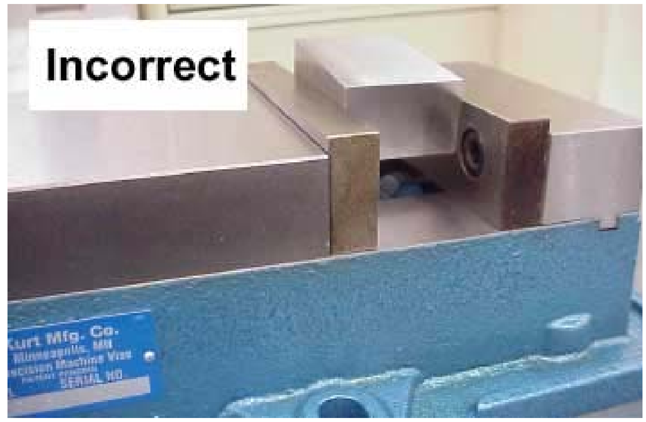


Locate the part in the center of the vise. This equalizes the pressure on the vise jaws.

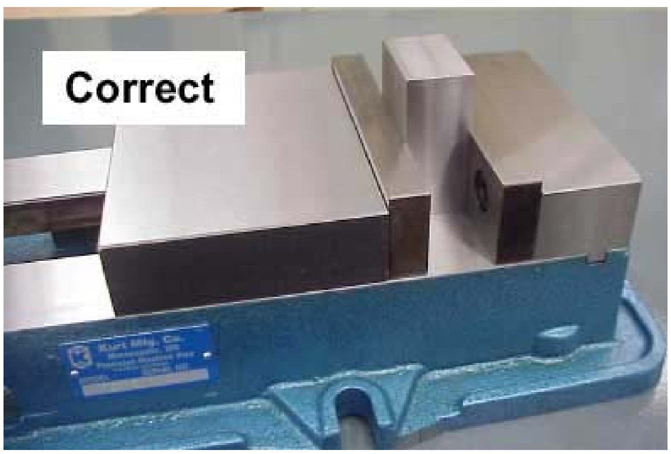


Holding the workpiece off center puts unequal pressure on the vise jaws. This can cause the piece to loosen up.

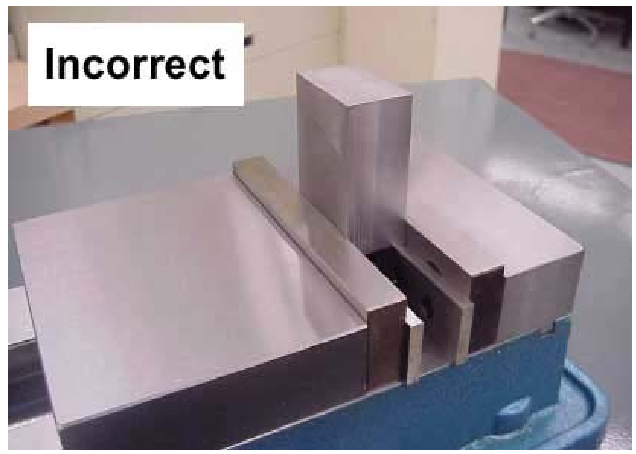
The workpiece should always be supported by the bottom of the vise or by parallels.



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.

Figure 6: Vise Clamping Principles For Milling

V-Blocks

V-Blocks hold and support round work for milling or drilling (Figure 7). V-Blocks come in many different sizes. On milling machines, V-Blocks are typically clamped directly to the table (Figure 8).

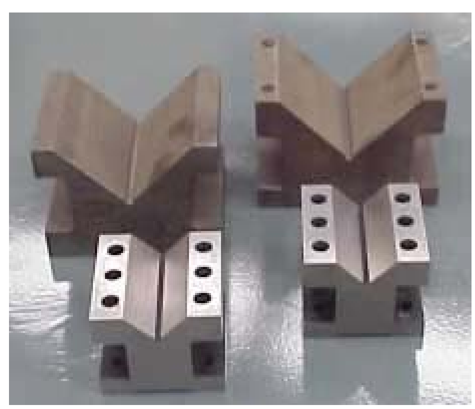


Figure 7: V-Blocks

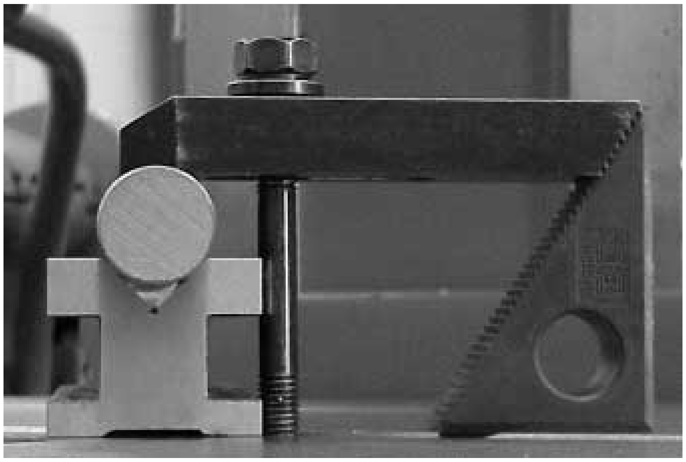


Figure 8: **A V-Block and a strap clamp being used to clamp a round part to the table.**

Angle Plates

An angle plate is an L shaped piece of Cast Iron or Steel that has tapped holes or slots to facilitate the clamping of the workpiece(Figure 9).Angle plates are used when parts need to have machining operations performed at a 90 degree angle to the axis of the table(Figure 10).

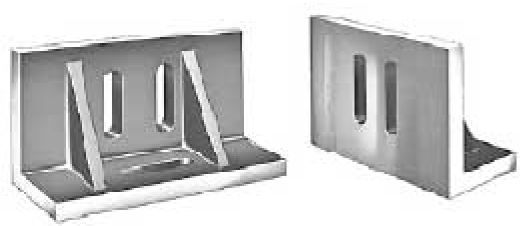


Figure 9: **Angle Plates**

Figure 10: **Angle plate being used to machine the end of a long part.**

Direct Mounting to the Table

Work that is too large or has an odd configuration is usually bolted directly to the table (Figure 11). This method of work holding takes the most ingenuity and expertise.

There are a number of accessories that can be used to help you set up the workpiece.

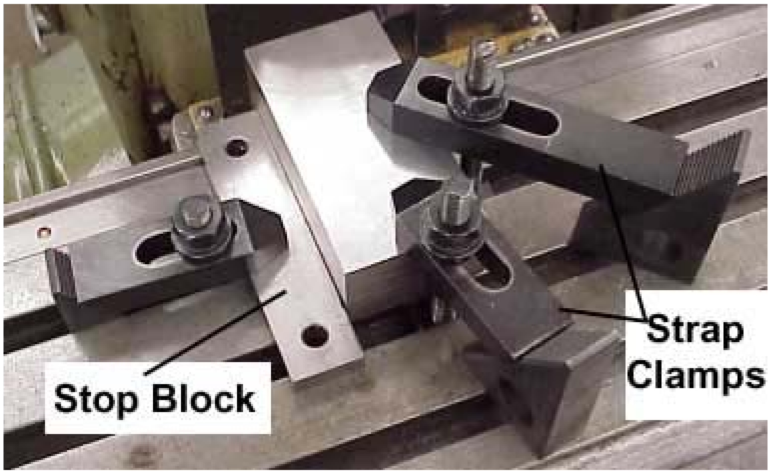


Figure 11: Direct Clamping using strap clamps-Notice the stop block. It is used to align the work as well as prevent the part from slipping.

Parallels

Parallels are pieces of steel bar stock accurately machines so that the opposing sides are parallel to each other (Figure 13). Parallels are provided in sets of two with identical dimensions.

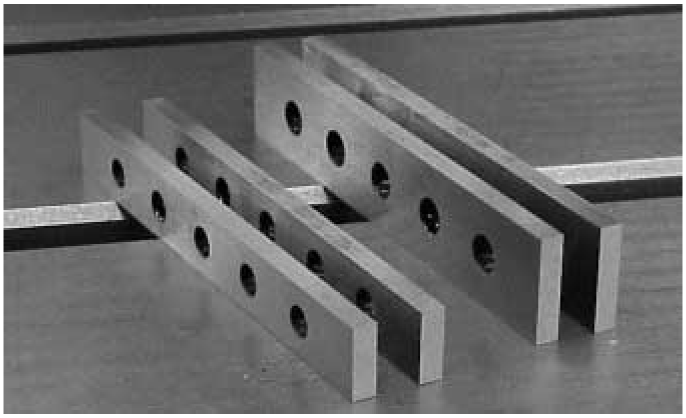


Figure 13: Parallels come in sets of two.

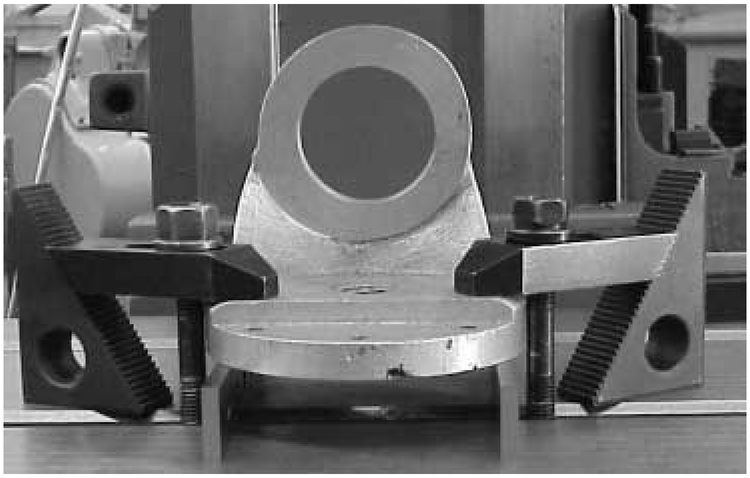
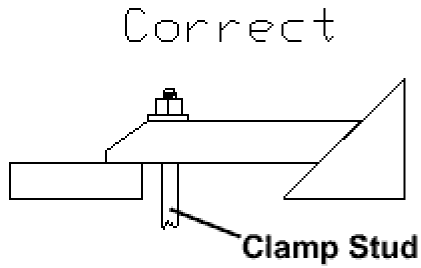


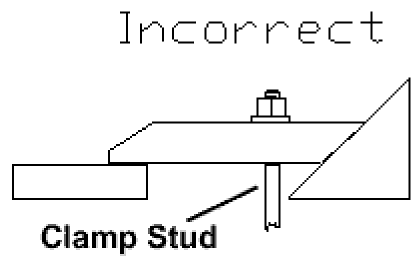
Figure 14: Parallels being used to raise the workpiece above the table surface.

Parallels are used in order to provide clearance under the work so the cutting tool does not damage the machine table or the vise base (see Figure 14).

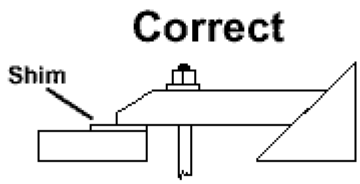
In Figure 15 please study the correct and incorrect direct clamping practices.



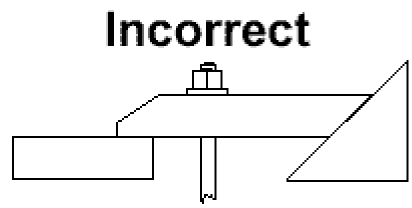
Place clamp stud close to the workpiece.



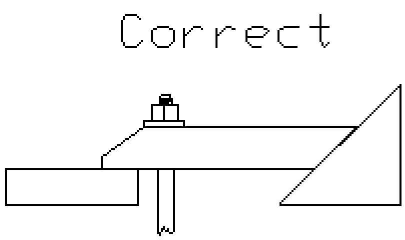
Do not place clamp stud closer to the support



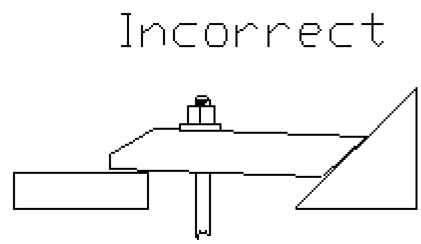
Use shims between finished surfaces and clamps



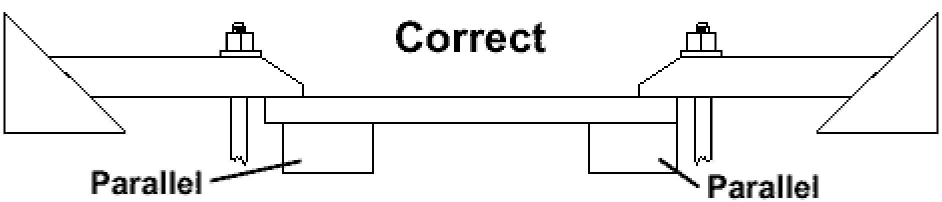
Clamps in contact with finished surfaces will mar the workpiece.



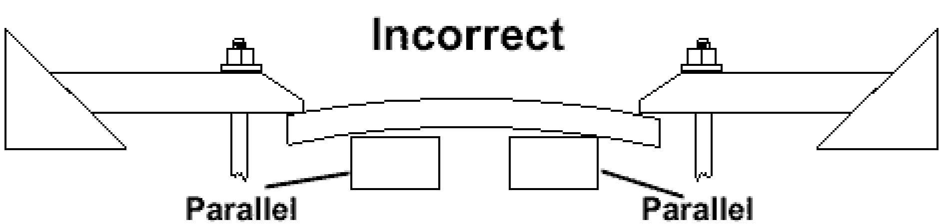
Clamps that are level or with a slight decline toward the workpiece will equalize the clamping pressure.



Angling clamps incorrectly puts pressure on the support, not the workpiece.



Place support parallels directly under clamps.



The spring caused by improper parallel placement will cause the part to bow.

Figure 15: Correct and Incorrect Clamping Practices

"Milling Machines"
Tool Holding

A Milling Machine without the tooling would be a fairly useless machine tool. It is the vast amount of tool holders and accessories that go along with the milling machine that expands the uses for this machine. This section is entitled Tool Holding . In tool holding we try to include the most common types of tool holding methods.

Collets

There are two basic types of collets used on milling machines. The solid collet and the split collet (Figure 1 & 2).

Figure 1

Figure 2

Solid Collets- The solid collet is the most rigid type of tool holding collet. The solid type of collet is commonly referred to as an endmill holder. The solid type of collet has a precision ground shank which fits precisely into the spindle of the machine. The collet is held in the machine using a draw-in bolt which runs through the center of the spindle (Figure 3).

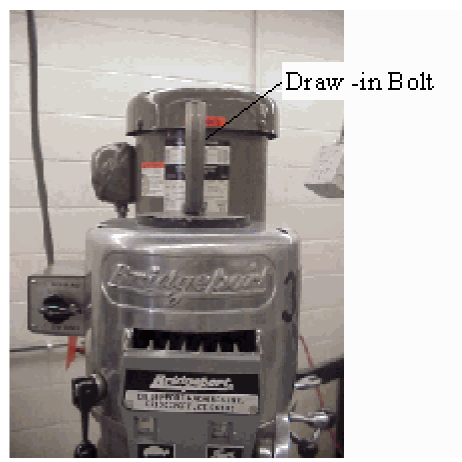


Figure 3

The **solid collet** also has a precision ground hole in it to accept the shank of the cutter. The cutter, in a solid collet, is secured using a set screw(s) (Figure 1). The set screw is tightened down on top of the flat which is ground or cast into the shank of the tool. Solid collets are used were the cutting forces might cause the tool to slip in a less rigid type of tool holder. Typical applications for solid collets would be indexable carbide endmilling and form cutting using a form relief cutter such as a t-slot or dovetail cutter. Solid collets come in many different sizes. Each size is precision ground to accept different size cutters and tool holder shanks.

Split Collets-Split collets are very popular on vertical milling machines. On the type of split collet shown in Figure 2, the tapered neck of the split collet is pulled into the spindle taper of the machine using the draw bar or draw bolt on the machine spindle. The pulling in of the collet causes the split collet to squeeze down onto the tool shank. Split collets are a very effective tool holding method, although under heavy cutting pressures split collets may have a tendency to slip. Another type of split collet system where the tool slippage may be minimized is the collet chuck system (Figure 4).

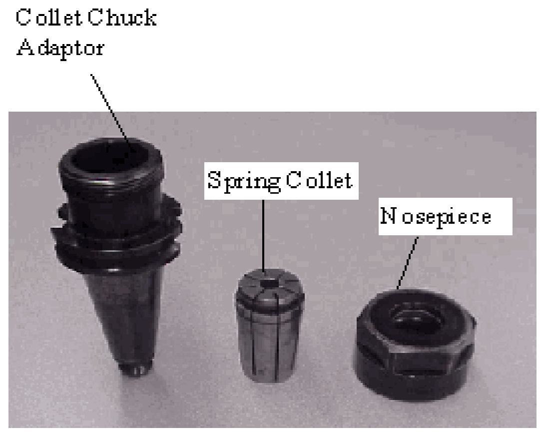


Figure 4

The collet chuck system uses a split type collet commonly referred to as a spring collet. The collet chuck adapter is machined to accept the spring collet. As the nosepiece for the collet chuck is tightened the collet clamps down onto the tool shank. Some collet chuck systems utilize a non-pull out button which aligns with the flat on the tool shank to prevent slippage (Figure 5).

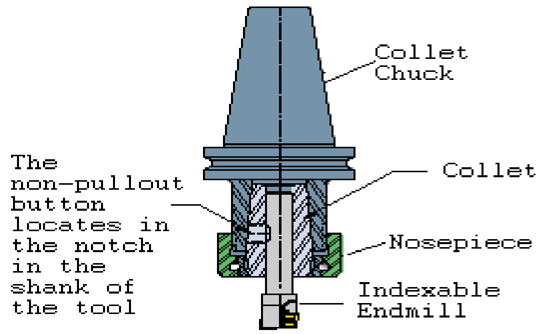


Figure 5

It is important to note that when using the collet chuck system, snap the collet into the nosepiece first before placing the tool and the collet into the body of the collet chuck (figure 6). Failure to assemble the collet chuck in the proper order can cause serious damage to the collet and the chuck.

Figure 6

To use the shell end mill, it has to be attached to an adapter before it can be mounted in the machine spindle. The adapter (Figure 8)holds the milling cutter in place through the use of a clamp screw. Drive keys mounted in the adapter align with keyways formed in the shell end mill and are used to drive the cutter. The shell end mill and the adapter are aligned through the use of a large counter bore on the back of the cutter and a precision ground pilot on the nose of the adapter.

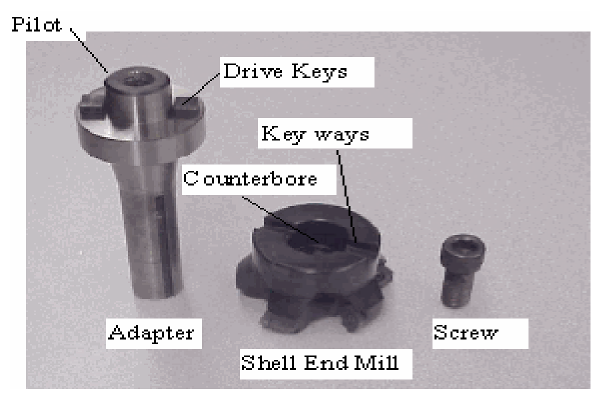


Figure 8

"Vertical Milling Machine"

Machine Construction

The main parts of the vertical mill are the; base, column, knee, saddle, table, ram, and tool head. Below you will find illustrations of different types of vertical milling machines and their parts. Study these parts and be ready to answer questions concerning their names locations and uses.

Ram Type Vertical Milling Machine

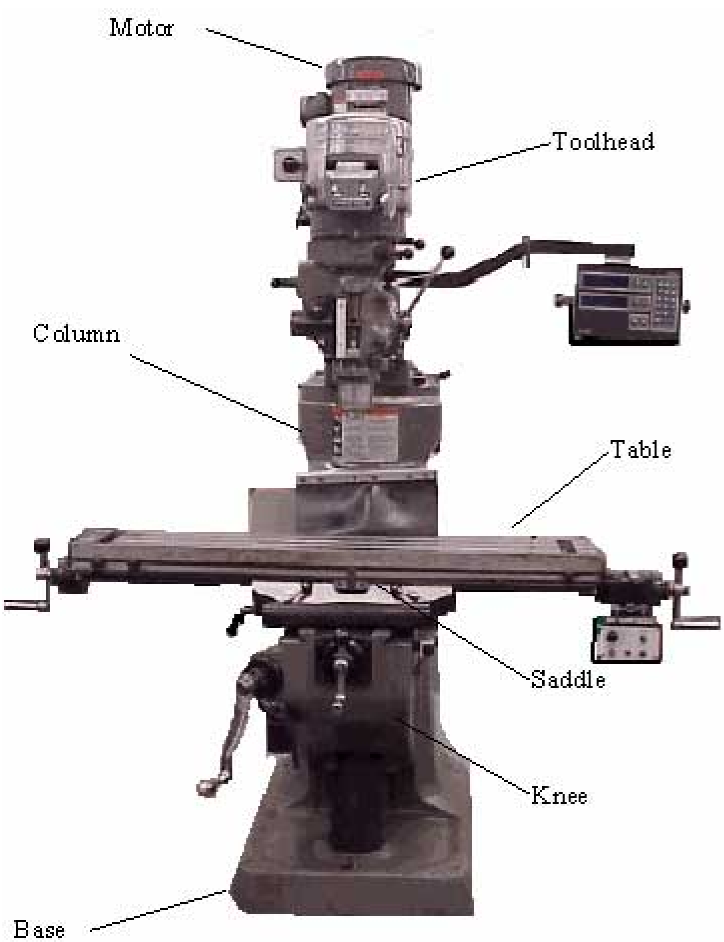


Figure 1: Ram Type Vertical Milling Machine

Motor-The motor supplies the power to the spindle.

Toolhead-The toolhead houses the spindle. The toolhead is located at the end of the Ram. The toolhead also contains the motor.

Column-The column of the milling machine, along with the base, are the major structural components. They hold, align, and support the rest of the machine.

Table-Holds and secures the workpiece for machining.

Saddle-The saddle it attached to the knee. The saddle provides the in and out, or Y axis travel of the table.

Knee-The knee supports the saddle and the table. The knee can be moved up and down for workpiece positioning.

Ram-The ram allows the Toolhead to slide in and out. The ram gives the machine greater capacity and flexibility. It is recommended that the tool head be kept as close to the column as possible during heavy milling work.

Vertical Milling Machine Construction

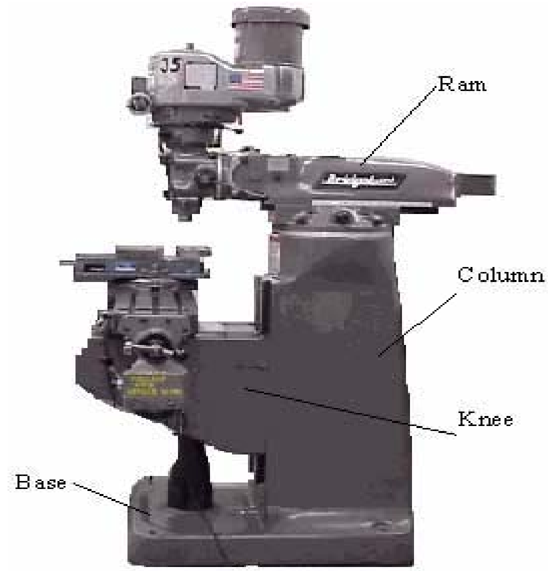


Figure 2: **Vertical Milling Machine Construction**

Base- The base of the milling machine, along with the column, are the major structural components. They hold, align, and support the rest of the machine.

Vertical Milling Machine Components

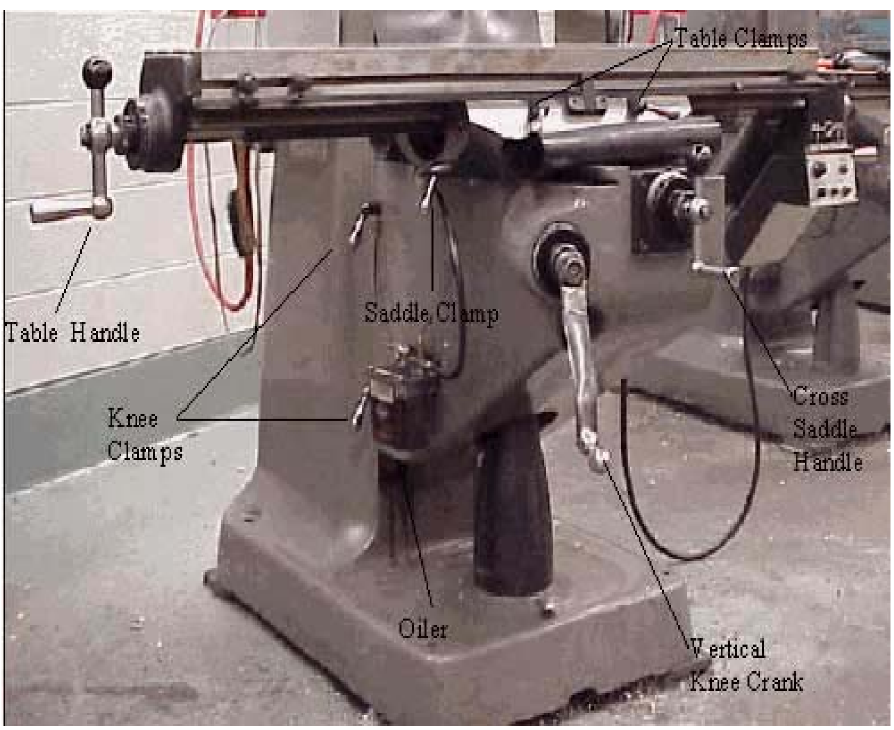


Figure 3: **Vertical Milling Machine Components**

Clamps- The **knee**, **table** and **saddle** all come equipped with clamps. The clamps are used to maintain the position of their respective components. All of the clamps should be locked when machining, **except** the clamp for the axis that is moving.

Handles-The **table** and **saddle** handles are used to position the part with respect to the tool.

Oiler-The oiler feeds lubricant, under pressure, to the knee, table, and the saddle. Always give the oiler "one shot" before you begin operating the machine.

Knee Crank-The knee crank is used to raise and lower the knee.

Vertical Milling Machine Head Controls

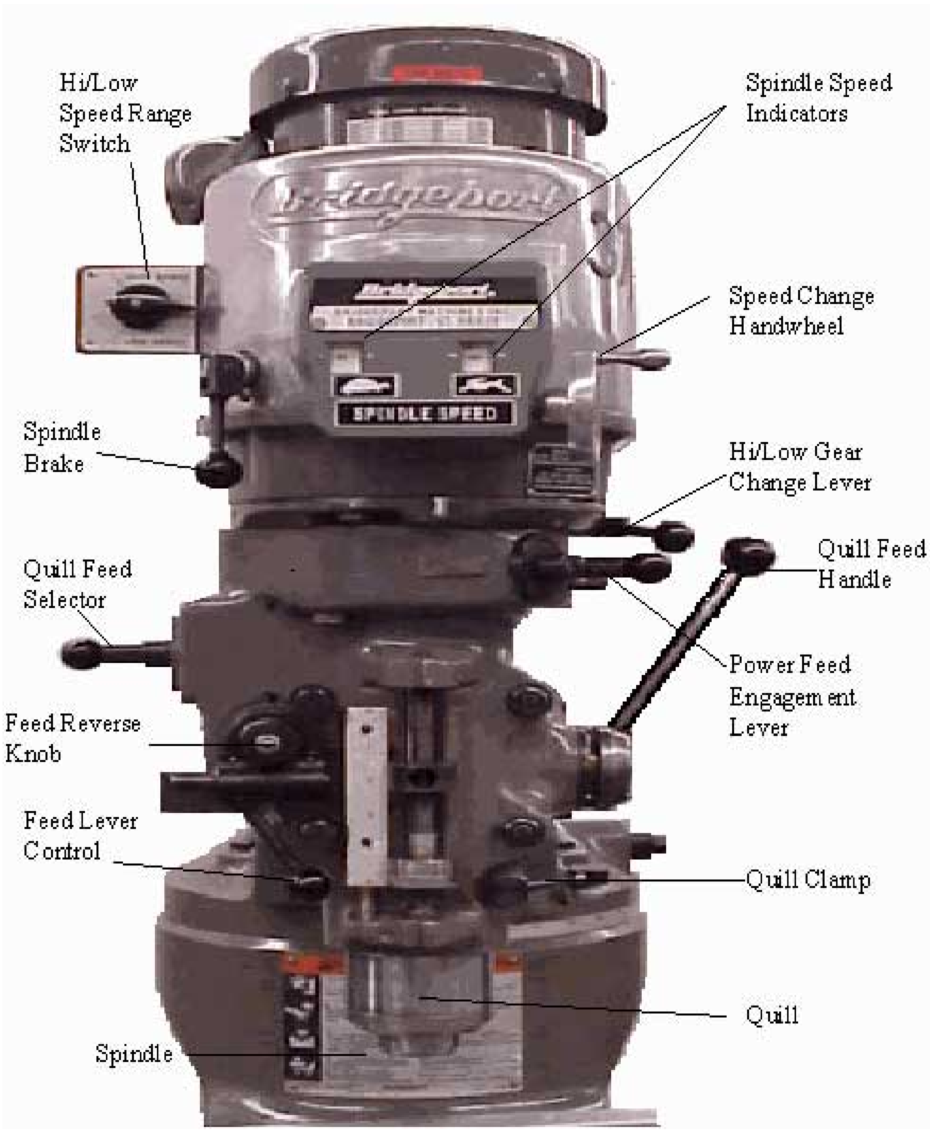


Figure 4: Vertical Milling Machine Head Controls

Hi/Low Speed Range Switch-This is the spindle reversing switch. This switch and the Hi/Low gear lever work in conjunction to one another. Make sure that the switches are set alike to avoid mistakenly running the spindle backwards.

Speed Change Handwheel-This is the variable speed control. The handwheel works in conjunction with the spindle speed indicator. Do not turn this handwheel unless the spindle is running.

Spindle Brake-This handle engages the spindle brake. The handle can be moved in either direction to enable the brake. Never enable the brake with the spindle on.

Hi/Low Gear Change Lever-This lever is used to put the spindle in the Hi or Low gear range. Turn the spindle by hand while engaging this lever. This will help mesh the gears.

Quill Feed Handle-This is the handle you use to raise and lower the quill manually.

Quill Feed Selector-This crank is used to select the feed rate for the quill feed. The feed rates include 0.0015", 0.003", and 0.006" per revolution rates.

Power Feed Engagement Lever-This lever engages the power feed worm gear. When the lever is in the proper position, the power feed worm gear is engaged.

Feed Reverse Knob-The position of this knob determines the quill feed direction. The quill feed reverse knob position is influenced by the spindle direction. The three positions of the knob are; **In**, **Middle**, and **Out**. The middle position is the neutral position. Check the feed direction above the workpiece before engaging the power feed.

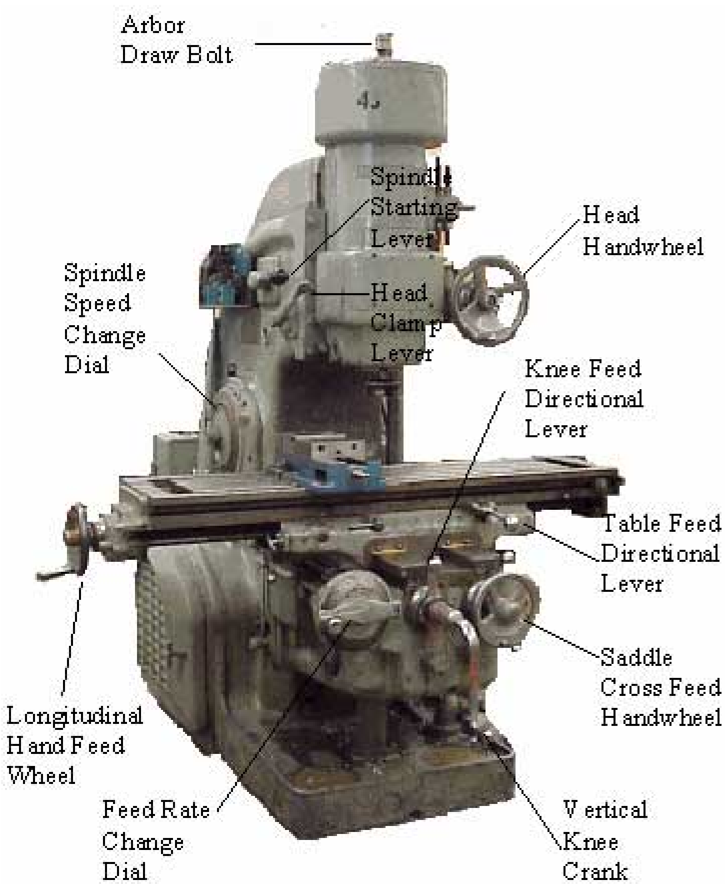
Feed Lever Control-The feed lever is a clutch which engages the quill feed. The quill feed will stay engaged until the quill stop comes in contact with the micrometer adjusting nut or the Feed Lever is released.

Quill Clamp-The quill clamp is a friction type clamp to be used when milling or anytime you don't want the quill to move.

Quill-The quill contains the spindle assembly. The quill can be moved manually or by using the automatic quill feed.

Spindle-The spindle holds the tool and provides the actual tool rotation.

C-Frame Style Vertical Milling Machine Components



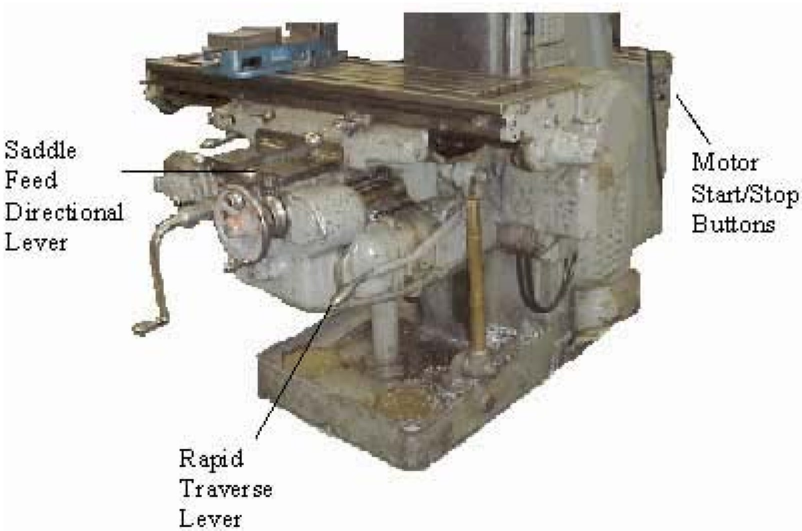


Figure 5 & 6: C-Frame Style Vertical Milling Machine Components

Arbor Draw Bolt-The arbor draw bolt draws the tool holder up into the spindle. The arbor draw bolt is equipped with a jam nut to keep the draw bolt from loosening up during operation.

Spindle Speed Change Dial-The spindle speed change dial is the spindle speed selector. On this type of milling machine the main power must be on to change speeds, but the spindle must be stopped.

Feed Rate Change Dial- The feed rate change dial is used to select the feed rate for the power feed table movement.

Table Feed Directional Lever- The table feed directional lever establishes the direction of table feed. When the table feed directional lever is positioned to the left or right, the table will feed in that direction at the selected feed rate or at a rapid traverse rate when using the rapid traverse lever.

Head Handwheel- The head hand wheel is used to hand feed or position the head up or down.

Head Clamp Lever- The head clamp lever locks or un-locks the head. The head should always be locked when ever it is not being positioned.

Spindle Starting Lever- The spindle starting lever starts the spindle. On some styles of vertical milling machines lifting the spindle handle may also start the feed motor. The spindle handle, when pulled down and held down, actuates the magnetic spindle brake.

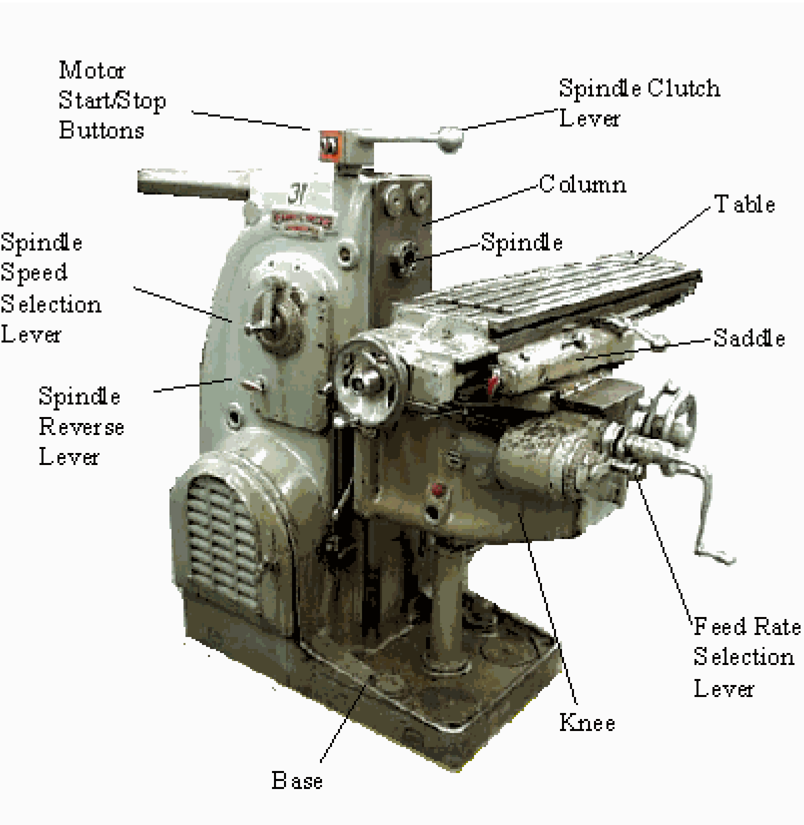
Saddle Feed Directional Lever- The saddle feed directional lever establishes the direction of in and out feed. When the saddle feed directional lever is positioned to the left or right, the table will feed in or out at the selected feed rate or at a rapid traverse rate when using the rapid traverse lever.

Rapid Traverse Lever- The rapid traverse lever engages the rapid traverse gear on the feed motor. The rapid traverse is used for rapid table positioning. The appropriate feed direction lever must be engaged in order for the rapid traverse lever to be used.

Motor Start/Stop Buttons- The motor start and stop buttons control the power to the main motor for the machine.

"Horizontal Milling Machine"

Machine Construction



The main parts of the horizontal mill are the; base, column, knee, saddle, table, spindle, overarm and arbor supports. Below you will find illustrations of a horizontal milling machines and it's parts. Study these parts and be ready to answer questions concerning their names locations and uses.

Figure 1 Horizontal Milling Machine

Column-The column of the milling machine, along with the base, are the major structural components. They hold, align, and support the rest of the machine.

Table-Holds and secures the workpiece for machining.

Saddle-The saddle is attached to the knee. The saddle provides the in and out, or Y axis table travel.

Knee-The knee supports the saddle and the table. The knee can be moved up and down for workpiece positioning.

Base- The base of the milling machine, along with the column, are the major structural components. They hold, align, and support the rest of the machine.

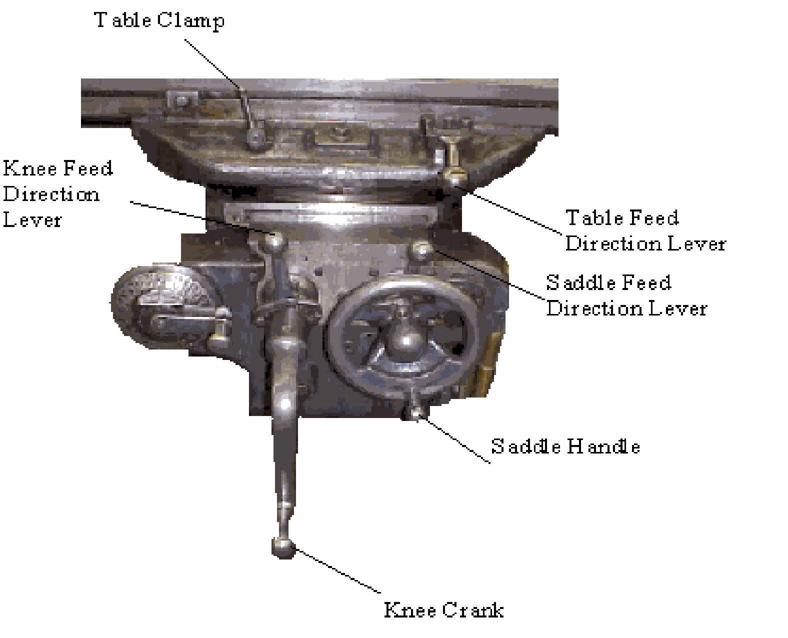
Spindle-The spindle holds the tool and provides the actual tool rotation.

Spindle Reverse Lever-The position of this lever determines the spindle direction. The three positions of the handle are; In, Middle, and Out. The middle position is the neutral position. Never move the spindle reverse lever when the spindle is turning.

Spindle Speed Selection Lever-The spindle speed selection lever is used to change the spindle R.P.M. setting. This type of machine has a geared head so the spindle speed can only be changed when the spindle is stopped.

Spindle Clutch Lever-The spindle clutch lever engages the spindle clutch to the motor. By manipulating the spindle clutch lever the operator can start and stop the spindle.

Feed Rate Selection Lever-The feed rate selection lever is used to change the feed rate setting. The feed rate settings are expressed in inches per minute.



Motor Start and Stop Buttons- The motor start and stop buttons control the power to the main motor for the machine.

Clamps- The knee, table and saddle all come equipped with clamps. The clamps are used to maintain the position of their respective components. All of the clamps should be locked when machining, except the clamp for the axis that is moving.

Handles-The table and saddle handles are used to manually position the part with respect to the tool.

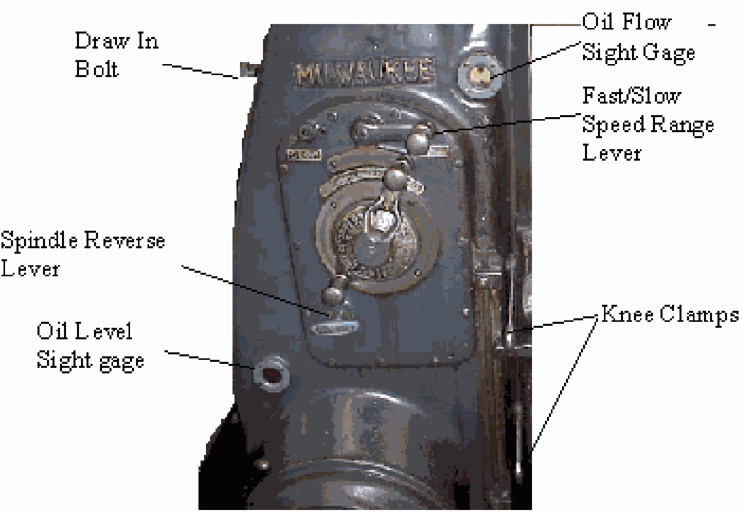


Figure 2 Horizontal Milling Machine Components

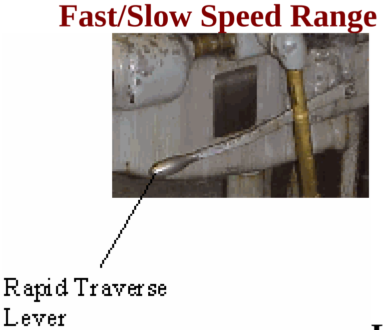
Knee Crank-The knee crank is used to raise and lower the knee.

Table Feed Directional Lever- The table feed directional lever establishes the direction of table feed. When the table feed directional lever is positioned to the left or right, the table will feed in that direction at the selected feed rate or at a rapid traverse rate when using the rapid traverse lever.

Saddle Feed Directional Lever- The saddle feed directional lever establishes the direction of in and out feed. When the saddle feed directional lever is positioned to the left or right, the table will feed in or out at the selected feed rate or at a rapid traverse rate when using the rapid traverse lever.

Figure 3 Horizontal Milling Machine Components

Fast/Slow Speed Range



Lever- This lever is used to put the spindle in the Fast/Slow gear range.

The Fast/Slow gear range lever allows the operator to select the speed range from which to set the R.P.M. setting from. Turn the spindle by hand while engaging this lever. This will help mesh the gears.

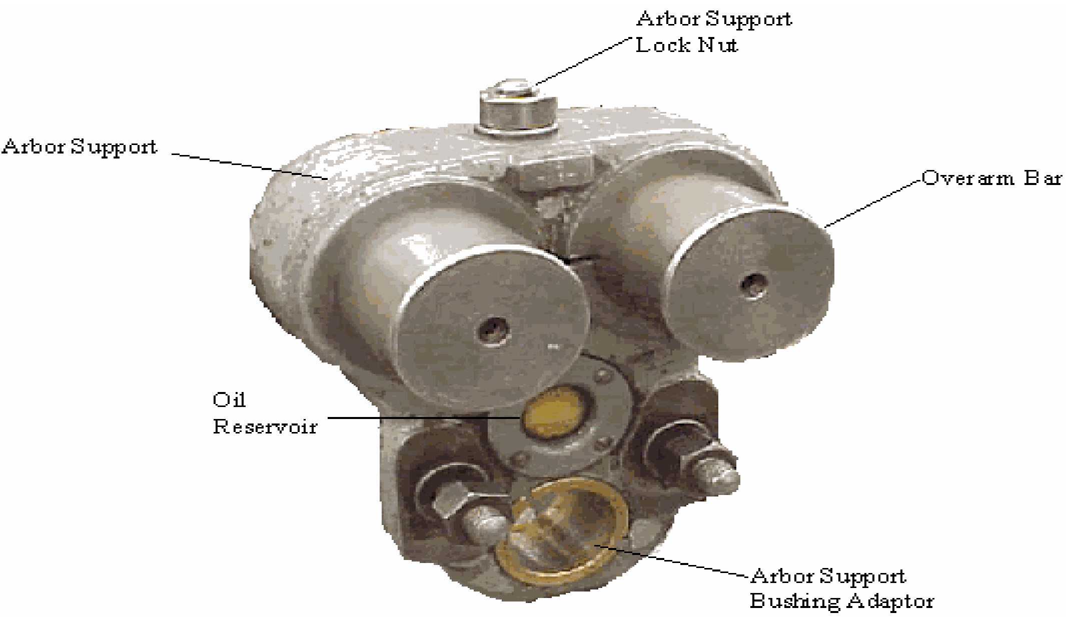


Figure 4 Arbor Support Components

Draw In Bolt-The arbor draw in bolt draws the tool holder into the spindle. The arbor draw bolt is equipped with a jam nut to keep the draw in bolt from loosening up during operation.

Rapid Traverse Lever-The rapid traverse lever engages the rapid traverse gear on the feed motor. The rapid traverse is used for rapid table positioning. The appropriate feed direction lever must be engaged in order for the rapid traverse lever to be used.

Oil Flow Sight Gage-The oil flow sight gage assures to the operator that while the spindle is turning it is being properly lubricated. When the spindle clutch is engaged a steady flow of oil should be visible in this sight gage.

Oil Level Sight Gage-The oil level sight gage indicates the oil reservoir level. The oil level in this sight gage should be visible at all times.

Arbor Support-The arbor support supports the end of the arbor that is opposite the spindle. The arbor support is attached to the overarms bars.

Arbor Support Lock Nut-The arbor support lock nut fastens the arbor support to the overarm bars.

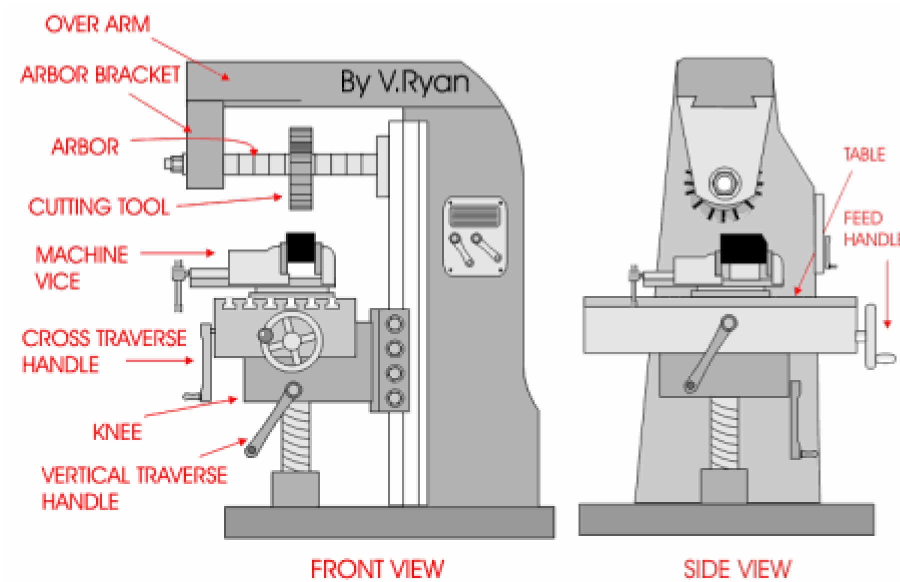
Overarm Bars-The Overarm bars align and support the arbor support.

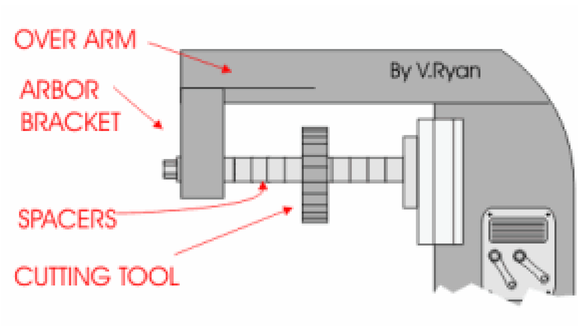
Oil Reservoir-The oil reservoir holds and distributes oil to the overarm support bushing and arbor bearing collar. Proper lubrication and fit between the arbor bearing collar and the arbor support bushing are crucial.

Arbor Support Bushing Adaptor-The bushing adaptor comes in various sizes. The bushing adaptor allows the operator to use different size arbor support bushings in the same arbor support and also allows for slight adjustments for fit between the bushing and the collar.

THE HORIZONTAL MILLING MACHINE

The Horizontal Milling Machine is a very robust and sturdy machine. A variety of cutters are available to removed/shape material that is normally held in a strong machine vice. This horizontal miller is used when a vertical miller is less suitable. For instance, if a lot of material has to be removed by the cutters or there is less of a need for accuracy - a horizontal milling machine is chosen.





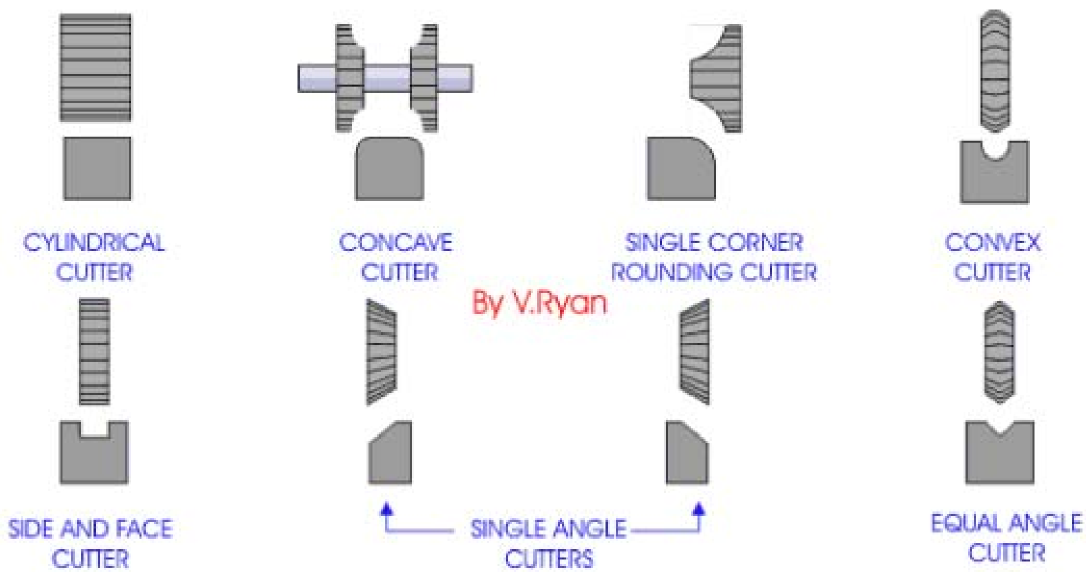
The cutter can be changed very easily. The arbor bracket is removed by loosening nuts and bolts that hold the arbor firmly in position. The arbor can be slid off the over arm. The spacers are then removed as well as the original cutter. The new cutter is placed in position, spacers slid back onto the arbor and the arbor bracket tightened back in position.

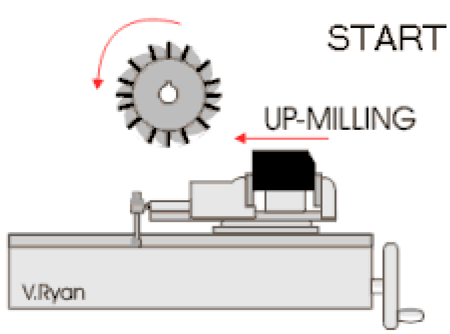
THE HORIZONTAL MILLING MACHINE
CUTTERS AND UP-MILLING

A large range of cutters are available. They are generally made from high speed steel which means they will cut through metals such as mild steel and aluminium. Some of the profiles (shapes) of the cutters are shown below.

Cylindrical cutters are used to remove a lot of waste material from a surface. More detailed cutters, such as concave cutters, are used to machine a shape onto a surface.

When machining with any of these cutters it is important to use coolant (soluble oil) as the cutter will heat up as well as the material being machined. The coolant cools the cutters and the material which means that the expensive cutters last longer. It is also necessary to remove material a little at a time. Several slow passes over the material may be needed to manufacture the desired shape.





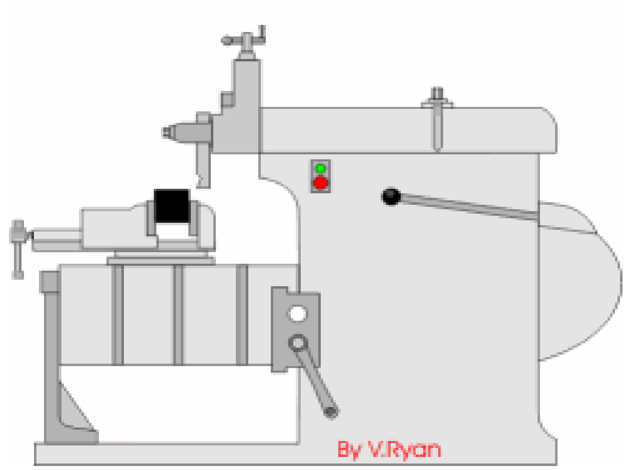
UP-MILLING

The safest way to machine a piece of metal using a horizontal miller is to feed the metal into the cutter, against its rotation. This is called up-milling and it is the technique used in school workshops. The metal must be held very firmly in a large machine vice, usually a nylon or leather mallet is used to hammer round the handle of the vice to ensure it is extremely tight.

THE SHAPING MACHINE

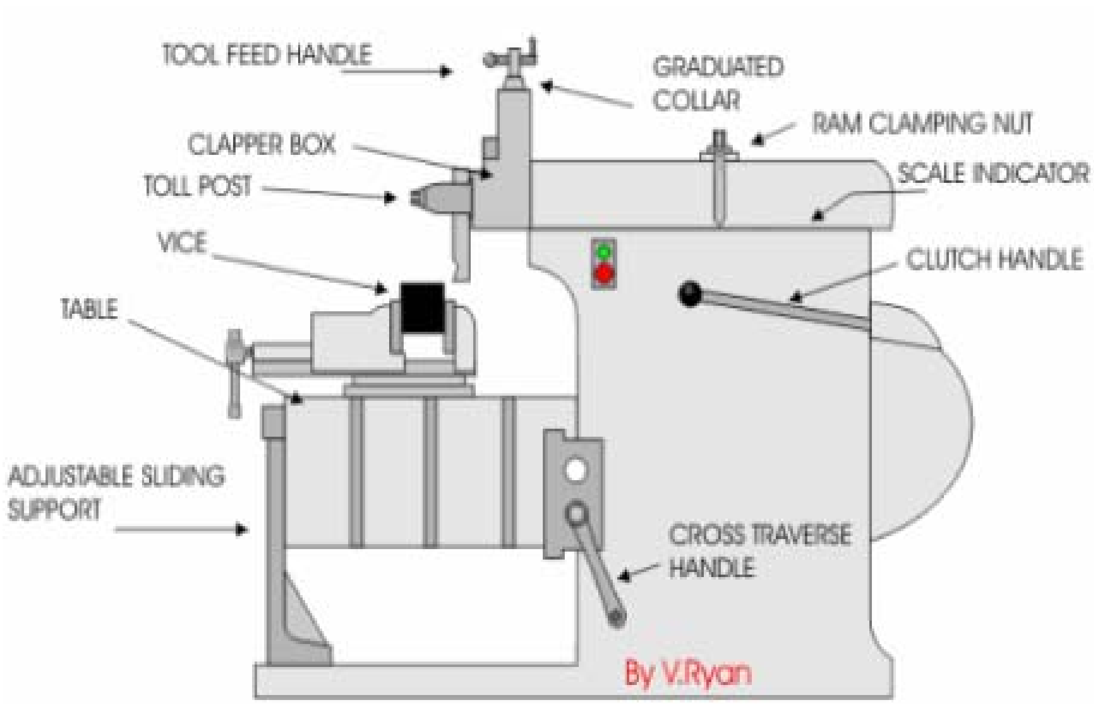
A shaping machine is used to machine surfaces. It can cut curves, angles and many other shapes. It is a popular machine in a workshop because its movement is very simple although it can produce a variety of work.

Shaping machines come in a range of sizes but the most common size is seen opposite.



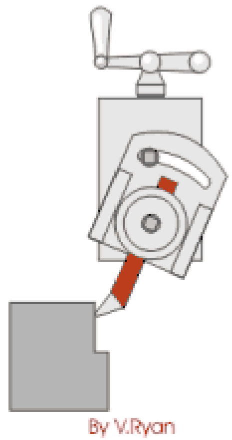
The main parts are indicated below:

The tool feed handle can be turned to slowly feed the cutting tool into the material as the 'ram' moves forwards and backwards. The strong machine vice holds the material securely. A small vice would not be suitable as the work could quite easily be pulled out of position and be damaged. The vice rests on a steel table which can be adjusted so that it ca be moved up and down and then locked in position. Pulling back on the clutch handle starts the 'ram' moving forwards and backwards.

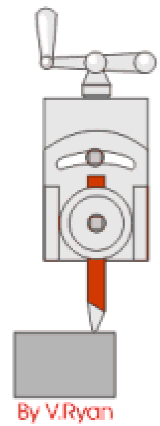


The tool post and the tool slide can be angled as seen below. This allows the shaper to be used for different types of work

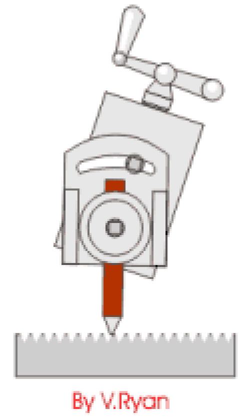
DIAG. A: The tool post has been turned at an angle so that side of the material can be machined



DIAG. B: The tool post is not angled so that the tool can be used to level a surface.

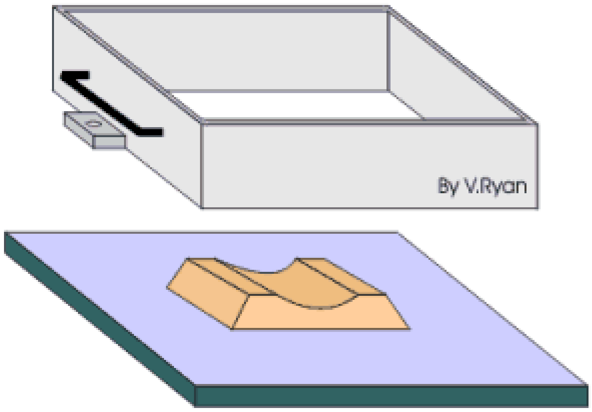


DIAG. C: The top slide is slowly feed into the material so that a ‘rack’ can be machined for a rack and pinion gear system.

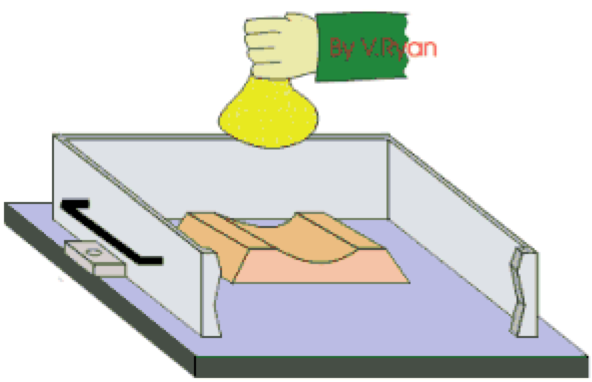


FOUNDRY WORK (1)

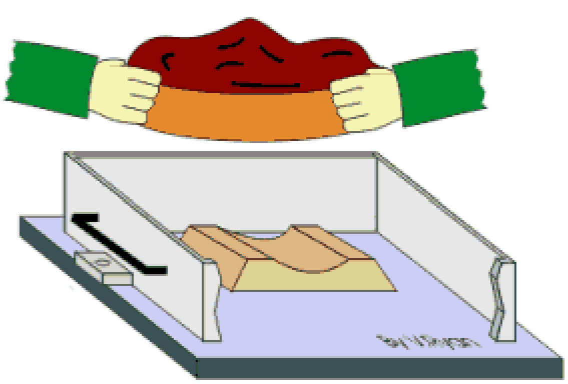
A specialised part of the manufacturing/engineering world is casting or foundry work as it is properly called. In schools and colleges this usually involves casting molten aluminium. Before any casting can take place a wooden pattern is made precisely. This is called pattern making and in industry this is a very skilful job. Any inaccuracy at this stage will result in the final cast being wrong or even failing. In schools the pattern is usually made from a softwood and its sides are given a draft (an angle) so that it can be removed from the sand easily.



The diagrams to the left shows the pattern on a flat board and a casting box called a ‘drag’ being placed over it.

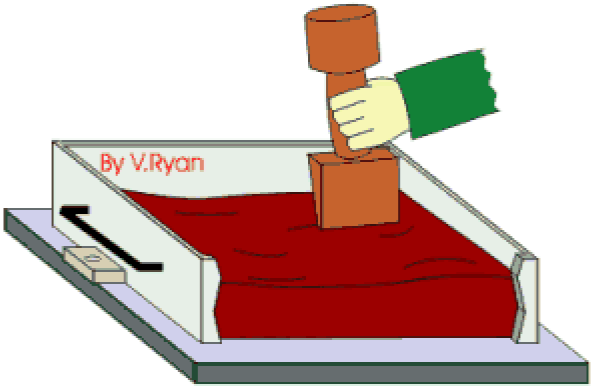


Special casting sand will soon be packed around the pattern but to ensure to can be removed easily from the sand, parting powder is sprinkled over and around it. (parting powder is similar to talcum powder). It stops the casting sand sticking to the pattern and pulling away with it when the pattern is finally removed from the sand.



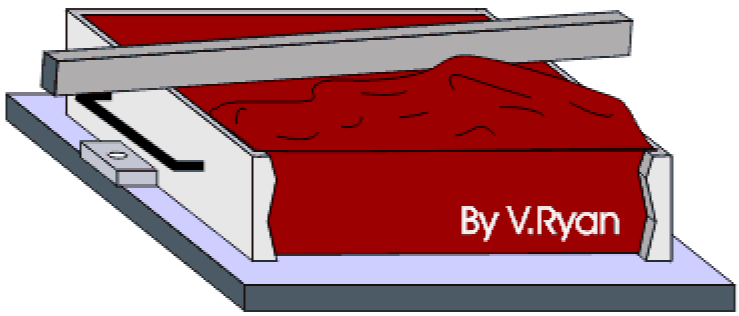
Casting sand is then shaken through a sieve (called riddled sand) so that only fine particles fall around the pattern. This is called facing sand and it must be fine so that detail on the pattern shows up on the final casting.
Different types of sand are available. The safest is called petro-bond. This is a mixture of quality sand and oil. The cheapest is called green sand and this is mixed with water. Green sand must be mixed carefully as if too much water is added - when molten aluminium is poured into the mould an explosion can result.

FOUNDRY WORK (2)

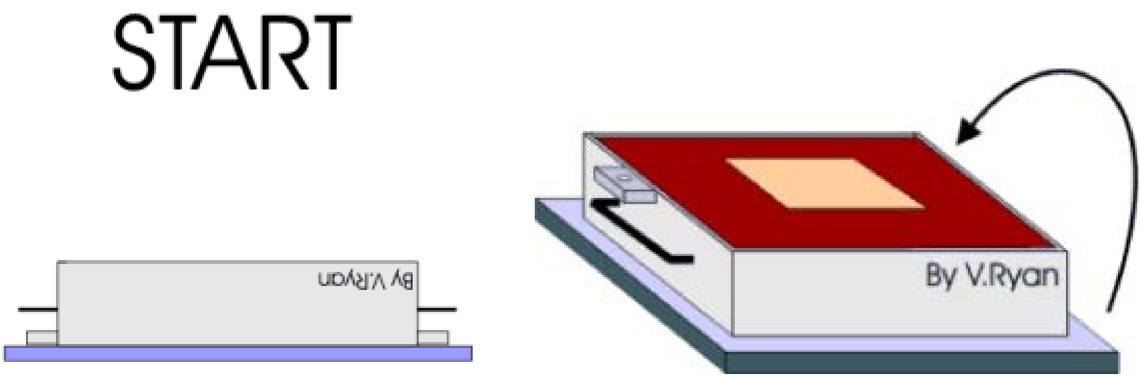


The drag is then packed with more casting sand. It is a good idea to sieve all the sand being placed above the pattern and then ram it down firmly using a ramming tool. The tool has two ends, one is cylindrical and is used for general packing down of the sand. The other end is quite pointed and this can be used for packing sand close up to the pattern.

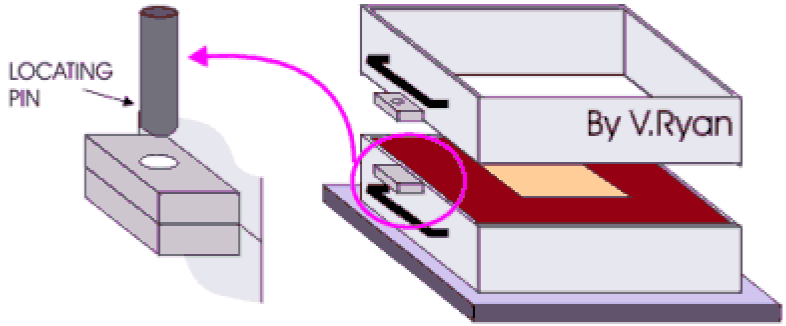
When the drag is packed fully it is levelled off (called 'strickled off') using a straight steel bar.

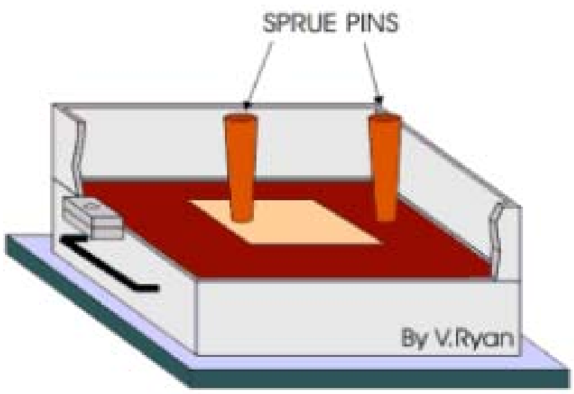


The entire drag and its contents are then turned over so that the base of the pattern can be seen.



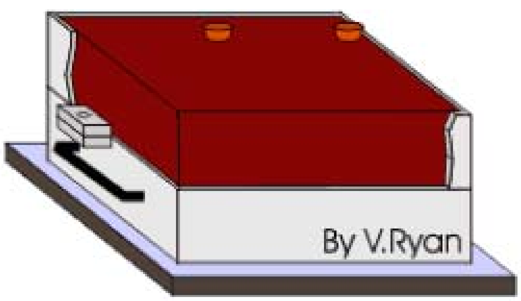
A top box called a 'cope' is then placed on top of the drag and locating pins are put in position so that the casting boxes cannot move sideways.

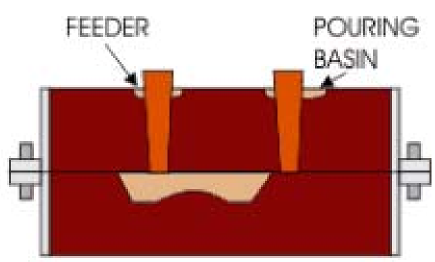




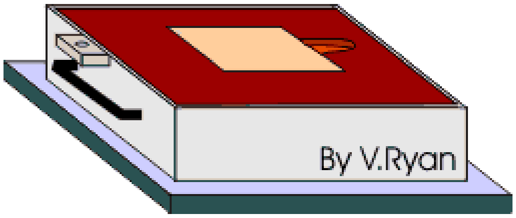
Sprue pins are positioned. One usually on the back of the pattern and the other to the side. These will eventually provide an entrance and exit for the molten aluminium when it is poured into the sand. The sand is packed/rammed into the cope in the same way as the drag. Parting powder is first applied, followed by facing sand. The sprue pins should be taller than the box and stand out from the sand when it is levelled with a strickling bar.

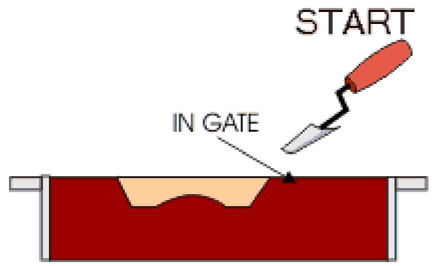
Small depressions are dug into the sand at the top of the two sprue pins. These are useful when the aluminium is poured. The depressions are called the pouring basin and feeder.

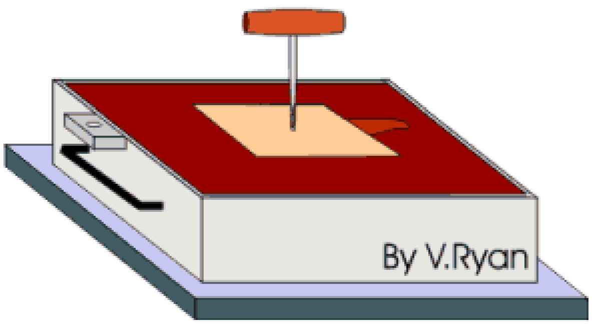




The top box (the cope) is then removed and if all is well the cope with the sand inside should lift off the drag (bottom box) without the sand falling out. A small ‘gate’ is cut below the position of one of the sprue pins. This will help the molten aluminium flow into the cavity left by the mould. Small tools are available or can easily be made to dig a variety of shapes in the casting sand. They are similar to small trowels.

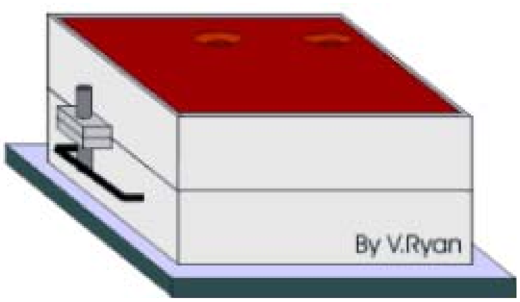


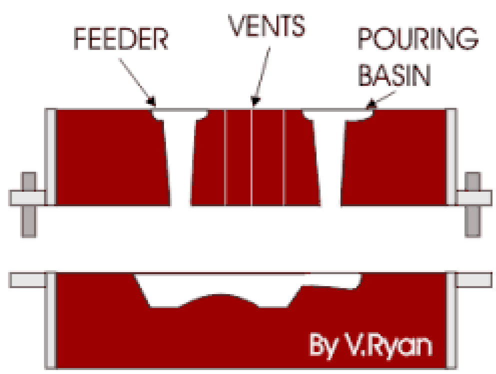




The pattern is removed using a 'spike'. The end of the spike can be threaded and so it can be screwed into the softwood pattern. Before removing the pattern it is a good idea to gently tap the spike so that it loosens the pattern from the sand. It can then be lifted away from the casting box (drag).

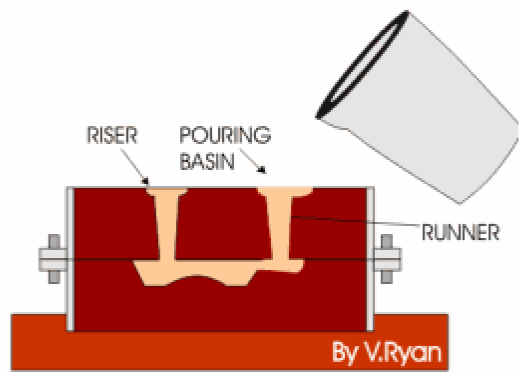
The cope (top casting box) is placed back on top of the drag and the locating pins put in position. Before this is done vents can be created using a thin piece of welding rod, pushing it through the sand . This allows gases to escape once the aluminium is poured.



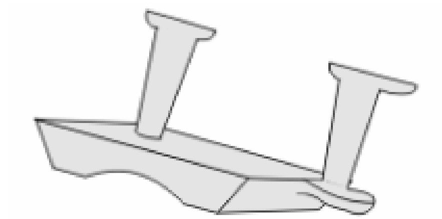


The aluminium is poured with great care. This is discussed in detail on other information sheets. The aluminium is poured down the hole left by the first sprue pin (now called the 'runner'). As it runs down the runner it flows through the 'gate' cut by the trowel, into the cavity left by the pattern and up the riser (the hole left by the second sprue pin).

The casting should be left for at least an hour before removal from the sand.

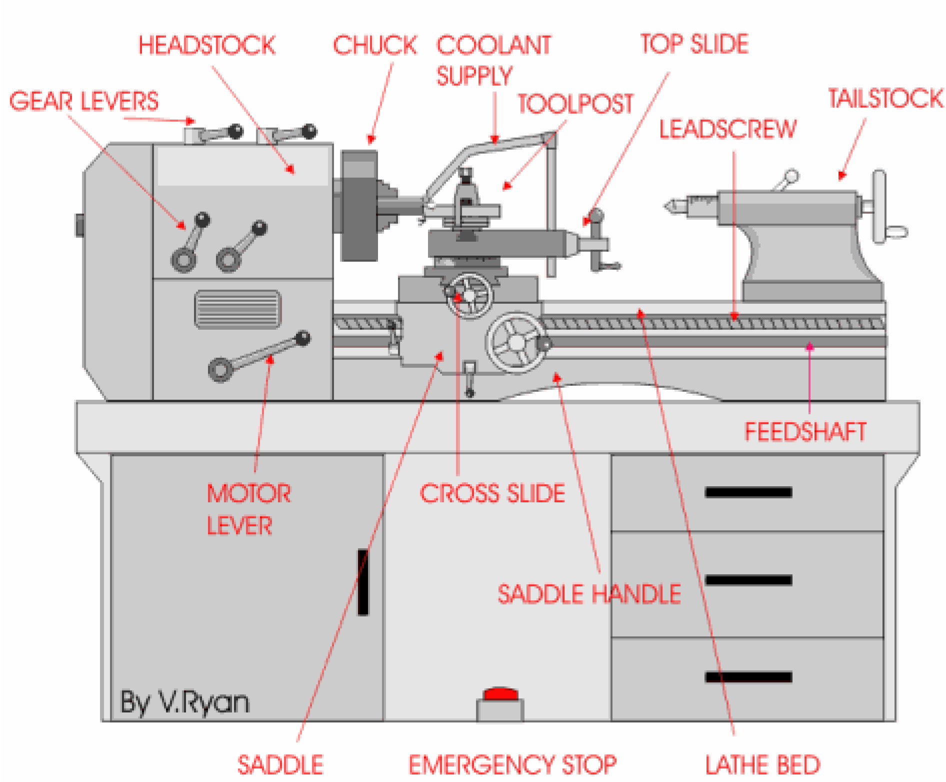


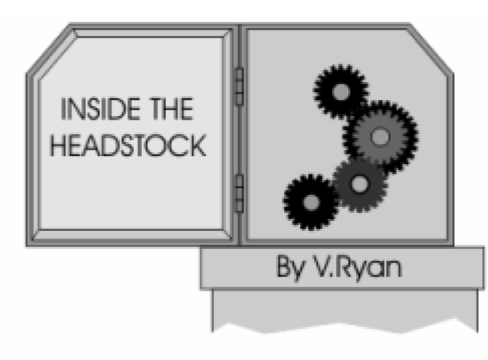
When removed from the sand, the runner and riser are cut away and the casting is ready for machining.



THE CENTRE LATHE

The Centre Lathe is used to manufacture cylindrical shapes from a range of materials including; steels and plastics. Many of the components that go together to make an engine work have been manufactured using lathes. These may be lathes operated directly by people (manual lathes) or computer controlled lathes (CNC machines) that have been programmed to carry out a particular task. A basic manual centre lathe is shown below. This type of lathe is controlled by a person turning the various handles on the top slide and cross slide in order to make a product / part.



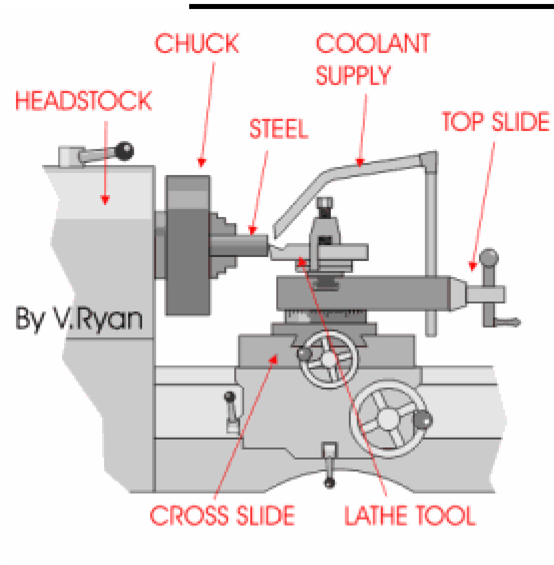


The headstock of a centre lathe can be opened, revealing an arrangement of gears. These gears are sometimes replaced to alter the speed of rotation of the chuck. The lathe must be switched off before opening, although the motor should automatically cut off if the door is opened while the machine is running (a safety feature).

The speed of rotation of the chuck is usually set by using the gear levers. These are usually on top of the headstock or along the front and allow for a wide range of speeds.

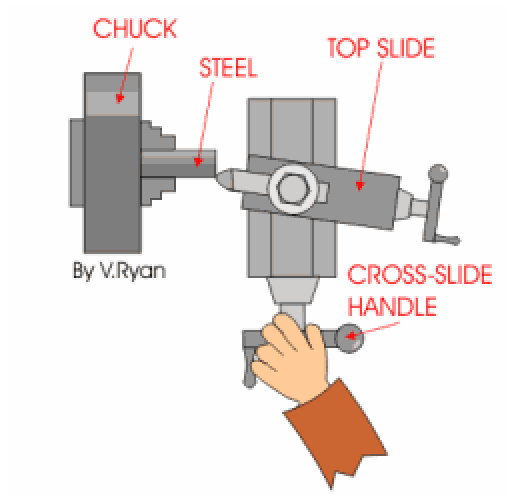
However, sometimes the only way to set the lathe to a particular speed is to change the gear arrangement inside the headstock. Most machines will have a number of alterative gear wheels for this purpose.

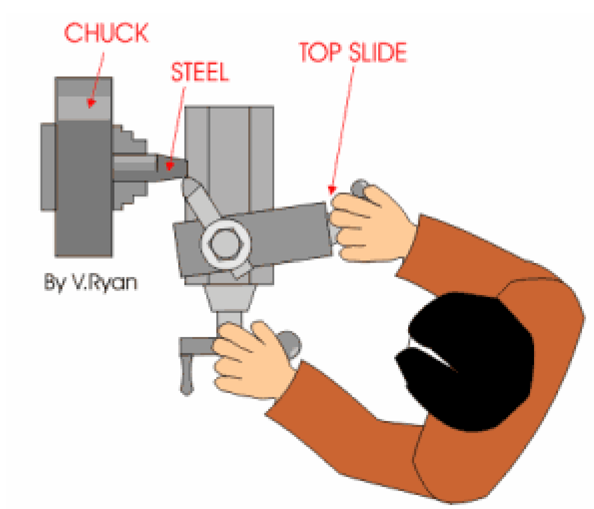
THE CENTRE LATHE - 'FACING OFF'



A very basic operation is called 'facing off'. A piece of steel has been placed in the chuck and the lathe cutting tool is used to level the end. This is done by turning the cross-slide handle so that the cross-slide moves and the cutting tool cuts the surface of the steel.

Only a small amount of material should be removed - each pass of the cross slide. After each pass of the cutting tool the top slide can be rotated clockwise to move the tool forward approximately 1mm. This sequence is repeated until the steel has been levelled (faced off). When using a centre lathe it is always advisable to work patiently and safely. Do not attempt to removed too much material in one go. At best this will caused damage to the steel being worked on and to the expensive cutting tool being used. At worse an accident will occur.



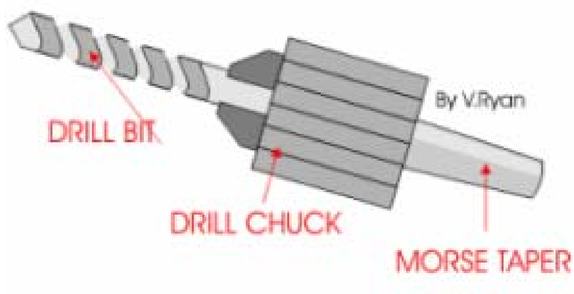


TURNING A SHORT TAPER

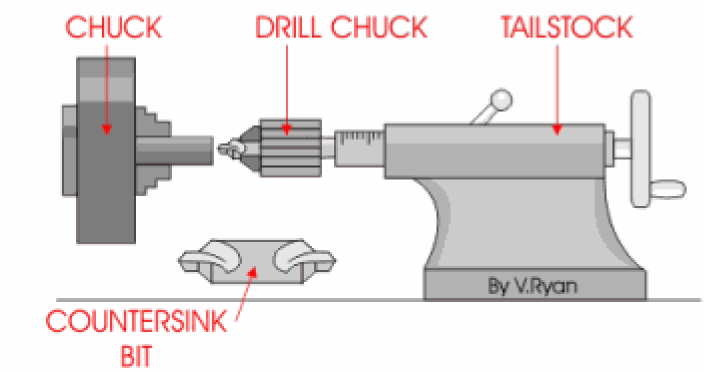
When turning a short taper the topslide is set a the required angle. This is normally done by loosening two small allen screws and then rotating the topslide to the angle and tightening back up the two allen screws.
When the chuck is rotating the topslide handle can be rotated slowly by hand in a clockwise direction. A small amount of metal is removed each time until the taper is formed. If too much steels stands out from the chuck the steel will vibrate and the surface finish will be very poor.

DRILLING WITH THE CENTRE LATHE

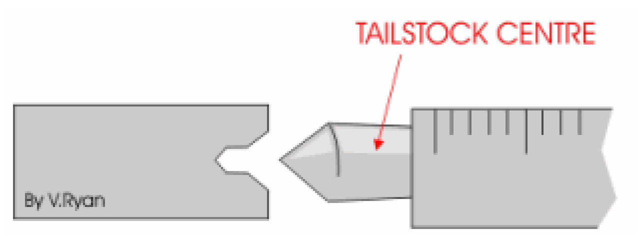
USING THE TAILSTOCK FOR DRILLING



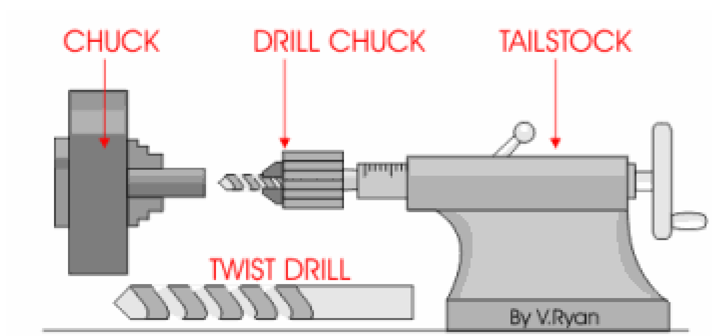
The tailstock of a lathe can be used for drilling, with the aid of a drill chuck attachment. The drill chuck has a morse taper shaft which can be push into the shaft of the tailstock, locking it in position.



The usual starting point for drilling with a centre lathe is to use a countersink bit. This is used to drill slightly into the material and creates a starting point for other drills that are going to be used. Attempting to drill with a traditional drill bit without countersinking first will lead to the drill bit slipping straight away. It is not possible to drill a hole successfully or safely with out using a centre drill first.

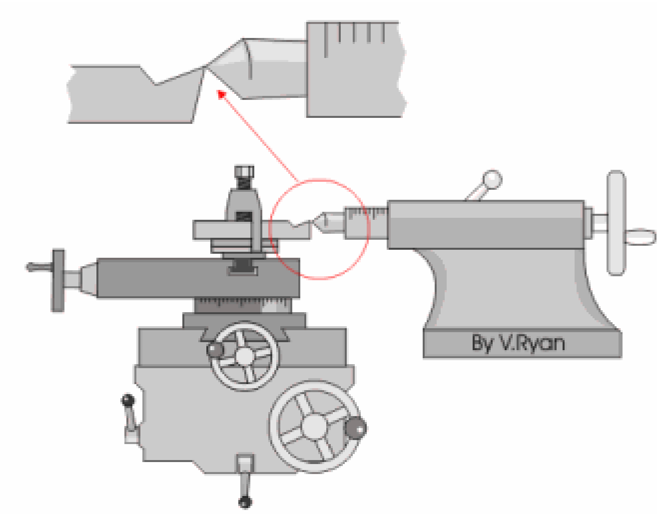


If a long piece of material has to be turned on a lathe then a centre drill is used to produce the hole at one end. This allows the drilled end to be supported by the tailstock centre.



Once a hole has been produced by a centre drill, machine twist drills can be used to enlarge the hole and if necessary to drill all the way through. If a large diameter hole is needed then a small hole is drilled first (eg. 4mm dia). Then the hole is enlarged approximately 2mm at a time. Trying to drill a large diameter hole in one go will inevitably lead to the drill bit over heating and then jamming in the material. This is potentially dangerous. When drilling, it is very important to use soluble oil as a coolant. This should be constantly fed onto the drill bit to keep it cool. This will help prevent jamming and over heating. Over heating will blunt the drill bit quickly.

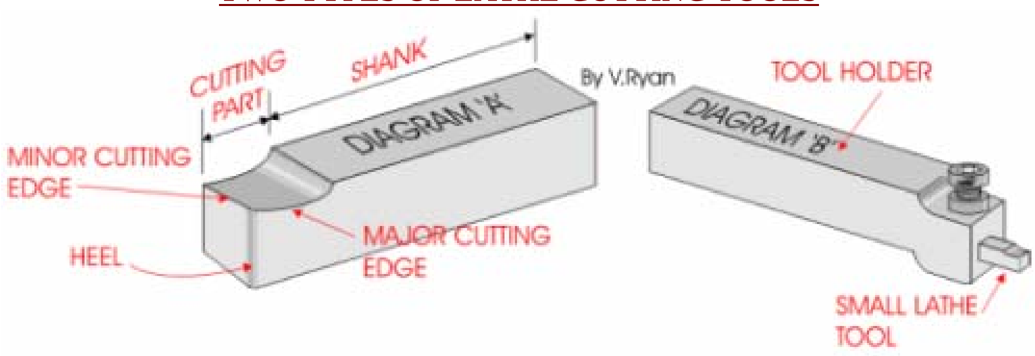
HOW TO CENTRE THE CUTTING TOOL



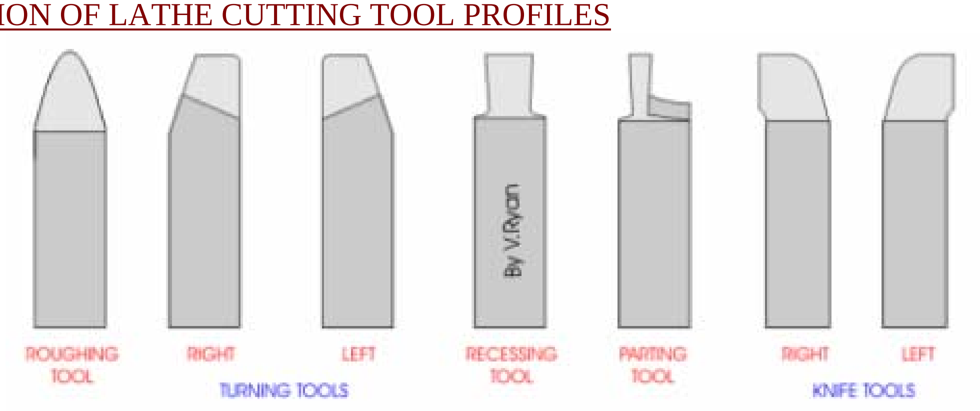
Before any turning takes place it is common practice to check that the point of the lathe tool is centred. This means that the lathe tool point should be the same height as the tip of the tailstock centre. If this is not done and the tool point is either above or below the centre point - usually the finish to the steel will be poor. Also, a significant amount of vibration could take place during turning.

The best lathe cutting tools are made from high speed steel. Diagram 'A' shows a typical solid lathe tool. The shank is clearly shown, this is the part that is fixed into the toolpost. Diagram 'B' shows a second type. This is a tool holder. A small lathe tool made of high speed steel is tightened into the cast steel tool holder. The advantage of this type is that the smaller lathe tools are cheaper to buy.

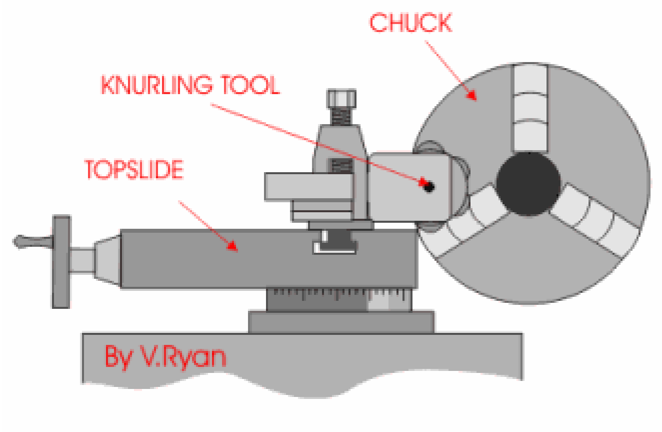
TWO TYPES OF LATHE CUTTING TOOLS



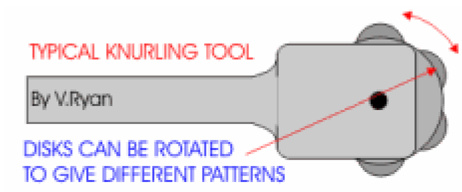
A SELECTION OF LATHE CUTTING TOOL PROFILES

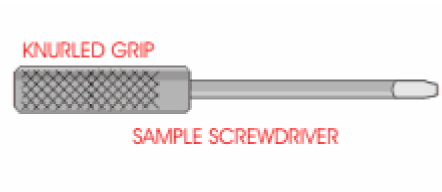


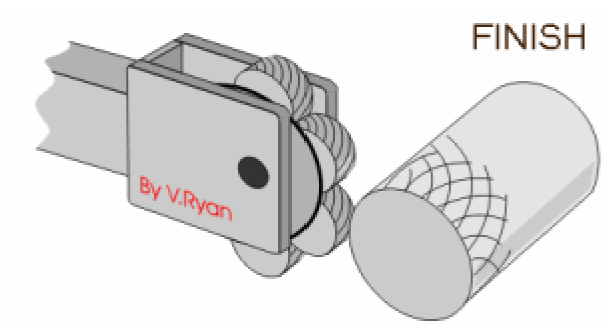
HOW TO USE A KNURLING TOOL



A knurling tool is used to press a pattern onto a round section. The pattern is normally used as a grip for a handle. Apprentice engineers often manufacture screwdrivers. These have patterned handles, to provide a grip and this achieved through the technique called knurling. The pattern produced is called a 'knurled pattern'.







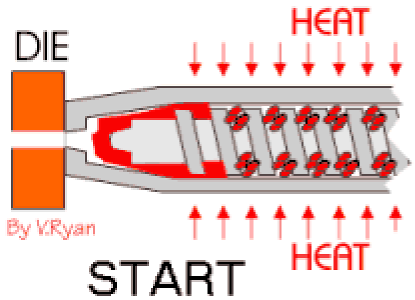
This diagram shows the knurling tool pressed against a piece of round section steel. The lathe is set so that the chuck revolves at a low speed. The knurling tool is then pressed against the rotating steel and pressure is slowly increased until the tool produces a pattern on the steel.

The automatic control lever is engaged which starts the automatic traverse of the saddle. As the saddle moves along the bed of the lathe the knurled pattern is pressed into the steel along its length.

If the traverse of the lathe is stopped and then reversed a diamond pattern is produced.

Depending on the knurling tool selected, a variety of knurled patterns can be produced. Three typical patterns are seen opposite

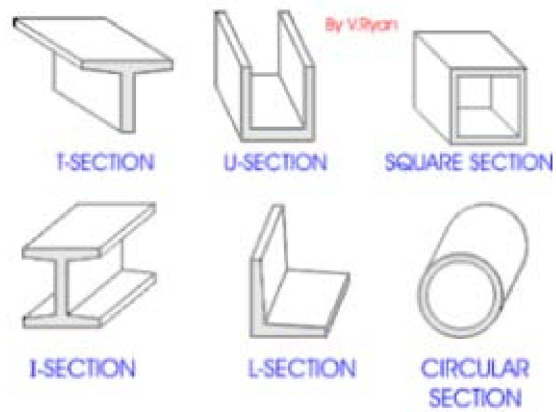
EXTRUSION



(Only the left- hand side of the machine is shown - the right-hand side is the same as the injection moulding machine)

A machine used to extrude materials is very similar to the injection moulding machine above. A motor turns a thread which feeds granules of plastic through a heater. The granules melt into a liquid which is forced through a die, forming a long 'tube like' shape. The extrusion is then cooled and forms a solid shape. The shape of the die determines the shape of the tube.

Opposite are examples of the type of shapes (sections) that can be extruded using an extrusion machine.



Describe items you have seen that have been formed through extrusion.

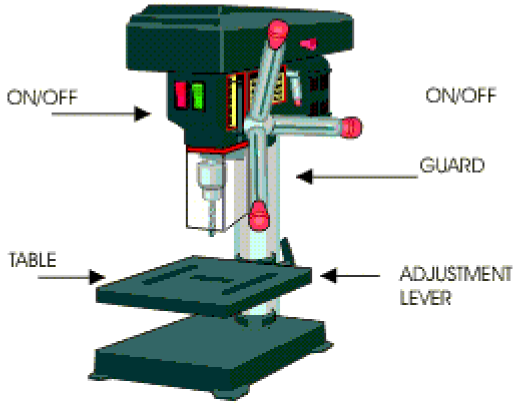
WORKSHOP MACHINERY - MACHINE DRILLS

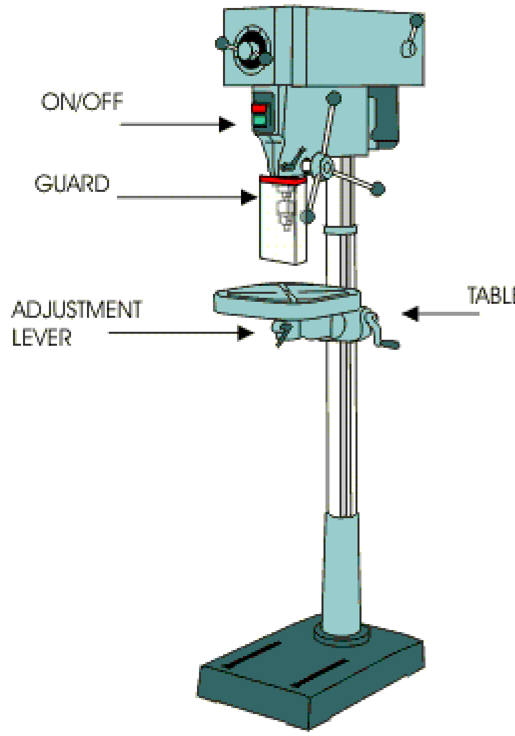
V. Ryan © 2001

There are two types of machine drill, the bench drill and the pillar drill. The bench drill is used for drilling holes through materials including a range of woods, plastics and metals. It is normally bolted to a bench so that it cannot be pushed over and that larger pieces of material can be drilled safely.
The larger version of the machine drill is called the pillar drill. This has a long column which stands on the floor. This can do exactly the same work as the bench drill but because of its larger size it is capable of being used to drill larger pieces of materials and produce larger holes.

BENCH DRILL

PILLAR DRILL





SAFETY

1. Always use the guard.
2. Wear goggles when drilling materials.
3. Clamp the materials down or use a machine vice.
4. Never hold materials by hand while drilling.
5. Always allow the ‘chippings’ to clear the drill by drilling a small amount at a time.
6. Follow all teacher instructions carefully.

1. Draw a bench drill and label the most important parts.
2. List safety factors regarding the use of the drilling machines.
3. Demonstrate the use of the bench/pillar drill to a group of pupils, emphasising safety.

EXAMPLES OF BITS USED WITH DRILLING MACHINES

Twist Drill	Forstner Bit	Hole Saw
Used for drilling holes. A normal drill set will include sizes from 1mm to 14mm.	Used for larger diameter holes. When using this bit the hole is drilled very slowly so that the bit does not 'jam' in the wood.	For large diameters a 'hole saw' can be used. The advantage of this type of drill bit is that the blade can be changed to give different sizes of diameter.

http://its.foxvalley.tec.wi.us/MachShop4/CarbCut/default.htm