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A Study on Types of Lathe Machine and Operations: Review

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ABSTRACT

In this paper, the review of this paper pertaining to the present research topic has been carried out to gain knowledge and to become familiar with the established techniques and methodology. Types of Lathe Machine and its Operations is a term that covers a large collection of manufacturing processes designed to remove unwanted material, usually in the form of chips, from a work-piece by different types of lathe machines. It also covers action of individual lathe. Machining is used to convert castings, forgings, or preformed blocks of metal into desired shapes, with size and finish specified to fulfil design requirements. Almost every manufactured product has components that require machining. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces and crankshafts. The typical lathe provides a variety of rotating speeds and a means to manually and automatically move the cutting tool into the workpiece. Machinists and maintenance shop personnel must be thoroughly familiar with the lathe and its operations to accomplish the repair and fabrication of needed parts.

Keywords: *Drilling; Sawing; Drilling operations; Sawing operation; Workshop; Machine tools.*

1.0 Introduction

The lathe, probably one of the earliest machine tools, is one of the most versatile and widely used machine tool, so also known as mother machine tool. The job to be machined is held and rotated in a lathe chuck; a cutting tool is advanced which is stationary against the rotating job. This is accomplished by holding workpiece securely on the machine and turning against tool which will remove material from workpiece. To cut the material the tool should be harder than the workpiece and should be rigidly hold on the machine and should be fed in definite way relative to the workpiece. Some of the common operations performed on a lathe are facing, turning, drilling, threading, knurling, and boring etc.

2.0 Types of Lathe

Lathes are manufactured in a variety of types and sizes, from very small bench lathes used for precision work to huge lathes used for turning large steel shaft. But the principle of operation and function of all types of lathe is same. The different types of lathes given as:

2.1.Speed lathe

Speed lathe is the simplest types of lathe. It consists of bed, headstock, tailstock and tool post. There is no food box, lead screw or carriage. Tool is mounted on the tool post and is fed into work purely by hand control.

Figure 1: Speed Lathe

Due to this characteristic of lathe enables the designer to give high speeds range from 1200 to 3600 rpm. The headstock is construction is very

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simple and only two or three speeds are available. The "speed lathe" has been so named because of the very high speed of the spindle speed. It is mainly used for wood working, spinning, centering and polishing etc.

2.2 Engine lathe

It is the most common types of lathe and is widely used in workshop. Similar to the speed lathe, the engine lathe has got all the basic parts, e.g. bed, headstock and tailstock. But the headstock of the engine lathe is much more robust in construction and it contains mechanism for multiple speed. The cutting tool may be fed both in cross and longitudinal direction with reference to the lathe axis with the help of carriage. Engine lathes are classified according to the method of power transmission to the machine.

Figure 2: Engine Lathe

2.3 Bench lathe

This type of lathe is usually mounted on a bench. It has practically all the parts of engine lathe and it performs all the operations, its only difference being in the size. This lathe is used for small and precise work.

Figure 3: Bench Lathe

2.4 Tool room lathe

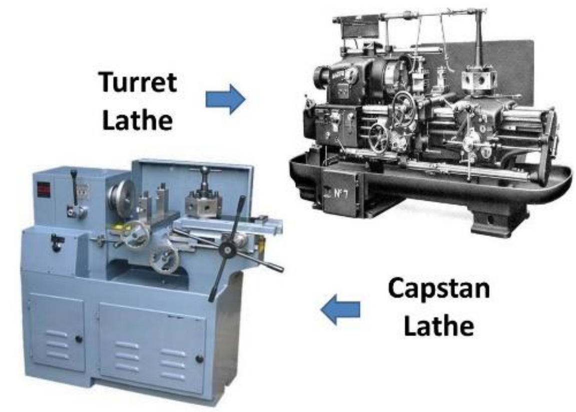
A tool room lathe having features similar to an engine lathe and is much more accurate and has wide range of speed from very low to 2500 rpm. It is used for manufacturing precision components, dies, tools, jigs etc. and hence it is called as tool room lathe.

Figure 4: Tool Room Lathe

2.5 Capstan and turret lathe

These types of lathes having provision to hold a number of tools and can be used for performing wider range of operations. These are particularly suitable for mass production of identical parts in minimum time.

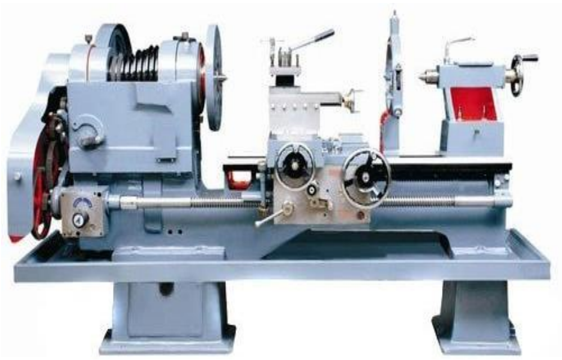
Figure 5: Capstan and Turret Lathe



2.6 Special purpose lathe

They are used for special purpose and jobs which cannot be accommodated or convenient machined on a standard lathe. It can be categories into four: wheel lathe, gap bed lathe, T-lathe and duplicating lathe. Wheel lathe is used to produce locomotive wheels. Gap bed lathe is used for machining extra-large diameter workpiece. T-lathe is used for machining of rotors for jet engines. Duplicating lathe is used for duplicating the shape of a flat or round template on to the workpiece.

Figure 6: Special Purpose Lathe



2.7 Automatic lathe (CNC)

These are high speed, heavy duty, mass production lathes with complete automatic control. Once the tools are set and machine is started it performs all the operations to finish the job. The changing of tools, speeds and feeds are also done automatically.

Figure 7: CNC Lathe

3.0 Lathe Operations

In order to perform operations in lathe, workpiece may be supported and driven by any one of the following methods:

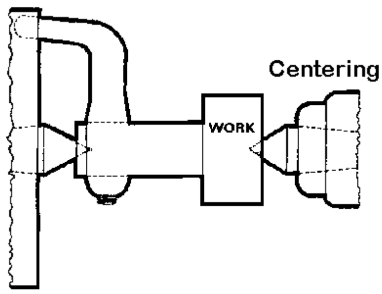
1. Held between centers and driven by carriers and catch plates.
2. Held on mandrel which is supported between centers and driven by carriers and catch plates.
3. Held and driven by chuck with the other end supported on the tailstock center.
4. Held and driven by chuck or faceplate or an angle plate.

Such operations carried out in lathe machines are centering, turning, taper turning, facing, knurling, filing, polishing, grooving, spinning, spring winding, forming, eccentric turning, chamfering, thread cutting, drilling, reaming, boring, counter boring, taper boring, internal thread cutting, tapping, undercutting, parting off, milling and grinding.

3.1 Centering

When work is required to be turned between centers or between a chuck and center, conical shaped holes must be provided at the ends of the workpiece to provide bearing surface for lathe centers. To prepare a cylindrical workpiece for centering, it is first necessary to locate the center hole. Center holes are produced by using combined drill and counter shank tool. This is held on drill chuck and may be mounted on headstock or in tailstock. The included angle of the hole should be exactly 60 to fit 60-point angle of lathe center.

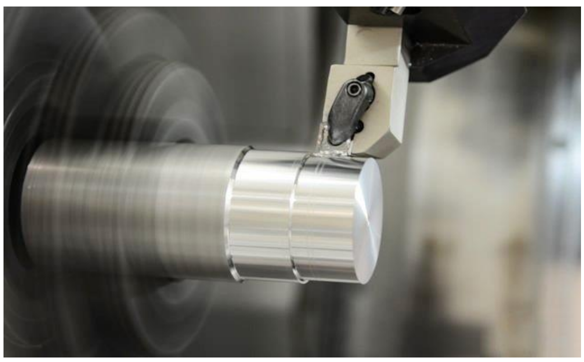
Figure 8: Centering



3.2 Turning

Turning in a lathe is to remove excess amount of material from workpiece to produce a cone shaped or a cylindrical surface.

Figure 9: Turning



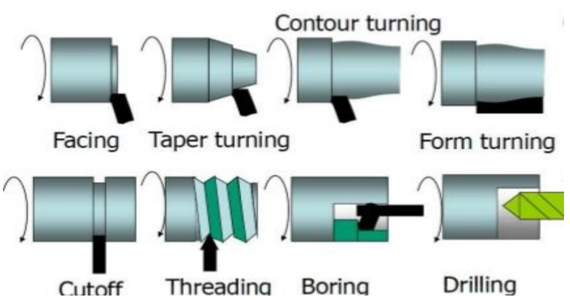
Round turning is the process of removal of excess material from workpiece in a minimum time by applying high rate of feed and heavy depth of cut. The depth of cut for rough turning operation in average machine shop work is from 2 to 5 mm and rate of feed from 0.3 to 1.5 mm per revolution of workpiece. Whereas finish turning requires high cutting speed, small feed and a very small depth of cut to generate a smooth surface. In finish turning depth of cut rages from 0.5 to 1 mm and rate of feed is from 0.1 to 0.3 mm per revolution of workpiece. When workpiece having different diameter is turned, the surface forming the step from one diameter to other is called shoulder, and machining this part of the workpiece is called shoulder turning. There are four types of shoulders; Square shoulder, angular or beveled shoulder, radius shoulder and undercut shoulder.

3.3 Taper turning

A taper defined as a uniform increase or decrease in diameter of workpiece measured along its length. It produces conical surface by gradual reduction in diameter. Tapering of a part has wide application in construction of the machine. Almost all machine spindles have taper holes which receive taper shank of various tool and work holding devices. Taper turning is done by five basic methods given below:

A. By a broad nose form tool
B. By setting over the tailstock center
C. By swiveling the compound rest
D. By taper turning attachment
E. By combining longitudinal and cross feed in a special lathe

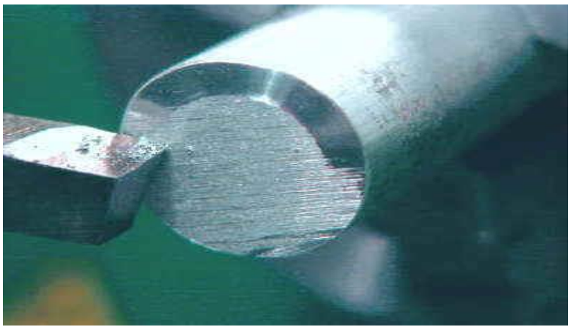
Figure 10: Taper Turning



3.4 Facing

Facing is an operation of machining the end of the workpiece to produce a flat surface. This is also used to cut the workpiece to the required length. A properly ground facing tool is mounted in a tool holder in the tool post. A regular turning tool may also be used for facing a large workpiece. The surface is finished to size by giving usual roughing and finishing cuts. For roughing the average of cross feed from 0.3 to 0.7 mm per revolution and depth of cut from 2 to 5 mm. For finishing the average of cross feed from 0.1 to 0.3 mm per revolution and depth of cut 0.7 to 1 mm.

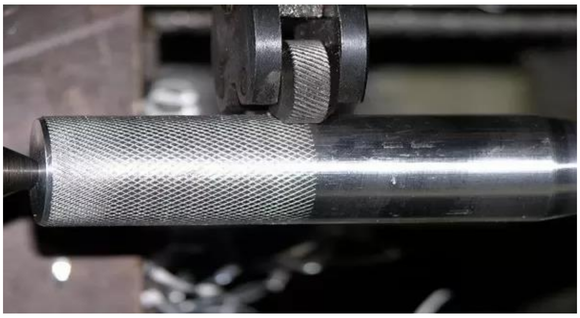
Figure 11: Facing



3.5 Knurling

Knurling is the process of embossing a diamond shaped pattern on a surface of the workpiece. The purpose of the knurling is to provide an effective gripping surface on the workpiece to prevent it from slipping when operated by hand. The operation is performed by a special knurling tool which consist of one set of hardened steel rollers in a holder with the teeth cut on their surface in a definite pattern. When single roller is used to generate parallel grooves and when two rollers are used, one right hand and one left hand to generate the diamond shaped pattern. Knurling is done at slowest speed available in lathe. Usually speed is reduced to one forth that of turning and some amount of oil is required. Speed varies from 1 to 2 mm per revolution.

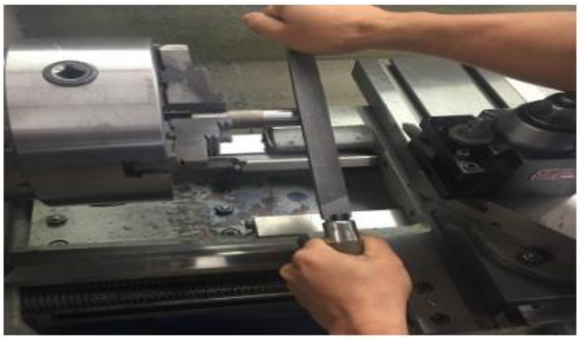
Figure 12: Knurling



3.6 Filing

This operation is done after turning to remove burrs, sharp corners and feed marks on the workpiece and also to bring it to size by removing very small amount of metal. The operation consists of passing a flat single cut file over the workpiece which revolves at very high speed. The file handle is gripped by left hand and the tip of the file by right hand to avoid accidents.

Figure 13: Filing



3.7 Polishing

Polishing is performed after filling to improve the surface quality of the workpiece. Polishing with successively finer grade of enemy cloth after filling results in very smooth and bright surface. The lathe is run at high speed from 1500 to 1800 rpm and used on enemy cloth.

Figure 14: Polishing

3.8 Grooving

Grooving is the process of reducing the diameter of the workpiece over a very narrow surface. It is often done at the end of thread to leave a small margin. The work is revolved half the speed of turning and a grooving tool of required shape is fed straight to the workpiece. A grooving tool is similar to a parting-off tool.

3.9 Spinning

Spinning is the process of forming a thin sheet of metal by revolving the job at high speed and pressing it against former attached to the headstock. A support is also given from the tailstock end. The pressure is gradually applied to the revolving sheet metal by long round nose forming tool.

Figure 15: Grooving

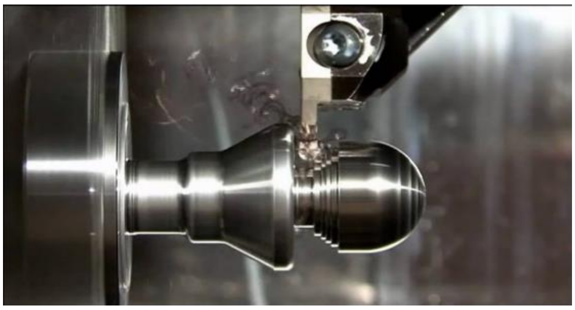


Figure 16: Spinning

3.10 Spring winding

Figure 17: Spring Winding

It is the process of making a coiled spring by passing the wire around a mandrel which is revolved on a chuck or between centers. A small hole is provided on a steel bar which is supported on a tool post and wire is allowed to pass through it. The diameter of mandrel should be less than the desire spring diameter as all spring expands in diameter after they are taken out of the mandrel.

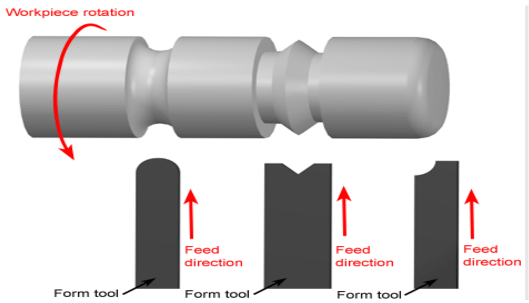
3.11 Forming

Forming is the process of turning a convex, concave or any irregular shape. Form turning may be accomplished by following three methods:

- Using a form tool
- Combing cross land longitudinal feed
- Tracing or copying a template

Usually two types of forming tools are used; straight and circular. Straight type is used for wider surface and circular type for narrower surfaces. The cross-feed ranges from 0.01 to 0.08 mm per revolution and the cutting speed is slightly less than that of the straight turning.

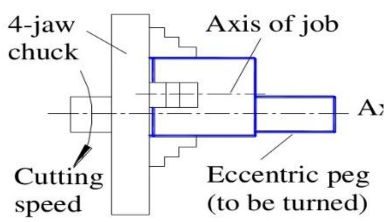
Figure 18: Forming



3.12 Eccentric turning

If a cylindrical workpiece has two separate axis of rotation one being out of center to the other center, the workpiece is termed eccentric and turning of different surface of workpiece ids known as eccentric turning. Crank shaft is the common example of eccentric turning. In eccentric turning counter balance weights are mounted on the faceplate to get uniform turning.

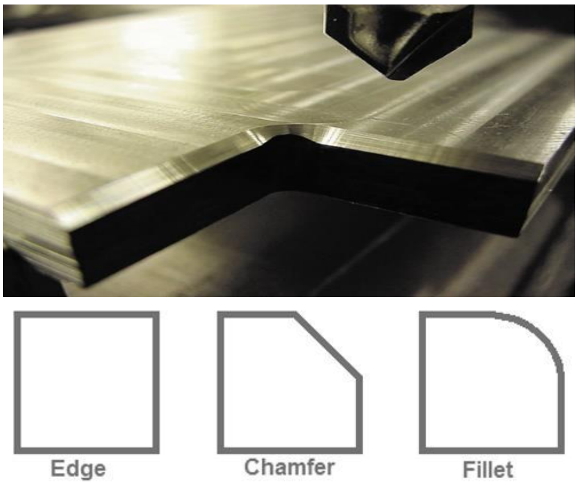
Figure 19: Eccentric Turning



3.13 Chamfering

Chamfering is the operation of beveling the extreme end of the workpiece. This is done to remove the burrs, to protect the end of workpiece from being damaged and to have better look. The operation may be carried out after knurling, rough turning, boring and drilling. Chamfering id essential operation after thread cutting so that nut may pass freely on the threaded workpiece.

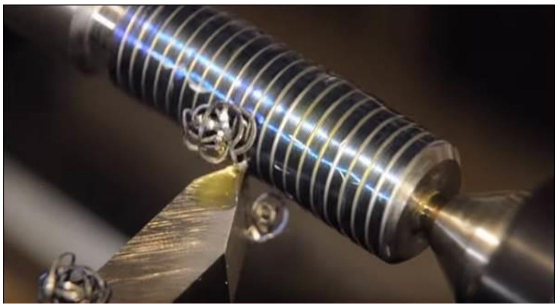
Figure 20: Chamfering



3.14 Thread cutting

It is most of the important operation performed in a lathe. The principle of the thread cutting is to produce a helical groove on a cylindrical or conical surface by feeding the tool longitudinally when the job is revolved between centers or by a chunk. The longitudinal feed should be equal to the pitch of thread to be cut per revolution. A chaser is a multipoint threading tool having the same form pitch of thread to be chased. A chaser is used to finish a partly cut thread to the size and shape required. Thread cutting is done at one third or one half of the speed of turning.

Figure 21: Thread Cutting



3.15 Drilling

It is the operation of the producing a cylindrical hole in a workpiece by rotating cutting edge of cuter is known as drill. It can be performed by a lathe any one of following methods.

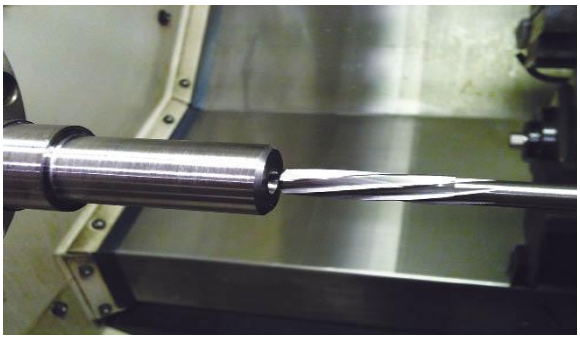
- The workpiece is revolved in a chuck or faceplate and drill is held in tailstock drill holder feeding is affected by feeding of tailstock center.
- The drill is held and revolved by drill chuck attached to the headstock spindle and workpiece is held and supported of tailstock spindle when workpiece is irregular in shape.

Figure 22: Drilling

3.16 Reaming

Reaming is the operation of finishing and sizing a hole which has been previously drilled or bored. The tool is called reamer, which has multiple cutting edge. Reamer is held on tailstock and is held stationary while work is revolved at very slow speed. Speed varies from 0.5 to 2 mm per revolution.

Figure 23: Reaming



3.17 Boring

It is the process of enlarging and turning a hole produced by drilling, punching, casting of forging. Boring cannot originate hole. Boring is similar to external turning operation can be performed in lathe by following methods:

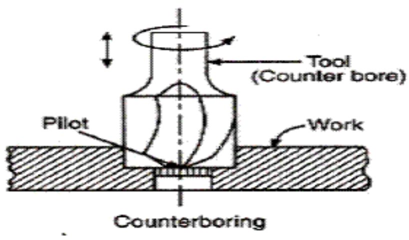
- The workpiece is revolved in a chuck and tool is fitted to the tool post is fed in to the workpiece. This method is suitable for boring small sized work.
- The workpiece is clamped on carriage and boring bar holding the tool is supported between centers and made to revolve. Longitudinal movement pf carriage provides a feeding movement and depth of cut is given by adjusting of tool insert.

Figure 24: Boring

3.18 Counter boring

It is the operation of enlarging a hole through a certain distance from one end instead of enlarging the whole drilled surface. It is similar to a shoulder work in external turning. The operation is similar to boring and a plain boring tool or a counter bore may be used.

Figure 25: Counter Boring



19. Taper boring

The principle of turning taper hole is similar to the external taper turning operation and is accomplished by rotating the workpiece on chuck and feeding the tool at an angle to the axis of rotation of the workpiece. Taper boring can be performed by following methods:

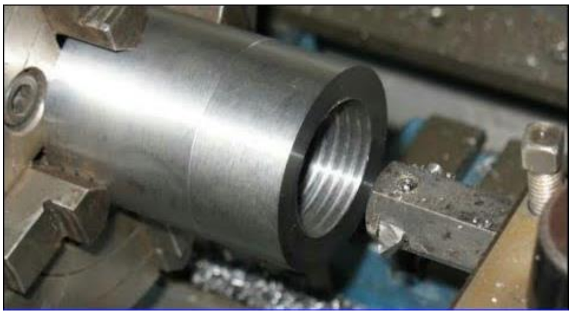
- A boring tool is mounted on tool post and swivelling the compound rest to desire angle; a short taper hole may be machined.
- Taper turning attachment may be used to guide the boring tool at an angle to the axis by disengaging the cross slide.
- Standard small tapers may be bored by using taper reamers on tailstock.

Figure 26: Taper Turning

3.20 Internal thread cutting

The principle of cutting internal thread is similar to that an external thread, the only difference being in tool used. The tool is similar to a boring tool with cutting edge ground to shape conforming to the type of thread to be cut. The hole is to be bored to the root diameter of the thread.

Figure 27: Internal Thread Cutting



3.21 Tapping

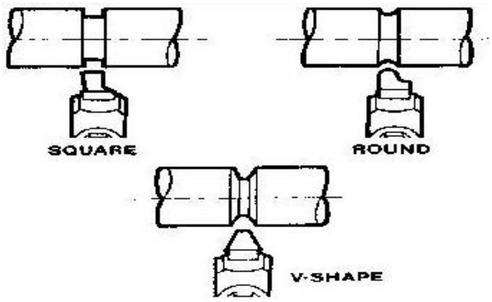
Figure 28: Tapping

Tapping is the operation of cutting internal threads of small diameter using a multiple cutting tool called the tap. In a lathe, workpiece is mounted on chuck and revolved at very low speed. A tap of required size held on fixture and it will automatically feed into the work with the help of special fixture.

3.22 Undercutting

Undercutting is similar to grooving operation when performed inside the hole. It is process of boring a groove at a distance from end of a hole this is similar to boring operation. Undercutting is done at the end of internal thread to provide clearance for tool.

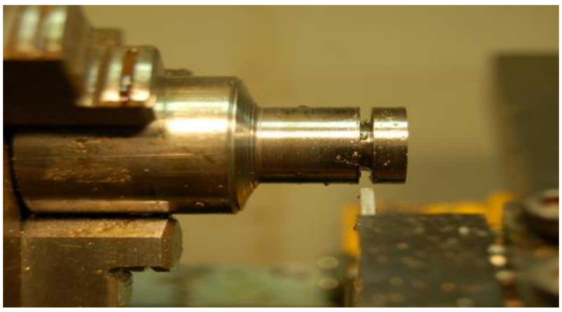
Figure 29: Undercutting



3.23 Parting off

Parting off is the operation of cutting a workpiece after it has been machined to the desired shape and size. The process involves rotating the workpiece on a chuck at half speed that of turning and feeding by narrow paring off tool perpendicular to the lathe axis. The feed varies from 0.07 to 0.15 mm per revolution and depth of cut which is equal to width of tool range from 3 to 10 mm.

Figure 30: Parting off



3.24 Milling

Milling is the operation of removing metal by feeding the workpiece against the rotating cutter having multiple cutting edges. It is performed in a lathe by any one of the following methods:

- For cutting Keyways or grooves, the workpiece is supported on the cross slide by a special attachment and fed against a rotating milling cutter held by a chuck. The depth of cut is given by vertical adjustment of the workpiece provided by the attachment.
- The workpiece may be supported between centres and held stationary. The attachment mounted on the carriage drives the cutter from an individual motor. The feeding movement is provided by the carriage and the vertical movement of the cutter is arranged in attachment. The number of grooves on the periphery of the workpiece may be cut by rotating the work by a fixed amount and machining it against the cutter. The gear wheel may be cut on a lathe by fixing universal diving head at the rear end of the headstock spindle. This permit dividing the periphery of the work by an equal amount.

3.25 Grinding

It is the operation of removing metal in the form of minute chips by feeding the work against a rotating abrasive wheel known as the grinding wheel. Both internal and external surfaces of the workpiece may be ground by using a special attachment mounted on cross side.

Figure 31: Milling

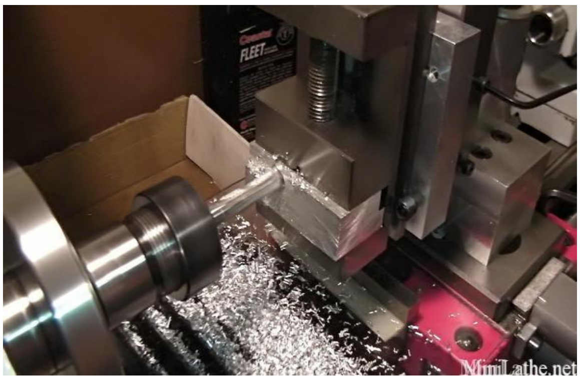
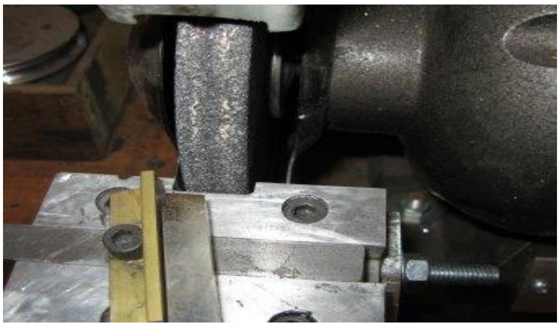


Figure 32: Grinding



4.0 Conclusions

A lathe machine is most important machine tool in metal industries. There are various types of lathe machine available but now a days NC, CNC and VMC machines are used for automation in metal cutting. Different lathes having different specifications and more convenient with its principle work. A lathe machine is designed in which work piece is rotating and cutting tool is stationary and can carry out many operations just by changing the tool. All the operations which discussed in this research pater are necessary for every raw metal and these operations are useful to make material more attractive, to give proper size and shape, to make more convenient and to protect from damage.

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