Fits

When two parts are to be assembled the relation resulting from the difference between their sizes before assembly is called a fit. The fit signifies the range of tightness or looseness which may result from the application of a specific combination of allowances and tolerances in the design of mating parts.

1.2.1 Types of Fits

The three types of fits are shown in Fig. 1.1 The disposition of tolerance zones for the three classes of fit are shown in Fig. 1.2.

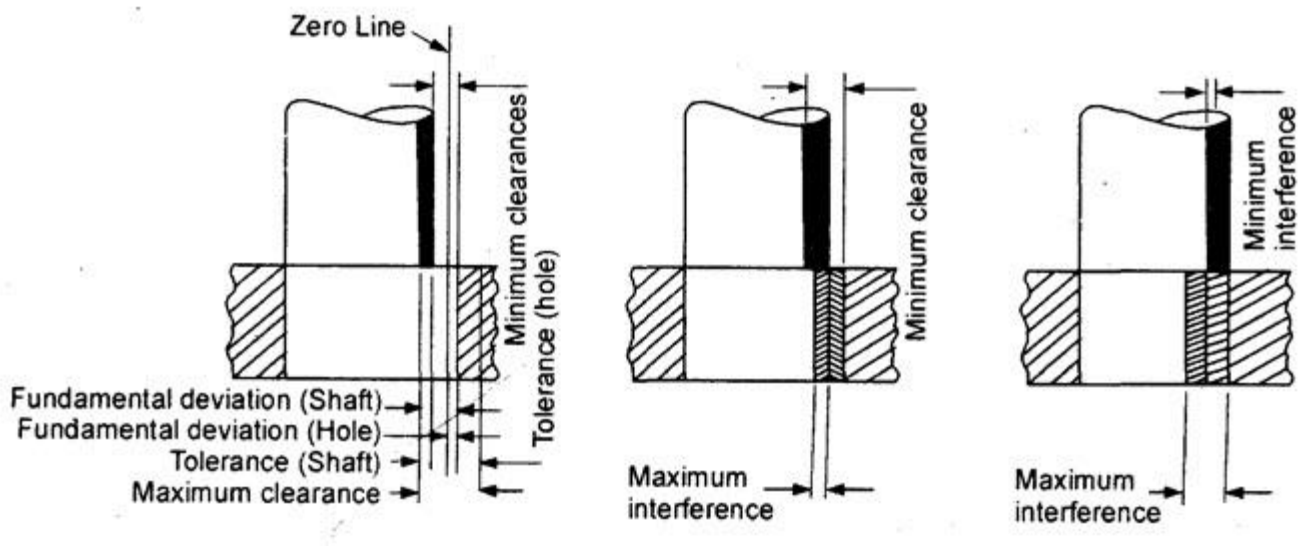


Fig. 1.1 Types of fits

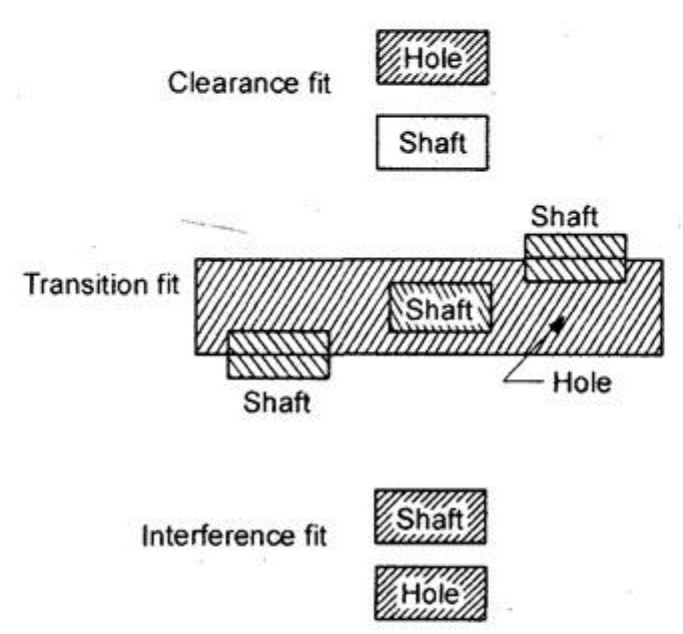


Fig. 1.2 Disposition of tolerance zones for the three classes of fit

There are three general types of fit between the mating parts

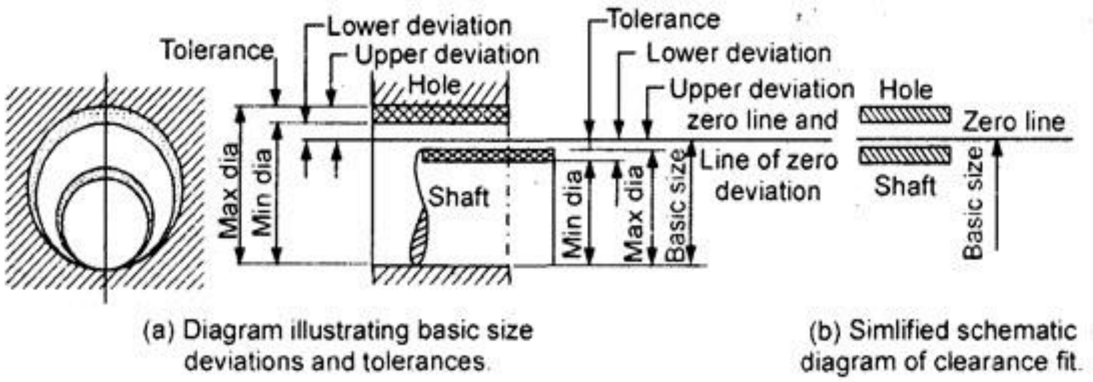
1. Clearance fit: A clearance fit is one having limits of size so prescribed that a clearance always results when mating parts are assembled.

2. Interference fit: An interference fit is one having limits of size so prescribed that an interference always results when mating parts are assembled.

3. Transition fit: A transition fit is one having limits of size so prescribed that either a clearance or interference may always result when mating parts are assembled.

1.3 Terminology

The terminology used in fits and tolerances is shown in Fig. 1.3. The important terms are



1.3 Terminology for fits and tolerances

Basic size: It is the exact theoretical size arrived at by design. It is also called nominal size.

Actual size: The size of a part as may be found by measurement.

Maximum limit of size: The greater of the two limits of size.

Minimum limit of size: The smaller of the two limits of size.

Allowance: It is an intentional difference between maximum material limits of mating parts. It is a minimum clearance or maximum interference between mating parts.

Deviation: The algebraic difference between a size (actual, maximum, etc.) and the corresponding basic size.

Actual deviation: The algebraic difference between the actual size and the corresponding basic size.

Upper deviation: The algebraic difference between the maximum limit of size and the corresponding basic size.

Upper deviation of hole = ES (& art Superior)

Upper deviation of shaft es

Lower deviation: The algebraic difference between the minimum limit of size and the corresponding basic size.

Lower deviation of hole = El (Ecart Inferior)

Lower deviation of shaft = ei

Upper deviation Lower deviation + Tolerance

Zero line: It is the line of zero deviation and represents the basic size.

Tolerance zone: It is the zone bounded by the two limits of size of the parts and defined by its magnitude, i.e. tolerance and by its position in relation to the zero line.

Fundamental deviation: That one of the two deviations which is conveniently chosen to define the position of the tolerance zone in relation to zero line, as shown in fig. 1.4.

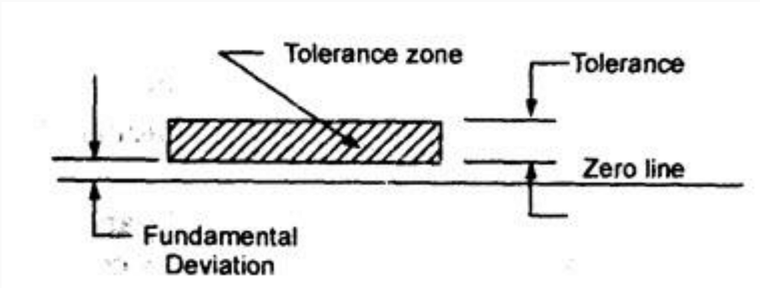


Fig. 1.4 Disposition of fundamental deviation and tolerance zone with respect to the zero line

Basic shaft: A shaft whose upper deviation is zero.

Basic hole: A hole whose, lower deviation of zero.

Clearance: It is the positive difference between the hole size and the shaft size.

Maximum clearance: The positive difference between the maximum size of a hole and the minimum size of a shaft.

Minimum clearance: The positive difference between the minimum size of a hole and the maximum size of a shaft.

1.4 Standard Tolerances

There are 18 standard grades of tolerances as specified by BIS with designations ITOI, ITO and IT to IT 16.

Standard tolerance unit, $i = 0.45\, D^{1/3} + 0.001\, D$

Where i = standard tolerance unit in microns

D = diameter in mm

The standard tolerances for the various grades are given in Table 1.1 and tolerance grades for various manufacturing processes in Table 1.2

Table 1.1 Standard tolerances.

Grade	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16
Value	7i	10i	16i	25i	40i	64i	100i	106i	200i	400i	640i	1000i

Table 1.2 Tolerance grade in various manufacturing processes.

Tolerance grade	Manufacturing process that can produce
16	Sand casting : flame cutting
15	Stamping
14	Die casting or moulding ; rubber moulding
13	Press work, tube rolling
12	Light press work ; tube drawing
11	Drilling, rough turning, boring, precision tube drawing
10	Milling, slotting, planing, metal rolling, or extrusion.
9	Worn capstan or automatic ; horizontal or vertical boring
8	Centre lathe turning and boring, reaming, capstan or automatic in good condition.
7	High quality turning, broaching, honing
6	Grinding or fine honing
5	Machine lapping, diamond or fine boring, fine grinding.

1.5 Hole Basis and Shaft Basis for Fits

1. Hole basis system: In this system, the different clearances and interferences are obtained in associating various shafts with a single hole, whose lower deviation is zero.

2. Shaft basis system: In this system, the different clearances and interferences are obtained in associating various holes with a single shaft, whose upper deviation is zero.

1.6 Selection of Fits

Hole basis system is the most commonly used system because due to the fixed character of hole production tools, it is difficult to produce holes with odd sizes. Commonly used types of fits are given in Table 1.3. Shafts 'a' to 'h' produce clearance fit, 'j' to 'n' transition fit, and 'p' onwards interference fit with hole.

Table 1.3 commonly used fits

Type of fit	Class of shaft	With holes			Remarks
		H6	H7	H8	
Clearance	d		d8	d8	Loose running fit used for plummer block bearings, loose pullyes, etc.
	e	e7	e8	e8–e9	Easy running fit used for properly lubricated bearings. Finer grades are used for heavily loaded bearings of turbogenerators, electric motors, etc.
	f	f6	f7	f8	Normal running fit used for normal grease or oil lubricated bearings where temperature changes are not too much. This fit may be used for bearings of small electric motors, pumps, or bearings of gear box shaft, etc.
	g	g5	g6	g7	It is close running fit or sliding fit or spigot and location fit.
	h	h5	h6	h7–h8	It is precision sliding fit or fine spigot or location fit.
Transition	j	j5	j6	j7	It is very accurate location fit giving easy assembly and dismentling. It is used in case like coupling spigots and recesses.
	k	k5	k6	k7	It is light keying fit.
	m	m5	m6	m7	It is medium kelvin fit.
	n	n5	n6	n7	It is heavy keying fit for tight assembly of mating surfaces.
Interference	p	p5	p6		It is light press fit with easy dismantling for non-ferrous parts and is standard fit with easy dismantling for assembly of ferrous and non-ferrous parts.
	r	r5	r6		It is light drive fit or non-ferrous parts and medium drive fit for ferrous parts assembly.
	s	s5	s6	s7	It is heavy drive fit for ferrous parts giving permanent or semi-permanent assembly but it is standard press fit for non-ferrous parts. It is used for pressing collars on to shafts, valve seatings etc.
	t	t5	t6	t7	It is force fit on ferrous parts for permanent assembly.

1.7 Dimensioning of Tolerances -Rules

1. The upper deviation should be written above the lower deviation value irrespective of whether it is a shaft or a hole (Fig. 1.5 (a)).

2. Both deviations are expressed to the same number of decimal places, except in the cases where the deviation in one direction is nil (Fig. 1.5 (b)).

3. Tolerances should be applied either to individual dimensions or by a general note, assigning uniform or graded tolerances (Fig. 1.5 (c)).

4. The use of general tolerance not greatly simplifies the drawing and saves much labour in its preparation. On the drawing, the limits on a dimension can be specified in two ways, i.e. (i) unilateral, and (n) bilateral. In unilateral tolerance system, the variation in size is permitted in one direction

1.8 Limit Gauges

Two sets of limit gauges are necessary for checking the size of various parts. There are two gauges: Go limit gauge, and Not Go limit gauge.

1. Go Limit: The Go limit applied to that of the two limits of size corresponds to the maximum material condition, i.e. (1) an upper limit of a shaft, and (ii) the lower limit of a hole. This is checked by the Go gauge.

2. Not Go Limit: The Not Go limit applied to that of the two limits of size corresponds to the minimum material condition, i.e. (1) lower limit of a shaft, and (ii) the upper limit of a hole. This is checked by the Not Go gauge.

1.9 Machining Symbols

During the manufacture of a machine, some surfaces of a component are to be machined, which are required to be indicated in the drawing. This will enable the pattern maker to provide machining allowance on that surface. Similarly, the grade of surface finish is required to be indicated on the surface to enable the machinist to carry out the job accordingly. Thus, on production drawings it is necessary to indicate the surfaces to be machined or finished by certain specific symbols. The machining symbol is indicated to the left of the system as shown in Fig. 1.6. The value of allowance is expressed in mm.

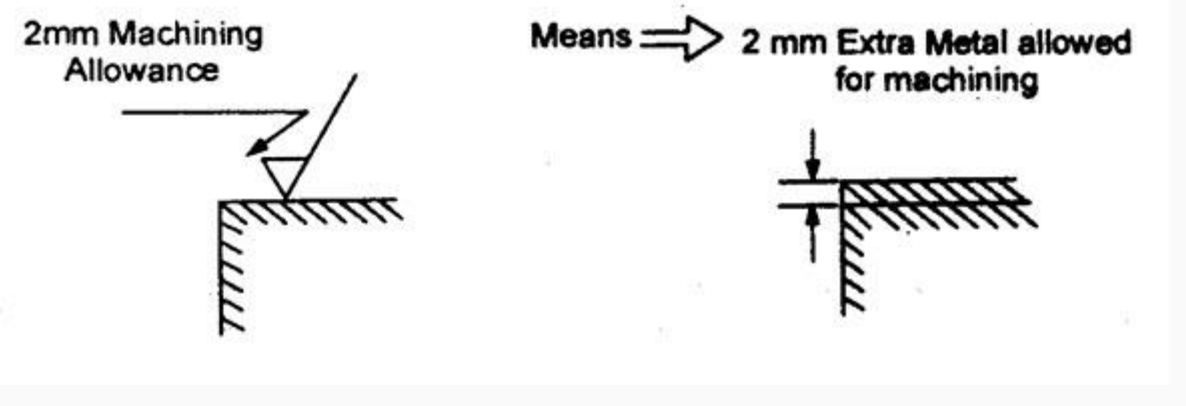


Fig. 1.6 Indication of machining allowances

The basic symbol used for indication of surface roughness consists of two legs of unequal length inclined at 600 to the line representing the surface under consideration, as shown in fig. 1.7. It may only be used alone when the meaning is expressed by a note.

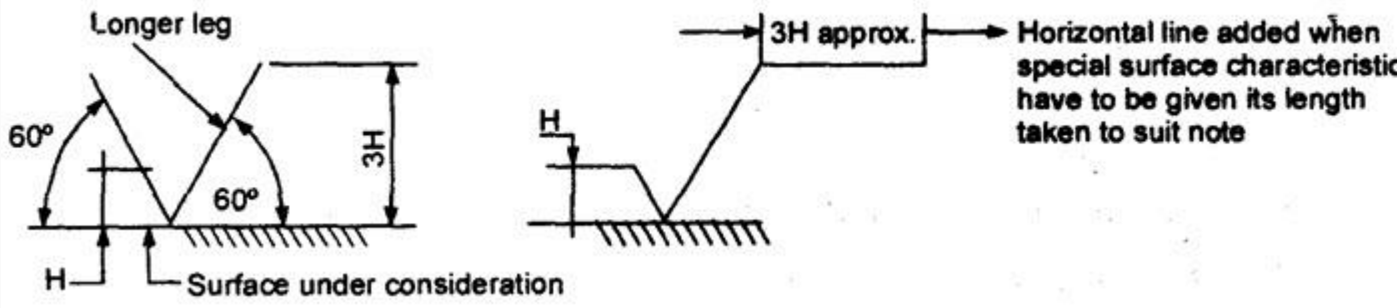


Fig. 1.7 Basic symbol for indication of surface roughness

The following guidelines may be used while specifying the machining symbols:

1. When the surface is produced by any method, it is indicated as shown in Fig. 1.8 (a).

2. When the removal of material by machining is required, a bar is added to the basic symbol, as shown in Fig. 1.8 (b).

3. Whenever the removal of material is not permitted In a circle is added to the basic symbol, as shown n Fig. 1.8 (c).

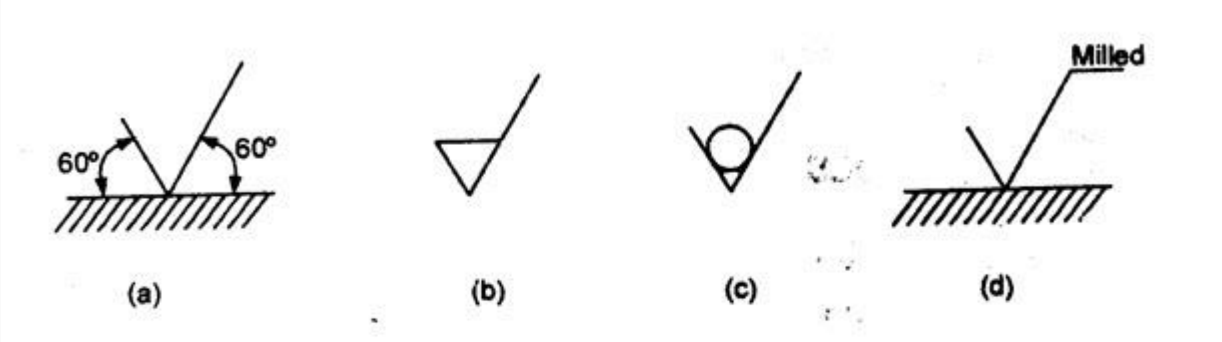


Fig. 5.8 Symbols used for indication of surface roughness

4. When some special surface characteristics are to be indicated (say a milled surface), a line added to the longer leg of the basic symbol, as shown in Fig. 1.8.

1.9.1 Indication of Surface Roughness

The roughness values Ra (urn) are given in Table 1.4

Table 1.4 Surface roughness values, Ra (a m)

Roughness value, R_a	50	25	12.5	6.3	3.2	1.6	0.8	0.4	0.2	0.10	0.050	0.025
Roughness grade symbols	N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1

The value defining the roughness value Ra in micron and roughness grade symbols are given on production drawings as shown in Fig. 1.9.

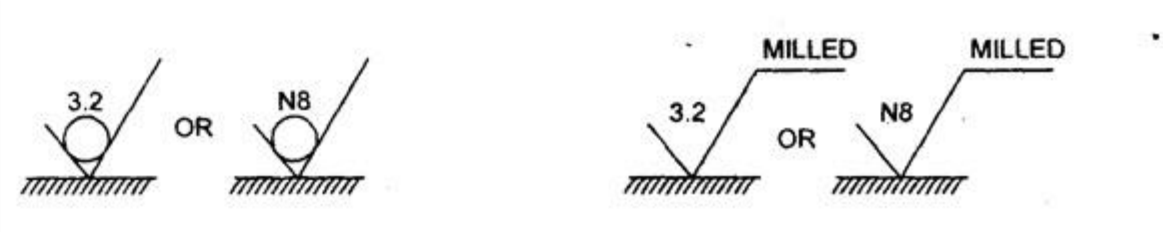


Fig. 1.9 Indication of surface roughness in micrometers or roughness grade symbols

When it is necessary to specify the maximum and minimum limits of the surface roughness, both the values or grades should be given as shown in Fig. .10.

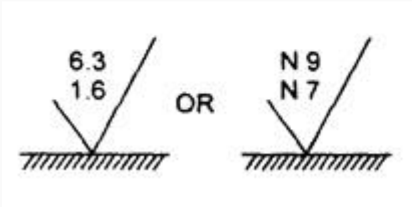


Fig. 1.10 Invocation of the maximum and minimum limits of surface roughness.

2. If it is necessary to indicate the sampling length, it is shown adjacent to the symbol (Fig. 1.11 (a))

3. If it is necessary to control direction of lay or the direction of the predominant surface patterns, it is indicated by a corresponding symbol added to the surface roughness symbol (Fig. 1.11 (b))

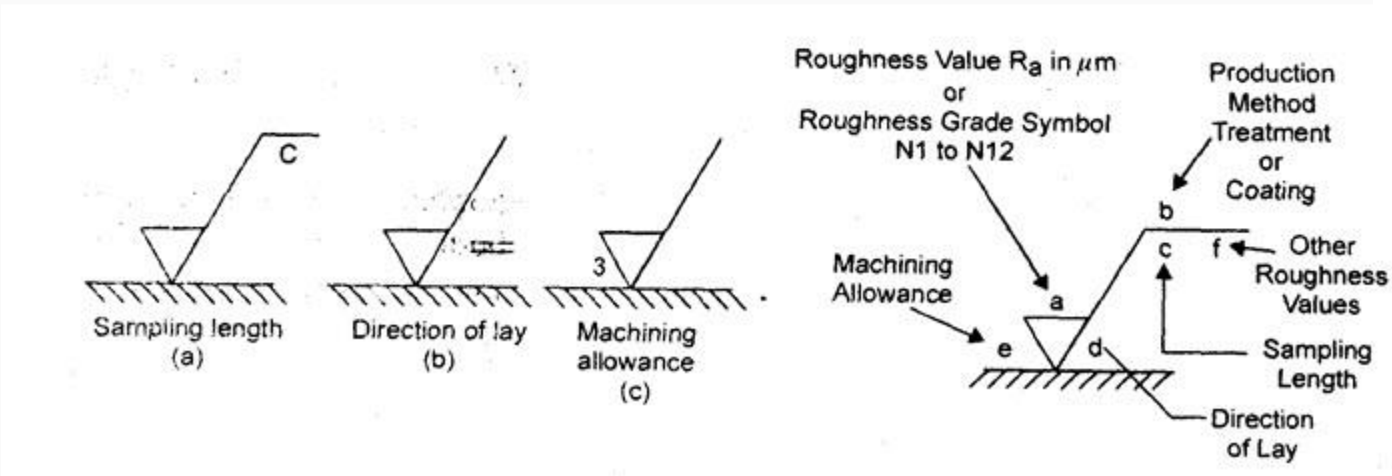


Fig. 1.11

4. Whenever, it necessary to specify the value of machining allowance, it is indicated in the left of the symbol (Fig. 1.11 (c)). This value is generally expressed in millimetres.

Thus, combining the above points, we can establish that the specification of surface

Roughness should be placed relative to the symbol as shown in Fig. 1.11 (d)

Where, a = Roughness value Ra in micrometers or Roughness grade symbol NI to N12

b = Production method, treatment or coating to be used

c = Sampling length

d = Direction of lay

e = Manufacturing allowance -

f = Other roughness value in bracket

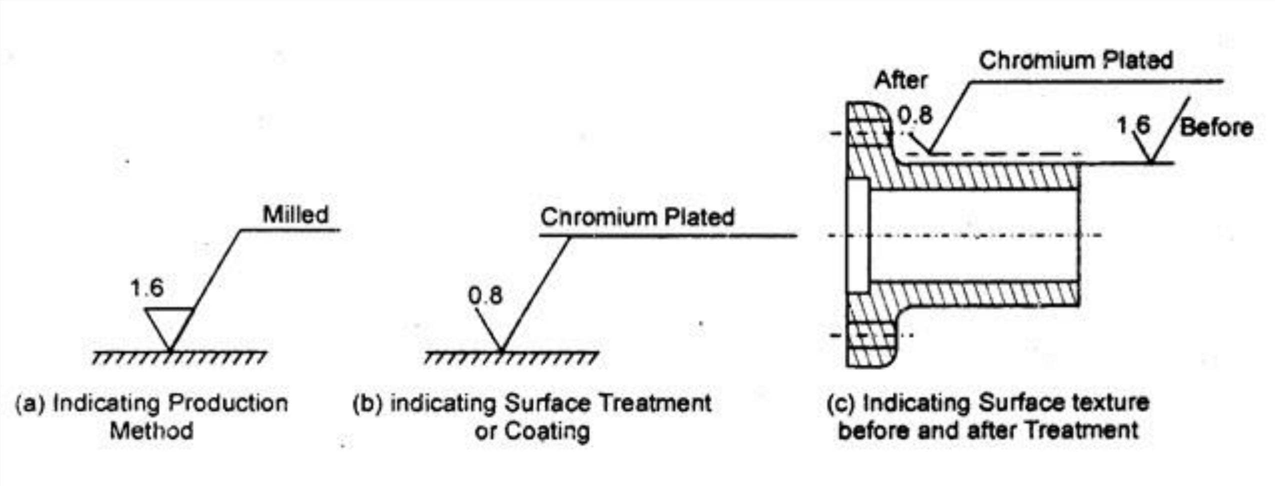


Fig. 1.12 Use of notes with surface texture symbol

5. If it is necessary to define surface roughness both before and after treatment should be explained in a suitable note or in accordance with Fig. 1.12.

Gauges are instruments that measure pressure, dimensions, levels, etc. They can be mechanical or electro-mechanical devices and offer displays ranging from direct-reading rules to digital LCDs. Gages which measure pressure are classified as analog or digital depending on their readouts. Dimensional gauges are classified by what they measure, be it bore diameter, depth, or height, and are specific to machining processes. Level gauges measure the level of fluid in tanks and pressure vessels. Other gauges are used in very specific measuring applications from spark plug gaps to screw threads.

Types of Gages

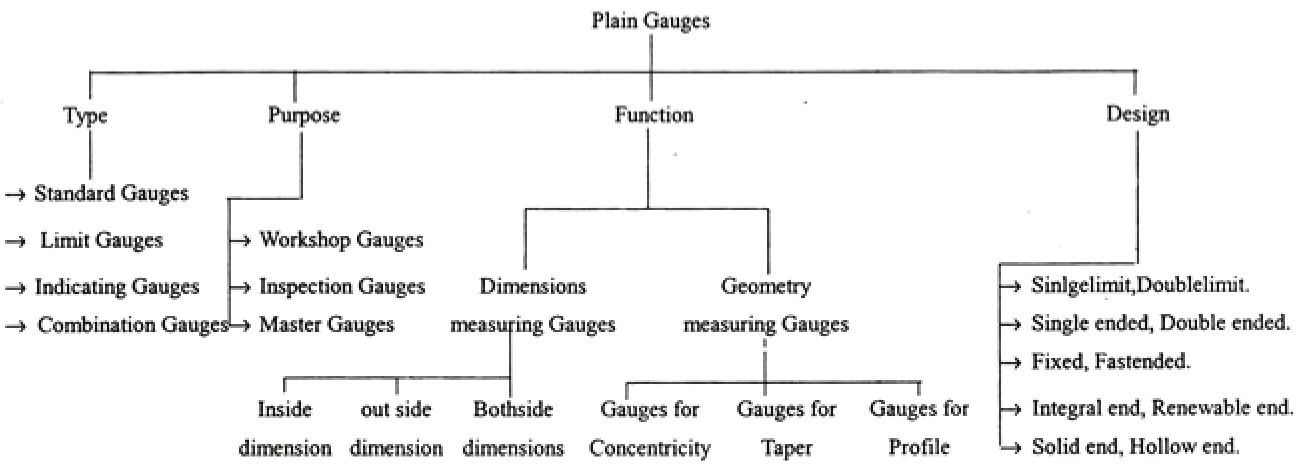


Chart 1 : Classification of Gauges.

. According to the Type:

According to the type and principle of manufacturing the gauges may be classified as:

(a) Standard gauges,

(b) Limit gauges,

(c) Indicating gauges, and

(d) Combination gauges.

(a) Standard Gauges:

If the Go gauge is an exact model of the mating member whose dimensions to be checked, then such a gauge is termed as the standard gauge.

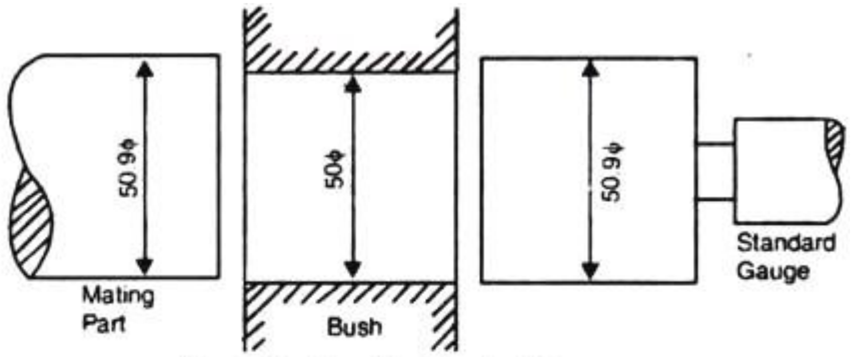


Fig 1.39. Use of a Standard Gauge.

For Example: If a bushing is manufactured to mate or assemble with shaft, then shaft is mating part. The busing is checked by a Go-gauge is a copy of the mating part, that is the shaft. The use of standard gauge is shown in Figure 1.39.

Standard gauge is only an ideal concept. It is not possible to use standard gauge because there is always some tolerance provided on the work component, and this tolerance does not takes into account of standard gauge.

(b) Limit Gauges:

Limit gauges are widely used in industries. As there are two limits of a component (high and low), two gauges are required to check each dimension of the component.

One gauge is called a “Go-Gauge” should pass through or over the part, while the other gauge called a “Not-Go-Gauge” should not pass through or over the part.

Two limit Gauges are shown in figure 1.40. A little consideration will show that (i) Gauges and component to be checked should be at same temperature and (ii) Gauges should pass through or over the component under their own weight with no noticeable pressure.

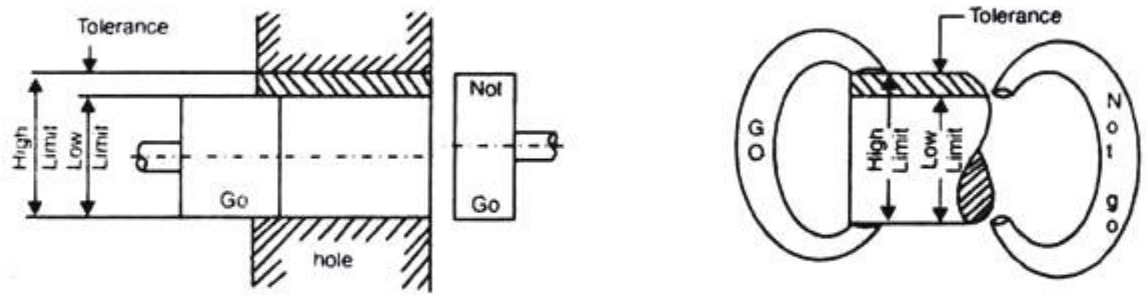


Fig. 1.40. Limit Gauge.

(c) Indicating Gauges:

Indicating gauges are complex in design and construction as compared to the other types of gauges. They are used to indicate the value of dimensions on a visual display system.

Dial gauge is a popular example of indicating gauges. Like dial gauge, all the indicating gauges incorporate some magnification system. For dimension control of a component, the pointer must lies between two prefixed points.

(d) Combination Gauges:

These are special designed gauges to measure or check more than one dimensions of a component in a given setup.

2. According to the Purpose:

According to the purpose, the gauges may be classified as:

(a) Workshop Gauges,

(b) Inspection Gauges, and

(c) Master Gauges (Reference Gauges).

(a) Workshop Gauges:

Workshop gauges are used by the machine operator to check the dimensions of the components as they are being produced. These gauges are designed to keep the size of the component near the centre line of the tolerance.

(b) Inspection Gauges:

Inspection gauges are used by the inspectors for the final acceptance of manufactured components when finished. These gauges have slightly larger tolerance than the workshop gauges so as to accept component slightly nearer the tolerance limit than the workshop gauges.

(c) Master Gauges:

Master gauges are also referred as reference gauges. These are used only for checking of other gauges. Due to expenditure involved, master gauges are seldom used and gauges are checked by conventional measuring instruments like, comparators, slip gauges, optimizers etc.

3. According to the Function:

According to the function, the gauges may be classified as:

(i) Dimension Measuring Gauges.

(ii) Geometry Measuring Gauges.

Dimension Measuring Gauges again may be classified as:

(a) Inside Dimension Measuring Gauges.

(b) Outside Dimension Measuring Gauges,

(c) Both side Dimension Measuring Gauges.

Analog Pressure

Analog Pressure Gages are mechanical instruments which measure the force that a contained liquid or gas exerts on a unit area. An analog gauge often relies on a coiled tube attached to a pointer to directly display pressure against a dial face. In rarer cases—an auto dashboard is one—the dial may display the analog signal of the pressure measured through a pressure transducer. Key specifications include maximum/minimum measurable pressure, dial size, connection location, connection size, and accuracy grade. Analog pressure gauges provide inexpensive measuring of pressure directly in pipelines and gas vessels. They can operate without electrical power and provide immediate and continuous readings. Most cannot be interrogated by a process controller. Manometers and vacuum gauges are also covered under pressure gauges.

Digital Pressure

Digital Pressure Gages are electro-mechanical instruments which measure the force that a contained liquid or gas exerts on a unit area. A digital pressure gauge displays pressure reading numerically usually with an LCD readout. Pressure sensing can be electronic or mechanical. Key specifications include maximum/minimum measurable pressure, signal output, connection location, connection size, and accuracy. Digital pressure gauges need power to operate which can be by battery or from an external source. They can be fitted with outputs for remote interrogation of permanent units or can also be used for portable pressure measuring.

Level

Level gauges are visual instruments used to determine the presence and height of liquid in tanks such as boilers. A level gauge commonly uses a transparent sight tube mounted to the tank sidewall which parallels the height of the fluid contained within the tank. Other methods of detecting the liquid level exist as well. Key specifications include pressure rating and media type, along with considerations for body material and features. Level gauges are often fitted with shut-off and drain valves for maintenance.

Bore

Bore gauges are electro-mechanical or mechanical metrology instruments that measure the internal diameters of machined holes. They are available with analog or digital displays. Key specifications include bore gauge type, measurement range, maximum measuring depth, graduation, as well as a host of possible features. Bore gauges are often supplied with multiple adapters to cover the measuring range.

Depth

Depth gauges are electro-mechanical or mechanical metrology instruments that measure the inside lengths of holes and other machined cavities. A depth gauge generally consists of an anvil, an indicating dial, and a probe assembly. Direct reading rules and digital readouts are available as well. Key specifications include depth gauge type, measurement range, graduation, dial reading, along with a host of possible features. Depth gauges vary in their readouts from simple direct reading tic marks to digitally displayed numerals, with corresponding accuracy. Other depth gauges are used for measuring the tread depths of tires.

Height

Height gauges are electro-mechanical or mechanical metrology instruments that measure the dimension of machined parts from a datum reference--a surface plate, for example. A height gauge generally consists of a rigid column mounted to flat base with a measuring head that displays height from the bottom of the base on a dial, vernier, or digital display. Key specifications include height gauge type, measurement range, and resolution. Height gauges are used in machining operations for inspecting finished parts.

Plug

Plug gauges are simple mechanical inspection instruments used to verify compliance of threaded or plain holes to upper and lower dimensional limits. Plug gauges are designed to “fit” or “not fit” (e.g. Go/No-Go gauge) into holes, etc. Key specifications of limit gauges include the gauge type, gauge function and measurement range. Plug gauges are primarily used as a quick pass/fail test to determine if a hole diameter or thread feature lies within the specified range of acceptance.

Ring

Ring gauges are simple mechanical inspection instruments used to verify product feature compliance to upper and lower dimensional limits. Ring gauges are designed to “fit” or “not fit” (e.g. Go/No-Go gauge) over cylindrical features. Key specifications for ring gauges include the gauge function and measurement range. Ring gauges are used as a quick pass/fail test to determine if the outside diameter or thread feature of a part lies within the specified range of acceptance.

Snap

Snap gauges are simple mechanical inspection instruments used to verify that the outside dimensions of parts are within their specified tolerances. Key specifications include features, range, and accuracy. Snap gauges can be either fixed or adjustable devices. Fixed snap gauges are manufactured to set measurements whereas adjustable snap gauges can be set to measure over ranges of measurements.

Force

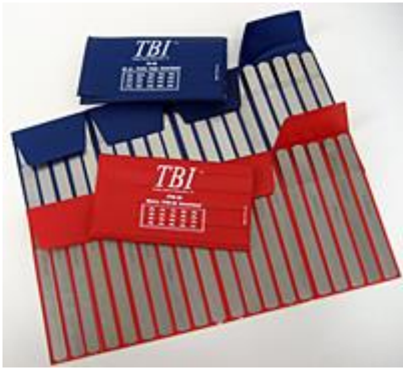
Force and Load Gages are mechanical or electronic metrology instruments that measure the pounds or kilograms applied to objects during compression and/or tension testing, to measure, for example, the force required to shut and latch a door. They can measure forces from very small to very large and can be purchased to fit a variety of ranges. Mechanical force meters can be bought to

display either in pounds or in kilograms while electronic versions can be switched between units.

Groove/ID-OD

Groove Gages are mechanical metrology instruments used in inspection applications to confirm dimensions of machined internal features such as ring grooves, undercuts, inside diameters, etc. They are generally configured to fit through the confines of narrow bores and then be opened to take the measure of any internal features. Some are used to measure concentricity.

Feeler



Feeler gauges are simple strips of dimensionally accurate shim stock used for measuring the gaps between machine elements. Setting automotive contact points and valve lash are two old-school examples of their use. In some instances they are used as precision assembly shims to adjust the clearances between mating parts. They are often sold as sets that increase in thickness by some interval such as 0.001 in. Spark plug gauges are included in this group.

Profile

Profile gauge are metrology instruments used to identify thread pitch sizes or to determine the flatness of surfaces. Thread profile gauges are usually sold as sets that cover a range of thread sizes. Profile gauges used to measure surface roughness often display peak readings along with total-indicated-runout, or TIR, measurements. Profile gauges are also used as templates for duplicating contours in woodworking, and are sometimes called contour gauges. Angular measuring gauges, fillet gauges, taper gauges, etc. are some of the other gauges included here as well.

Thickness

Thickness gauges are mechanical or electro-mechanical metrology instruments used for measuring wall thickness, paint thickness, etc. Some can be set up to measure absolute thickness or relative thickness. They usually employ a pair of caliper-like jaws that lightly contact the top and bottom of the surfaces being measured.

Applications and Industries

Although the term gauges encompasses a wide variety of measuring instruments, they can generally be grouped by what they measure. Thus a convenient way to find a particular kind of gauge is to select from the list of sub-categories by measurement type. Or, if an application is not listed there specifically, check under intended applications for additional choices.

Gages generally are direct reading instruments as opposed to sensors, transducers, etc. which tend to rely on electronics to make their measurements and are often integrated into a larger measuring systems. Thus pressure gauges, be they analog or digital, make direct readings and provide data at the instruments themselves. The same applies to level gauges and to the many various gauges used for machined parts metrology. Some gauges allow porting to external devices for data acquisition/documentation purposes, but this is not a requirement. Some gauges provide no reading at all, especially those referred to as fixed limit gauges, which are used to evaluate tolerancing on parts and provide simple yes or no answers to the question of whether or not a particular part falls within its design parameters. Other gauges such as feeler gauges also rely on this same simple tactile feedback.

Analog pressure gauges are selected over digital versions when cost is a concern or where accuracy isn't critical. Another advantage of analog gauges is that they need no power supply which for digital gauges usually means batteries. An advantage of many digital gauges is their ability to feed outputs to data acquisition systems.

Liquid level gauges are generally direct reading and sized according to the depth of the tank they monitor.

Analog and digital versions are generally available for the many metrology gauges such as depth, bore, etc. Again the ability to port measurements form the instrument makes digital gauges helpful for quality control documenting.

Limit gauges, profile gauges, etc. are generally single or dual measurement devices and so lack displays of any kind, making them one of the simplest forms of metrology gauges. They are designed to be used for quick verification that a part is made within tolerance.

Comparison Chart

	Vernier Caliper	**Micrometer**
Structure	Vernier caliper is a gun-like instrument.	Micrometer is an axe-like instrument.
Least Count	0.1 mm	0.01 mm.
Specific Functions	Vernier caliper with special type of jaws can take both, internal and external measurements accurately.	Screw gauge is used for taking external measurements as it lacks the appropriat structure for taking the inner measureme of the object.

What is Vernier Caliper?

Vernier Caliper is an measuring instrument, which consists of main scale and vernier scale, it has a least count of 0.1 mm. It has a gun-like structure and is used to measure the internal and external dimensions of objects extremely accurately. It is mostly preferred over other measuring instruments as it has special kind of jaws designed that can hold the object inward or outward and cane take the exact measurement of the object. Before taking the measurement with vernier caliper, the vernier scale zero and main scale zero should be exactly in front of each other. If the zeros of both the scales are not placed appropriately before the reading it may lead to the zero error in the measurement. Zero error can be of two types, positive zero error and negative zero error, if the vernier scale is to the left of the main scale than it is negative zero error and when the vernier sale is on the right side of the main scale than it is the positive zero error. The zero error can be eliminated by adding or subtracting the differences from actual measurement.

What is Micrometer?

The micrometer known as micrometer screw gauge is an instrument that is generally used for measuring the external measurement or diameter of an object. It is an axe-like device that have the least count 0.01 mm. As the word screw gauge hints about its mechanism, the object to be measured is placed it between the spindle and anvil and then the measurement is being taken. It is sometimes preferred over vernier caliper as it can take the minimum measurement of 0.01 mm, whereas vernier caliper can measure as least as 0.1 mm. Although, the most common types of micrometer screw gauge lacks the appropriate structure for taking the inner measurements of the object.

Metal cutting, shearing and bending

Hand Tools for Cutting Metal Manually
For smaller cutting jobs, hand tools, including hand shears and hacksaws may be used for cutting metal into the desired shape. This cutting method is best suited for projects using more pliable metals, such as thinner-gauge aluminum. Using hand tools to cut metal is not recommended if the metal must be cut into extremely small pieces because the force needed to cut the metal may simply break it, instead of cutting it as intended.

Chisels can also be used to remove excess metal and to make a shape more precise. Depending upon the job, you may opt to use a cold chisel, with a sharpened edge or a hot chisel, which is heated before being hammered through metal.

Using Machinery to Cut Metal
For larger projects or those that use thicker or more robust metals, manual cutting is not always practical. There are numerous machine-based cutting methods to choose from, based on your metal cutting needs.

- **Grinder** – For projects that require the finished part to be extremely smooth, a grinding machine may be your tool of choice. Using a rotating blade or wheel made of an abrasive material; a grinder uses friction to wear down the surface of the metal until it is smooth, similar to sanding wood.
- **Lathe** – Using a sharpened cutting tool against a rapidly spinning piece of material, a lathe will cut a piece of metal to its desired shape. This machine is very common in the machining industry because it allows for a higher degree of precision.
- **Punch** – This machine uses an extreme amount of pressure to force sharpened blades into or through metal to cut it into the shape desired. The amount of pressure generated by a machine punch is far greater than any human worker could produce, thus this cutting method is suitable for metals that are more robust. Some machine punches are capable of up to 1,000 hits per minute, making this cutting method very productive.
- **Water jet** – Using water or water mixed with an abrasive compound, this machine directs an intense and concentrated stream into metal and cuts it. This method is best suited for metals that may be sensitive to extreme heat or temperature changes because it does not use heat in the process.
- **Flame and plasma** – This process is similar to a water jet, but instead a flammable gas is pumped through a torch to create an intense hot flame. The flame then cuts the metal by

burning and melting it. Flame torches, such as oxyacetylene torches are very efficient for cutting. Plasma cutters are known for their high degree of precision because they burn much hotter.

Greater Precision in a New Method of Metal Cutting

Laser cutting is one of the newest and most exciting methods in cutting technology. These cutters apply an intense beam of light to the metal, heating it past its melting point, and then cut through the metal. A laser cutter is able to concentrate light onto a very small area, which makes this method suitable for projects that require a very high degree of precision. However, this method is slower and more expensive than other methods of metal cutting.

Metal shearing is a process where a sheet of metal is separated by applying great shearing force to it. In this article, we will discuss how the process of metal shearing really works.

The Shearing Machine

Basically, the process of shearing produces straight line cuts to separate any given piece of metal sheet. The machine which facilitates the shearing process is called power shear. It can be operated manually by labourers or can use advanced modes like hydraulic, pneumatic, or electric power.

Shearing is the **cutting** of sheet **metal** by means of two opposing blades. ... The sheet **metal bending** segment concentrates mainly on the terms defining a **bend** — neutral axis, **bend** allowance, **bend** radius, and springback — and focuses on the primary **bending** machine, the press brake.

Pipes and pipe fittings

Types of pipes

Cast Iron Pipes

These are probably the most common types of pipes used today in sewer lines of homes and some commercial properties. Cast iron pipes are strong and can withstand the weight of dirt and stones without breaking. The only major drawback of cast iron pipes is that they can rust and corrode really fast. The pipe can wear out and decrease in diameter over the years which is what causes the drains to clog. Cast iron pipes are most commonly used in indoor plumbing projects. Outdoor usage is least recommended.

Asbestos Pipe

This is a type of pipe that is made using asbestos and cement. Because this type of pipe is able to withstand high pressure, it can be used for water mains. However, this type of pipe can be damaged by root intrusion. If you have a tree near the septic tank or sewer line, it's best to install a different kind of pipe.

PVC Pipes

There are different types of **plastic/PVC pipes**. They include un-plasticized PVC pipes that is commonly used in cold water systems, plasticized PVC pipes used in low temperature and low strength applications and chlorinated PVC pipes that are designed to withstand high temperatures.

Galvanized Steel (GI) Pipes

When steel pipes are coated with zinc, you get galvanized pipes that are well protected from corrosion. Galvanized pipes come in different grades that represent varying levels of thickness. The light and medium level grades of galvanized pipes are used in internal plumbing. These pipes are more expensive than PVC pipes.

Concrete Pipes

These pipes are mostly used to supply water. They can be reinforced or unreinforced with varying diameters. The smaller unreinforced concrete pipes are used to drain rain water whereas the larger reinforced concrete pipes are used in major water supply projects.

HDPE Pipes

High density polyethylene pipes are probably the most effective pipes in the market. They come in various thicknesses and can be used in demanding pressure environments. This type of pipe can bend into a 90-degree angle and some have 50 years warranty due to their high quality. Roots can never grow into this type of pipe and that's why they are best recommended for sewer lines and water lines in different applications.

Pipe Fittings are Piping component that helps in Changes the direction of the flow such as elbows, tees. Changes the size of the pipe such as reducers, reducing tees. Connect different components such as couplings and stop the flows such as Caps.

There are different types of pipe fitting used in piping. Pipe Fittings used in piping work are mainly Elbow, Tee, Reducer, Union, Coupling, Cross, Cap, Swage Nipple, Plug, Bush, Expansion Joint, Adapters, Olet (Weldolet, Sockolet, Elbowlet, Thredolet, Nipolet, Letrolet, Swepolet), Steam Traps, Long Radius Bend, Flanges and Valve.

Pipe Elbow

The Elbow is used more than any other pipe fittings. It Provides flexibility to change the pipe direction. Elbow mainly available in two standard types 90° and 45°. However, it Can be cut to any other degree. Elbows are available in two radius types, Short radius (1D) and Long radius (1.5D).

90 Degree Elbow Pipe

90 Degree elbow is installed between the pipe to change the direction of the pipe by 90 Degree. Available in long and short radius form.

45 Degree Elbow

45 Degree elbow is installed between the pipe to change the direction of the pipe by 45 Degree.

Long Radius Elbow

In long radius elbow, centreline radius is 1.5 times the nominal size of the pipe or you can say 1.5 times the diameter of the pipe. Normally long radius elbows are used in piping as pressure loss is less as compared to short radius elbow. It required more space than short radius elbow.

Short Radius Elbow

In short radius elbow, centreline radius is same as the nominal size of the pipe or you can say one times the diameter of the pipe. Short radius elbows are used under limited space application.

However, it has a high-pressure drop due to a sudden change in the direction of flow.

Reducing Elbow

The 90 reducing elbow is designed to change direction as well as reduce the size of pipe within a piping system. The reducing elbow eliminates one pipe fitting and reduces the welding by more than one-third. Also, the gradual reduction in diameter throughout the arc of the reducing elbow provides lower resistance to flow and reduces the effect of stream turbulence and potential internal erosion. These features prevent sizeable pressure drops in the line.

Coating is a covering that can be applied to the surface of an object, normally called as substrate. The purpose of application of coating is the value enhancement of the substrate by improving its appearance, corrosion resistant property, wear resistance, etc. Process of coating involves application of thin film of functional material to a substrate. The functional material may be metallic or non-metallic; organic or inorganic; solid, liquid or gas. This can be genuine criteria of classification of coatings. Objectives After studying this unit, you should be able to • metallic and non-metallic coatings their comparison, • different coating processes, • applications of various coating processes, and • advantages and disadvantages of coatings.

4.2 METALLIC AND NON-METALLIC COATINGS 4.2.1 Non-Metallic Coatings Non-metals are used as coating material in case of non-metallic coatings. Common types of such coatings are plastic or rubber coating. This involves application of a layer of the of the given polymer onto a substrate material. Different categories of such coating are described below. (a) Wire and Cable Coating (b) Planer Coating (c) Contour Coating Wire and Cable Coating In this case whole length of conducting wire or electrical cable is coated with plastic or polymer to provide thermal or electrical insulation. 34 Manufacturing Practices-II Planer Coating It involves coating of a flat film over a flat surface. Contour Coating It is applied over a three dimensional object. It can be accomplished by dipping or spraying.

4.2.2 Metallic Coatings Metallic coating can be applied over metallic as well as non-metallic substrates. Sometimes non-metallic like plastics are coated to give metallic appearance. Some important metallic coating methods are described below. Electroplating Electroplating is also known as electro-chemical plating, is an electrolytic process. In this process metal ions in an electrolyte solution are deposited onto a cathode. In the electrolytic process, anode is generally made of metal being plated so it serves as source of coating metal. Workpiece where coating is to be applied made as cathode. Direct current from an external power source is passed through electrolyte solution. The electrolyte is an aqueous solution of acids, bases or salts. Electrolyte conducts electric current by the movement of plate metal ions in solution. For optimum results the parts to be plated should be chemically cleaned. Working Principle The process of electroplating is based on Faraday’s law (two laws). According to these two laws it is stated that : (a) the mass of a substance liberated in electrolysis is proportional to the quantity of electricity passed through the cell, and (b) the mass of the material liberated is proportional to its electrochemical equivalent (ratio of atomic weight to valence).

Pattern and foundary

Pattern Materials Some of the common materials used for pattern making are wood, metal, plaster, wax and plastic. Wood Wood is the most common material used for pattern making as it satisfies most of the essential requirements which are considered for a good pattern. It is light in weight and easily available at low cost, may be easily shaped into different forms as obtained good surface finish easily. The most common woods used for pattern are Deodar, Teak, Shishum and Mohogany. Metal It is used for pattern when a large number of casting with a closer dimensional accuracy is desired. The pattern of metal has a much longer life than wooden pattern as it does not change its shape when subjected to moist conditions. A metal pattern is itself cast from a wooden pattern called “Master Pattern”. Cast-iron, aluminium and its alloys, brass and white metal are commonly used as a pattern metals. Plaster Plaster of paris (gypsum cement) is also used for making patterns and coreboxes. It can be easily worked and casted into desired shape. It has a high compressive strength (up to 300 kg/ cm2). Its specific use is in making small patterns and core-boxes involving intricate shapes and closer dimensional control. Wax Patterns which are generally used in investment casting process are made by wax. The wax patterns are made by pouring the heated wax into a split die or metal mould. The die is kept cool by circulating the water around it. After complete cooling, the die parts are separated and wax in shape ofpattern is taken out. Plastic At present, plastics are finding their place as a pattern materials due to their specific characteristics such as high strength and resistance to wear, lightness in weight, fine surface finish and low solid shrinkage etc.

2.2.2 Types of Pattern The type of patterns selected for a particular casting depends upon many factors such as type of moulding process, number and size of casting and anticipated 27 Pattern Making and Foundry difficulty of moulding on account of design or typical shape of casting. The most common types of pattern are listed and described below : (a) Solid or Single Piece Pattern (b) Split Pattern (c) Gated Pattern (d) Loose Piece Pattern (e) Sweep Pattern (f) Match Plate Pattern (g) Multipiece Pattern Solid or Single Piece Pattern This type of pattern is the simplest of all the patterns. It is made without joints, partings or loose pieces (Figure 2.1). For moulding with two patterns, one or two moulding boxes may be used. Moulding operation with this pattern takes more times as the moulder has to cut his own runners, risers and feeding gates. This type of patterns are usually used for simple and large sizes of casting. Figure 2.1 : Single Piece Pattern Split Pattern Whenever the design of casting offers difficulty in making of mould and withdrawal of pattern with a single piece pattern, split or two-piece pattern is most suitable. This type of pattern eliminates this difficulty and can be used to form the mould of intricate design or unusual shape of casting. Split patterns are made in two parts so that one is placed in cope and other in drag with the dowel pins holding the two together (Figure 2.2). The surface formed at the line of separation of the two parts, usually at the centre line of the pattern, is called parting line. Parting Line Core Prints Figure 2.2 : Split Pattern 28 Workshop Technology Gated Pattern In mass production, a number of castings are prepared in a single multicavity mould by joining a group of patterns. In such type of multicavity mould, gates or runners for the molten metal are formed by connecting parts between the individual patterns as shown in Figure 2.3. Figure 2.3 : Gated Pattern These are made of wood or metal and specially used for mass productions of small castings. Loose Piece Pattern As per requirement, some solid or single piece type of patterns are made as assemblies of loose component pieces. Loose pieces are arranged in such a way that it can be removed from the mould easily as shown in Figure 2.4. Figure 2.4 : Loose Piece Pattern Usually, this type of pattern requires much maintenance and are slower to mould. Sweep Pattern Large sizes of symmetrical moulds are generally prepared by means of sweep patterns. It consists of a base, a wooden sweep board and a vertical spindle. The outer end of sweep board carries a shape corresponding to the shape of desired casting. Usually, sweep patterns are employed for moulding part carrying circular sections. The sweep board is attached with the vertical spindle. Section on AB A B Rammed Pattern Loose Pieces Core Prints Sand Mould Cavity Loose Pieces being Withdrawn 29 Pattern Making and Foundry After holding the spindle in vertical position, the moulding sand is rammed in place. As the sweep board is rotated about the spindle it will form a desired cavity in the moulding sand as depicted in Figure 2.5. Figure 2.5 : Sweep Pattern Spindle Sweep Match Plate Pattern Such type of patterns are widely used for producing small sizes of castings in mass scale and are made of metal. Match plate patterns are made in two pieces like split patterns. It consists of a wooden or metallic plate, called match plate. Both the parts of split pattern are mounted on both sides of this match plate (Figure 2.6). Groups of patterns on both sides of match plates are used to prepare the moulds at a time separately, i.e. for group of patterns on one side is prepared in drag while the other side group of patterns in cope. Figure 2.6 : Match Plate Pattern Multipiece Pattern Sometimes, it is necessary to prepare a pattern in more than two parts in order to facilitate an easy moulding and withdrawal of pattern (Figure 2.7)

Types of Metal Melting Furnaces

Cupola Furnace

One of the oldest style of melting furnaces, the cupola furnace, has a tall, cylindrical shape. The insides of these furnaces are lined with clay, blocks or bricks which protect the furnace's interior from heat, abrasion and oxidation. To melt the metal in the furnace, workers add layers of metal such as ferro alloys, limestone and coke. The limestone reacts with the metal, making the impurities float up to the surface of the melting metal.

Induction Furnace

Induction furnaces use alternating currents to create the necessary heat with which to melt the metal. The refractories, or the lining, of these are made from materials such as alumina, silica and magnesia. These furnaces work well for melting metal such as iron as well as metals that are nonferrous. Inside the induction furnaces are copper coils which are cooled with water.

Electric Furnaces

These furnaces are often used in steel mills as well as foundries. Metal and additives are poured into the furnace. The additives help to separate the impurities present in the metal. The furnace melts the metal through the use of granite or carbon electrodes which create an electric arc.

Hearth Furnace

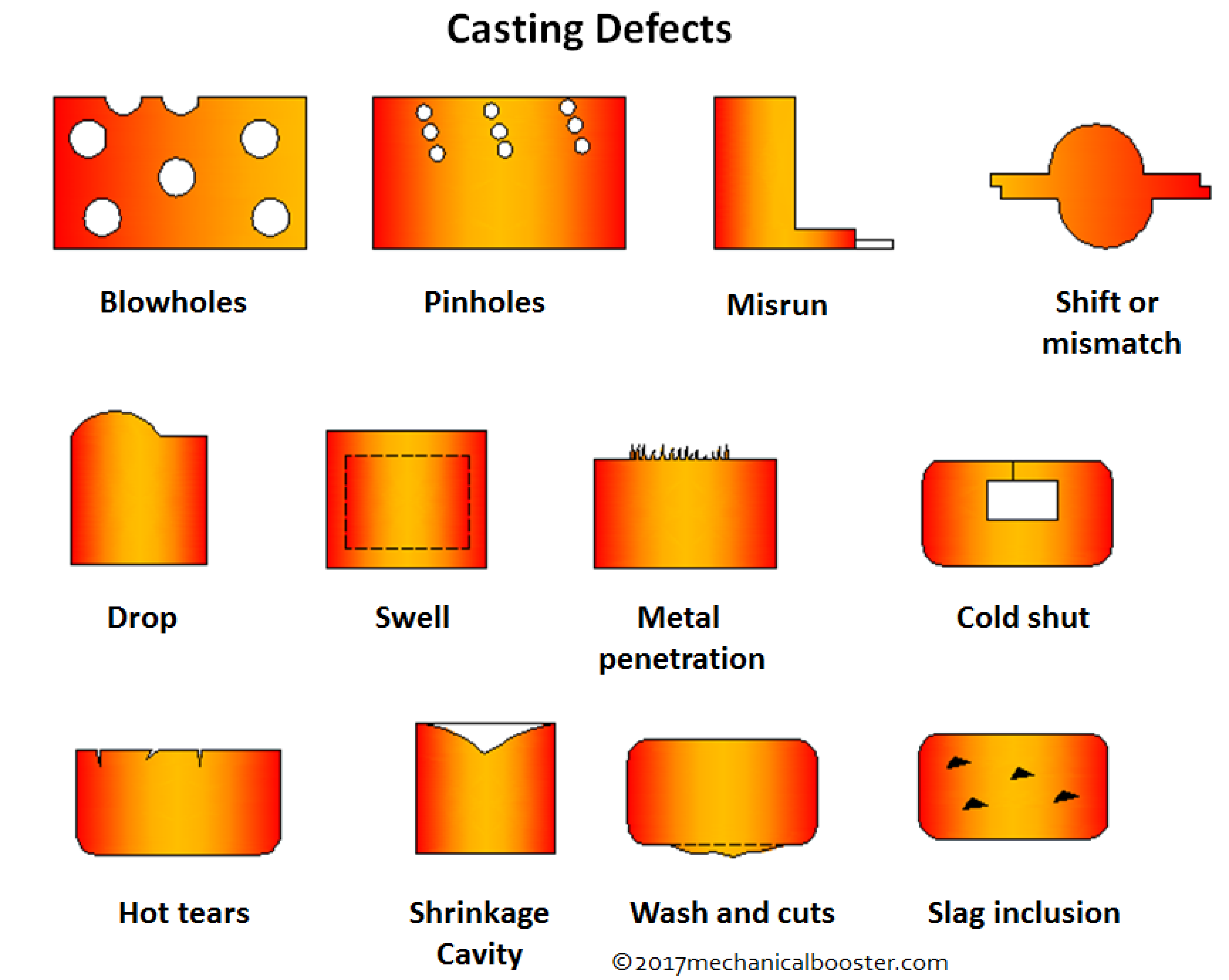
A hearth furnace works well for melting small quantities of nonferrous metal. These furnaces use natural gas or electricity to produce heat by which to melt the metal.

It is an unwanted irregularities that appear in the casting during metal casting process. There is various reason or sources which is responsible for the defects in the cast metal. Here in this section we will discuss all the major types of casting defects. Some of the defects produced may be neglected or tolerated and some are not acceptable, it must be eliminated for better functioning of the parts.

Types

Casting defects can be categorized into 5 types

1. Gas Porosity: Blowholes, open holes, pinholes
2. Shrinkage defects: shrinkage cavity
3. Mold material defects: Cut and washes, swell, drops, metal penetration, rat tail
4. Pouring metal defects: Cold shut, misrun, slag inclusion
5. Metallurgical defects: Hot tears, hot spot.



Introduction to Lathe machine & its classification

Lathe is one of the oldest machine tool. It machines the given work piece in to required product by employing turning effect. In a lathe the work piece revolves along with the chuck to which the motor is connected by various gears and shafts. In lathes tools have either longitudinal or transverse motion or cross feed. There are many types of lathes but they are broadly classified in to seven types.

1) Speed lathes
2) Engine lathes
3) Bench lathes
4) Tool room lathes
5) Capstan and turret lathes
6) Special purpose lathes
7) Automatic lathes

Speed lathe

This lathe is simplest of all the lathes and is easily understandable to everyone. As the name indicates very high speeds are generated. These lathes contain a bed, head stock, tail stock mounted on a adjustable slide. These lathes do not have tool post, feed rod, and lead screw. Very few ranges of speeds are possible by speed lathes. These lathes are in general employed for wood working, centering polishing and spinning.

Engine lathe

It is the most commonly used lathe and is of high importance in lathe family. The name engine is kept as in the past steam engines are used for running these lathes. This is similar to the speed lathes but the head stock is little robust in construction. Engine lathes have additional mechanisms to produce a wide range of speeds. Many parts like lead screw, feed rod, tool post etc. are also provided in these lathes. Speeds both in anti clockwise and clockwise directions can be generated very effectively.

Bench lathe

This is a very small lathe and is generally mounted over a bench. This contains all the parts of engine lathe but the major difference arises in size. These lathes are small in size and are generally used for doing small and precision works.

Tool room lathe

It has similar features of engine lathe but it is more accurately built and a wide range of speeds ranging from very low to very high speeds up to 2500rpm can be generated. It has many attachments like chuck, taper turning equipment, draw in collet attachment, thread chasing rest, pump for coolant etc. This is used for doing precision works like tools dies etc. tool room lathes are costlier when compared to engine lathes of same size.

Capstan and turret lathe

These are the developments made in engine lathe. These lathes found application in production work. In this lathes the tail stock is replaced by hexagonal turret. Based on the way the turret is mounted they will be classified in to capstan and turret lathes. Each face of the turret is mounted with a tool. These tools are arranged in an order. When the operation of one tool gets completed then while returning back of turret it takes a turn of 1200 making the next tool to come in to picture. By employing capstan and turret lathes production rate can be increased to a larger extent. These lathes found application where a lot of identical pieces needed to be generated.

Special purpose lathes

As the name indicates these lathes are designed for a specific purpose. These lathes are not so generally used as they have a unique job production. These type of lathes are used when there is requirement of mass production. Some of the special purpose lathes are wheel lathe which is used for finishing of journals, T-lathes, Gap bed lathes, Duplicating lathes, missile lathes etc.

Automatic lathes

These are latest king of lathes where every operation is automatically done by employing special computers. These lathes have high speed, heavy duty and are used for mass production. This lathe requires no flour men. A properly trained operator can efficiently run 7 to 10 machines at a time as all the work starting from loading till obtaining of finished goods every operation requires no man power. These lathes produce jobs with minimum tolerances and of very high accuracy. These lathes generally have very high cost. But the cost per piece is very less for this machine when compared to any other lathes.

Lathe operations – plain turning, facing, centring, parting off, undercutting

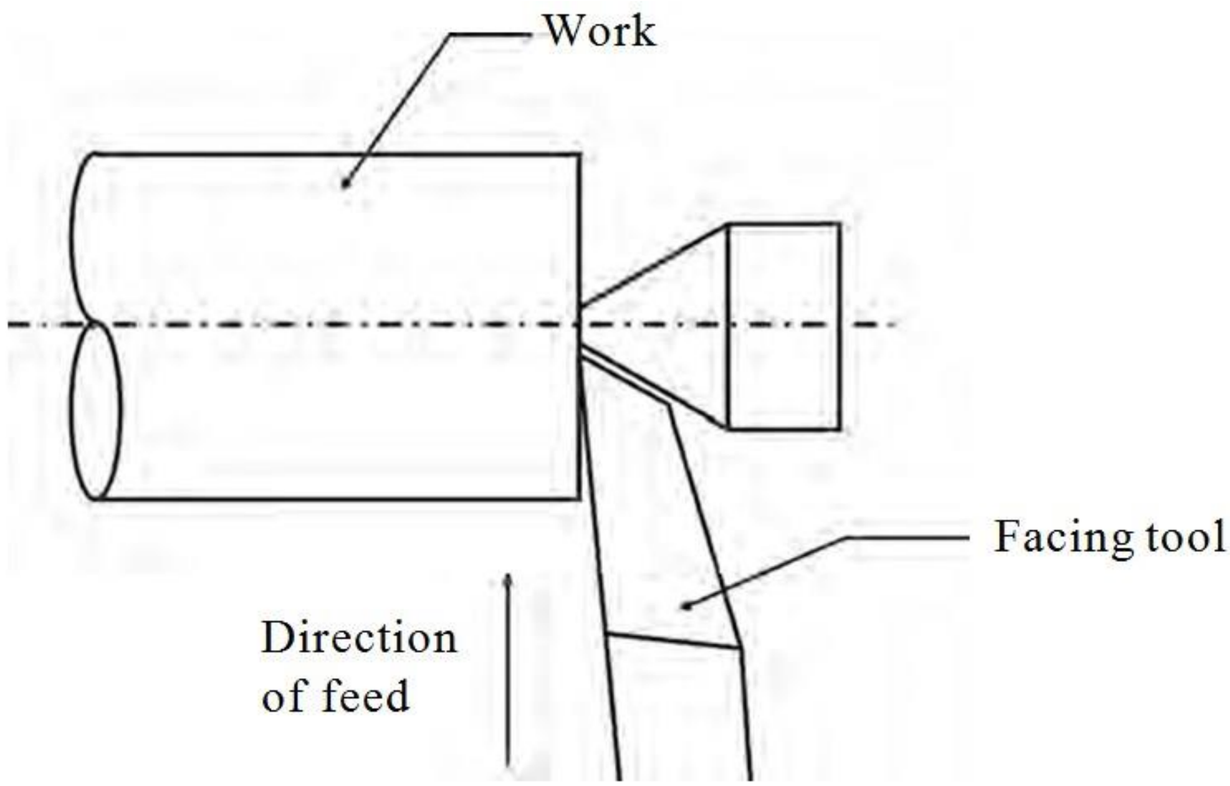
Various operations are performed in a lathe machine other than plain turning. These are:-

1. Facing
2. Turning
    1. Straight turning
    2. Step turning
3. Chamfering
4. Grooving
5. Forming

6. <u>Knurling</u>
7. <u>Undercutting</u>
8. <u>Eccentric turning</u>
9. <u>Taper turning</u>
10. <u>Thread cutting</u>
11. Drilling
12. Reaming
13. Boring
14. Tapping

Facing

Facing is the operation of machining the ends of a piece of work to produce flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work.



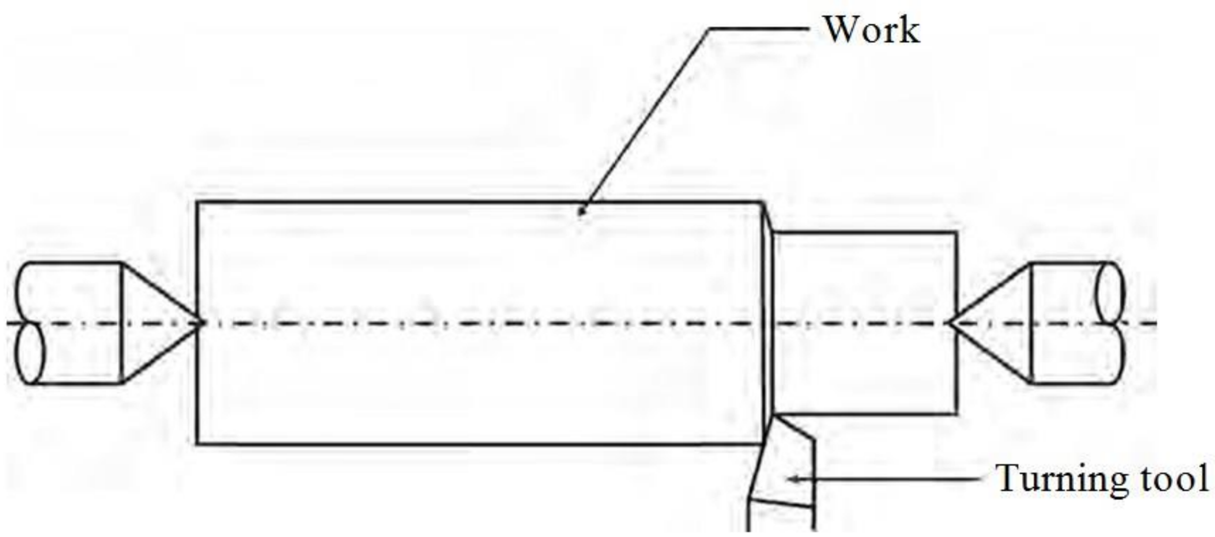
Facing

Turning

Turning in a lathe is to remove excess material from the workpiece to produce a cylindrical surface of required shape and size.

Straight turning

The work is turned straight when it is made to rotate about the lathe axis and the tool is fed parallel to the lathe axis. The straight turning produces a cylindrical surface by removing excess metal from the workpieces.



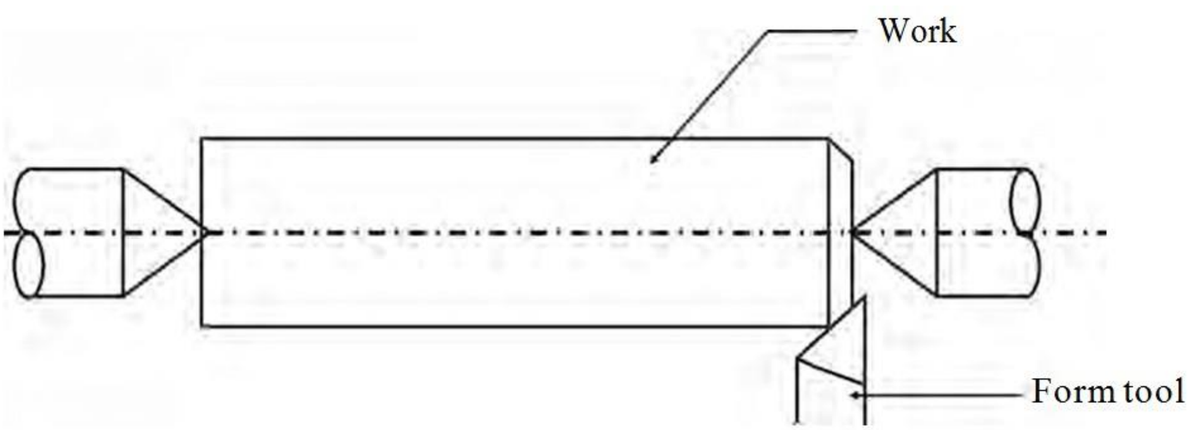
Straight turning

Step turning

Step turning is the process of turning different surfaces having different diameters. The work is held between centres and the tool is moved parallel to the axis of the lathe. It is also called shoulder turning.

Chamfering

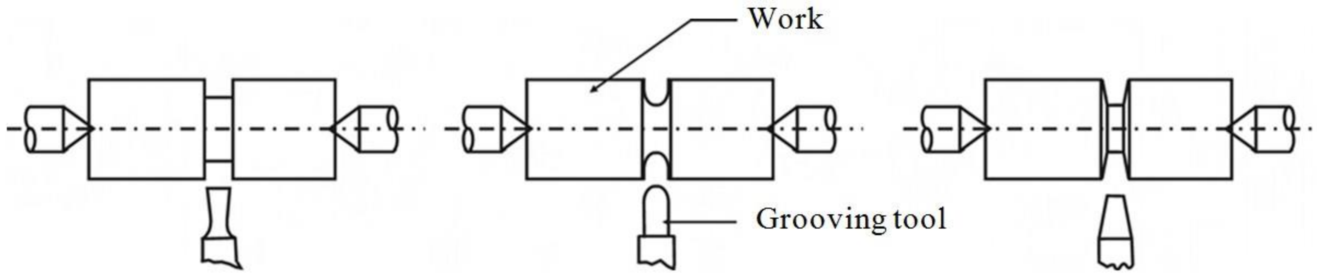
Chamfering is the operation of bevelling the extreme end of the workpiece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded workpiece.



Chamfering

Grooving

Grooving is the process of cutting a narrow goove on the cylindrical surface of the workpiece. It is often done at end of a thread or adjacent to a shoulder to leave a small margin. The groove may be square, radial or bevelled in shape.



Grooving

Forming

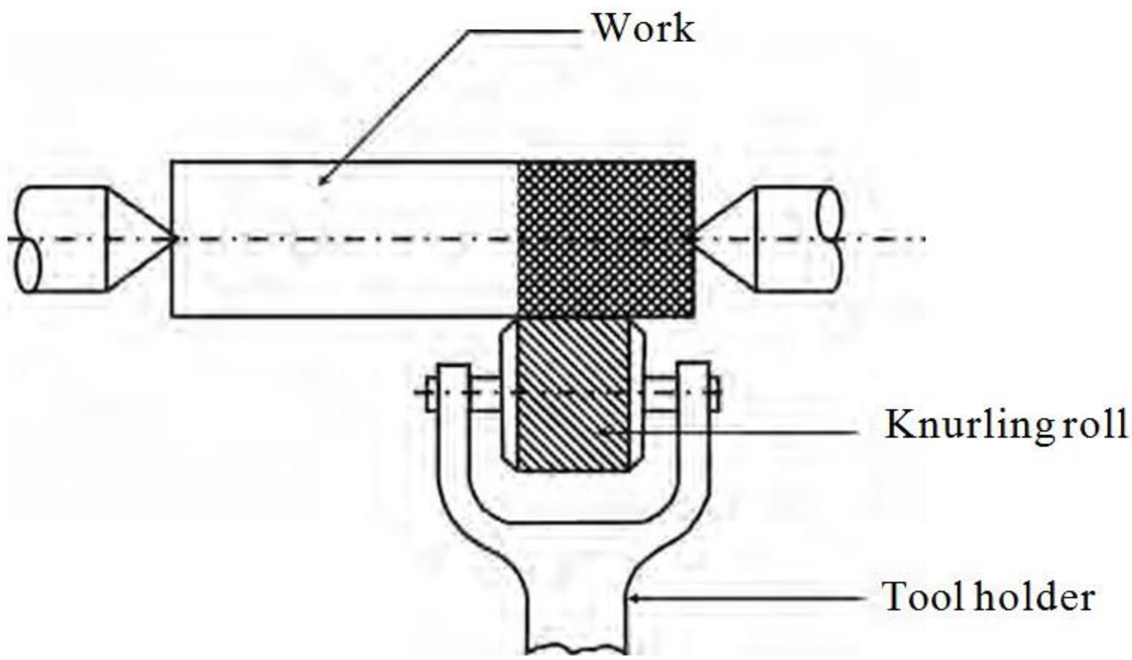
Forming is a process of turning a convex, concave or any irregular shape. For turning a small length formed surface, a forming tool having cutting edges conforming to the shape required is fed straight into the work.

Knurling

Knurling is the process of embossing a diamond shaped pattern on the surface of the workpiece. The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against the rotating work. The rollers emboss the required pattern. The tool holder is fed automatically to the required length.

Read more about Tool and Cutter Grinding Machines

Knurls are available in coarse, medium and fine pitches. The patterns may be straight, inclined or diamond shaped.



Knurling

The purpose of knurling is

1. to provide an effective gripping surface
2. to provide better appearance to the work
3. to slightly increase the diameter of the work

Undercutting

Undercutting is done

- at the end of a hole
- near the shoulder of stepped cylindrical surfaces
- at the end of the threaded portion in bolts

It is a process of enlarging the diameter if done internally and reducing the diameter if done externally over a short length. It is useful mainly to make fits perfect. Boring tools and parting tools are used for this operation.

Eccentric turning

If a cylindrical workpiece has two separate axes of rotating, one being out of centre to the other, the workpiece is termed as eccentric and turning of different surfaces of the workpiece is known as eccentric turning. The distance between the axes is known as offset. Eccentric turning may also be done on some special machines. If the offset distance is more, the work is held by means of special centres. If the offset between the centres is small, two sets of centres are marked on the faces of the work. The work is held and rotated between each set of centres to machine the eccentric surfaces.

Taper turning

Taper

A taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.

Taper turning methods

1. Form tool method
2. Compound rest method
3. Tailstock setover method
4. Taper turning attachment method
5. Combined feed method

Form tool method

A broad nose tool is ground to the required length and angle. It is set on the work by providing feed to the cross-slide. When the tool is fed into the work at right angles to the lathe axis, a tapered surface is generated.

This method is limited to turn short lengths of taper only. The length of the taper is shorter than the length of the cutting edge. Less feed is given as the entire cutting edge will be in contact with the work.

Compound rest method

The compound rest of the lathe is attached to a circular base graduated in degrees, which may be swiveled and clamped at any desired angle. The angle of taper is calculated using the formula

Read more about Salient Features and Specifications of Heavy Duty Lathe with Large Bore Spindle

The compound rest is swiveled to the angle calculated as above and clamped. Feed is given to the compund slide to generate the required taper.

Tailstock setover method

Turning taper by the setover method is done by shifting the axis of rotation of the workpiece at an angle to the lathe axis and feeding the tool parallel to the lathe axis. The construction of tailstock is designed to have two parts namely the base and the body. The base is fitted on the bed guideways and the body having the dead centre can be moved at cross to shift the lathe axis.

The amount of setover – s, can be calculated as follows

The dead centre is suitably shifted from its original position to the calculated distance. The work is held between centres and longitudinal feed is given by the carriage to generate the taper.

The advantage of this method is that the taper can be turned to the entire length of the work. Taper threads can also be cut by this method.

The amount of setover being limited, this method is suitable for turning small tapers (approx. upto 8°). Internal tapers cannot be done by this method.

Taper attachment method

The taper attachment consists of a bracket which is attached to the rear end of the lathe bed. It supports a guide bar pivoted at the centre. The bar having graduation in degrees may be swiveled on either side of the zero graduation and set at the desired angle to the lathe axis. A guide block is mounted on the guide bar and slides on it. The cross slide is made free from its screw by removing the binder screw. The rear end of the cross slide is tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path as the guide block will slide on the guide bar set at an angle of the lathe axis. The depth of cut is provided by the compound slide which is set parallel to the cross-slide.

Read more about What is the Role of BED in a Lathe?

The advantage of this method is that long tapers can be machined. As power feed can be employed, the work is completed at a shorter time. The disadvantage of this method is that internal tapers cannot be machined.

Combined feed method

Feed is given to the tool by the carriage and the cross-slide at the same time to move the tool at resultant direction to turn tapers.

Thread cutting

Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.

1. The job is revolved between centres or by a The longitudinal feed should be equal to the pitch of the thread to be cut per revolution of the work piece.
2. The carriage should be moved longitudinally obtaining feed through the leadscrew of the
3. A definite ratio between the longitudinal feed and rotation of the headstock spindle should be found Suitable gears with required number of teeth should be mounted on the spindle and the leadscrew.
4. A proper thread cutting tool is selected according to the shape of the It is mounted on the toolpost with its cutting edge at the lathe axis and perpendicular to the axis of the work.
5. The position of the tumbler gears are adjusted according to the type of the thread (right hand or left hand).
6. Suitable spindle speed is selected and it is obtained through back
7. Half nut lever is engaged at the right point as indicated by the thread chasing
8. Depth of cut is set suitably to allow the tool to make a light cut on the
9. When the cut is made for the required length, the half nut lever is The carriage is brought back to its original position and the above procedure is repeated until the required depth of the thread is achieved.
10. After the process of thread cutting is over, the thread is checked by suitable gauges.

Working principle of a shaper, principle parts of a shaper

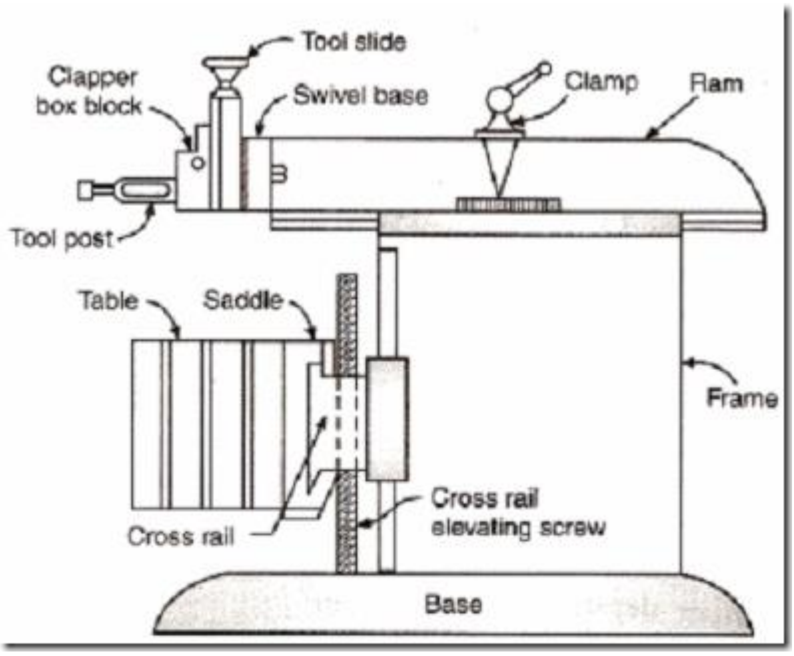
Introduction: The shaper is a machine tool used primarily for:

1. Producing a flat or plane surface which may be in a horizontal, a vertical or an angular plane.

2. Making slots, grooves and keyways

3. Producing contour of concave/convex or a combination of these

Working Principle: The job is rigidly fixed on the machine table. The single point cutting tool held properly in the tool post is mounted on a reciprocating ram. The reciprocating motion of the ram is obtained by a quick return motion mechanism. As the ram reciprocates, the tool cuts the material during its forward stroke. During return, there is no cutting action and this stroke is called the idle stroke. The forward and return strokes constitute one operating cycle of the shaper.



Construction: The main parts of the Shaper machine is Base, Body (Pillar, Frame, Column), Cross rail, Ram and tool head (Tool Post, Tool Slide, Clamper Box Block).

Base: The base is a heavy cast iron casting which is fixed to the shop floor. It supports the body frame and the entire load of the machine. The base absorbs and withstands vibrations and other forces which are likely to be induced during the shaping operations.

Body (Pillar, Frame, Column): It is mounted on the base and houses the drive mechanism compressing the main drives, the gear box and the quick return mechanism for the ram movement. The top of the body provides guide ways for the ram and its front provides the guide ways for the cross rail.

Cross rail: The cross rail is mounted on the front of the body frame and can be moved up and down. The vertical movement of the cross rail permits jobs of different heights to be accommodated below the tool. Sliding along the cross rail is a saddle which carries the work table.

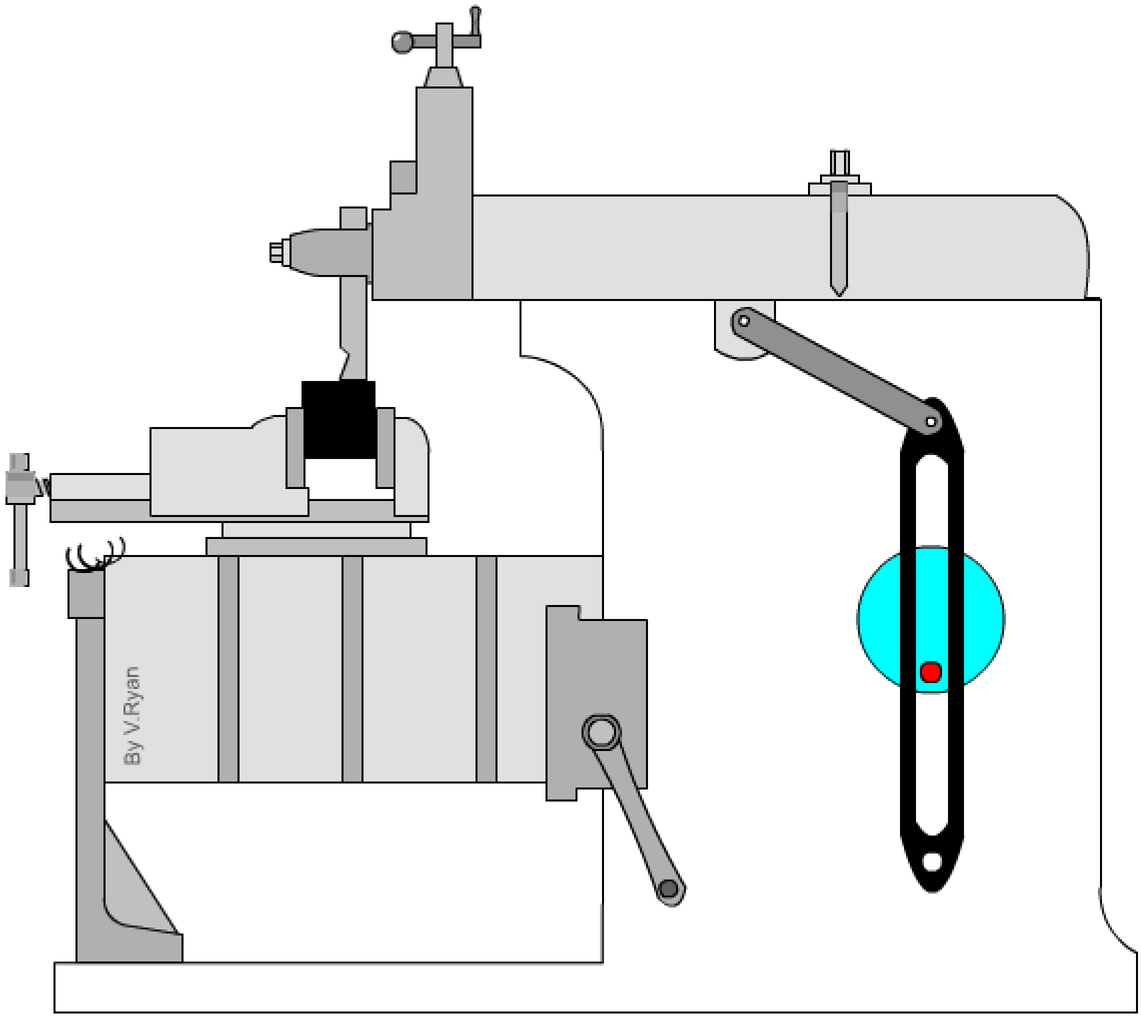
Ram and tool head: The ram is driven back and forth in its slides by the slotted link mechanism. The back and forth movement of ram is called stroke and it can be adjusted according to the length of the workpiece to be-machined.

Quick return mechanism

The shaping machine is used to machine flat metal surfaces especially where a large amount of metal has to b removed. Other machines such as milling machines are much more expensive and are more suited to removir amounts of metal, very accurately.

The reciprocating motion of the mechanism inside the shaping machine can be seen in the diagram. As the di the top of the machine moves forwards and backwards, pushing a cutting tool. The cutting tool removes the r work which is carefully bolted down.

THE SHAPING MACHINE



Shaper operations

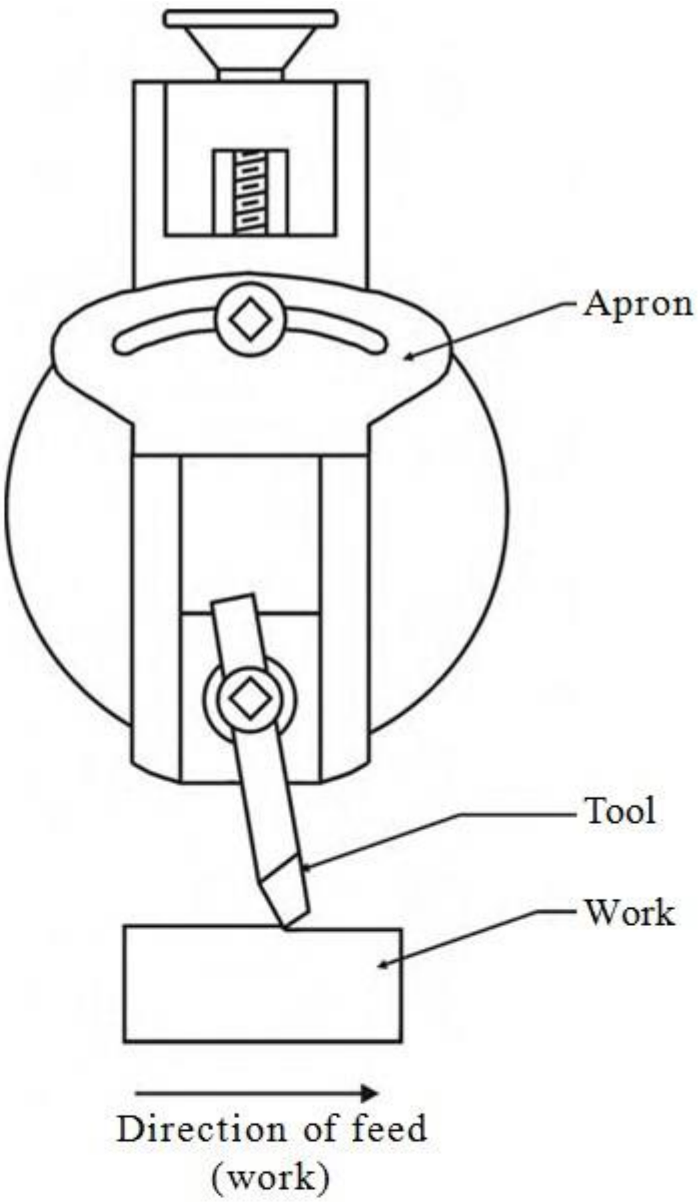
Different types of operations are performed in a shaping machine. They are broadly classified as

1. Regular operations
2. Special operations

Regular Operations

Machining Horizontal Surfaces

A shaper is mostly used to machine a flat, true surface on a workpiece. Horizontal surfaces are machined by moving the work mounted on the machine table at a cross direction with respect to the ram movement. The clapper box can be set vertical or slightly inclined towards the uncut surface. This arrangement enables the tool to lift automatically during the return stroke. The tool will not drag on the machined surface.

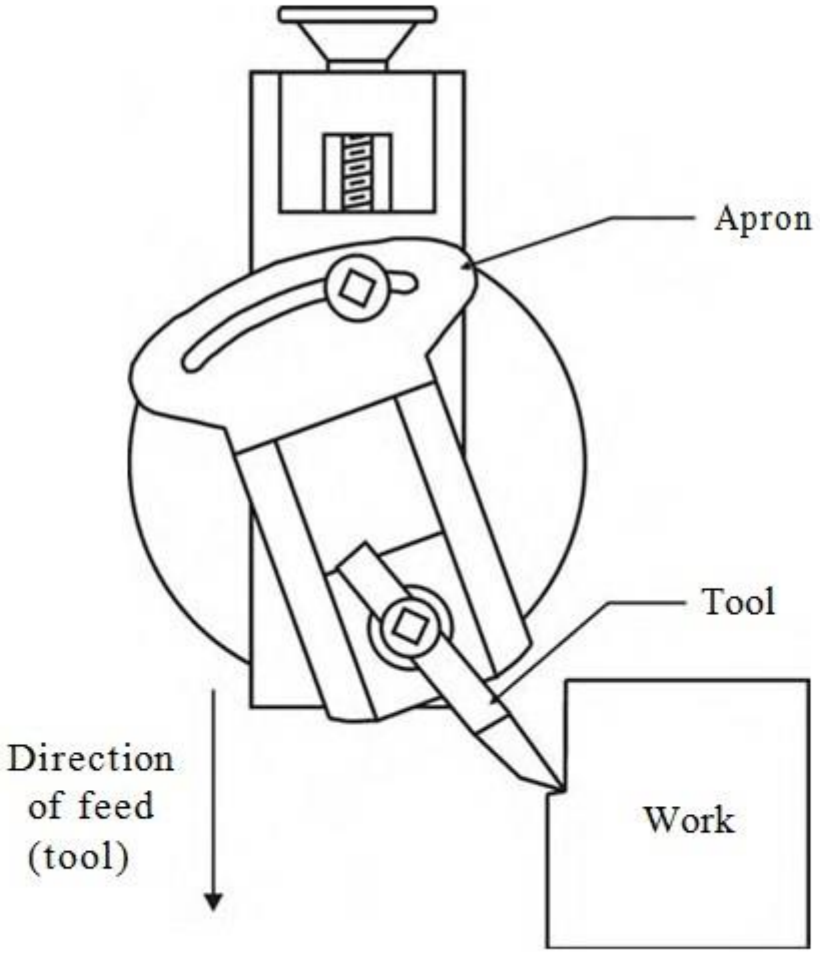


Machining a Horizontal Surface

Machining Vertical Surfaces

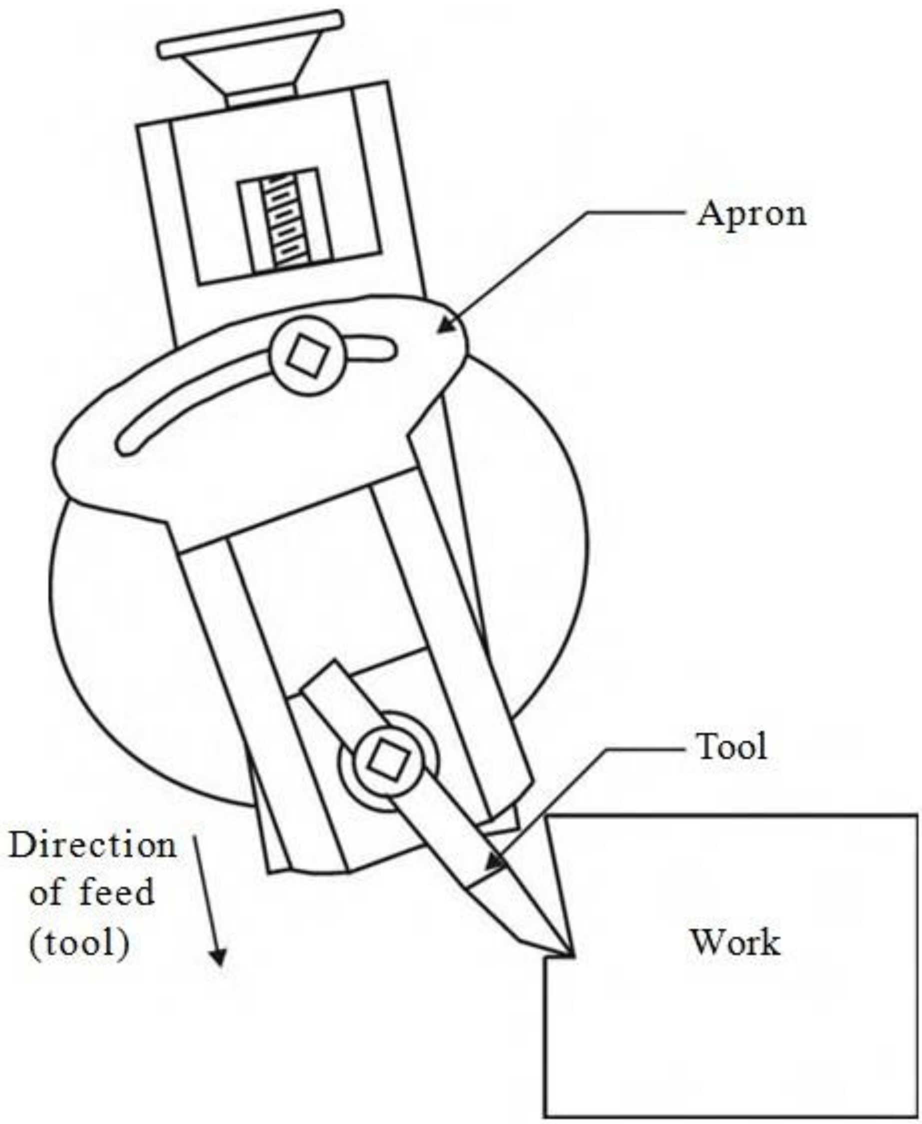
A vertical cut is made while machining the end of a workpiece, squaring up a block or machining a shoulder.

The feed is given to the tool by rotating the downfeed screw of the vertical slide. The table is not moved vertically for this purpose. The apron is swiveled away from the vertical surface being machined as shown in the diagram.



Machining a Vertical Surface

Machining Angular Surfaces



Machining a Angular Surface

If the surface to be machined is neither horizontal nor perpendicular, the surface is called inclined surface. Machining 'V' grooves and dovetail grooves are some examples for angular machining.

Machining the inclined (angular) surfaces can be done in several ways. They are

- **Taper strip method –** The taper strip is positioned on the table and fixed. On the taper strip, the job is fixed and machined. The angular surface is obtained.
- **Layout method –** Slanting surface is marked on the work piece. The job is positioned by suitable arrangement in such a way that the marked line is either horizontal or vertical. If the machining is carried out, the required angular surface is obtained.
- **Degree parallel method –** Degree parallel block is a wedge shaped precision block for a particular angle. The degree parallel block is placed first on the table. Over and above that, the workpiece is positioned and the machining is done as usual to obtain the required angular surface.
- **Universal vice method –** The job may be fixed in the universal vice and then the vice is swiveled to the required angular position. If the machining is carried out, the required slanting (angular) surface will be obtained.
- **Universal table method –** If the universal table is available in the shaping machine, then the table can be tilted to the required position and the work is fitted on that. The machining is done as usual to obtain the required angular surface.

- **Swivel toolhead method –** An angular cut is made at any angle other than a right angle to the horizontal or to the vertical plane. The work is set on the table and the vertical slide of the toolhead is swiveled to the required angle either towards left or towards right from the vertical position. The apron is then further swiveled away from the work to be machined.