CHAPTER 04

Grinding Machine

CDNVZ

Learning Objectives

- Students to understand the various types of grinding machines, different types of operation performed in it, Natural and Artificial abrasives and its type, manufacturing of grinding wheel and mounting of grinding wheel, dressing truing and super finishing process.

Puran thooimai neeraan amaiyum aganthooimai
Vaaimaiyaar kaana padum. –Kural 298

Outward purity the water will bestow, inward purity from truth alone will flow (or) purity of body is produced by water and purity of mind by truthfulness.

CONTENTS

Grinding machine

Ambrose Webster was an American scientist; citizen of Massachusetts invented the small grinding machine in 1860.

Grinding wheel

The scientist named Suyin Palson was invented grinding wheel with mixture of emery powder, clay and water in 1873.

4.1 Introduction

Grinding is a metal cutting operation where metal is cut by a rotating abrasive wheel. This machine on which grinding the operation is performed is called a grinding machine.

Grinding is done to obtain very high dimensional accuracy and good surface finish on the work place. The accuracy of grinding process is 0.000025 mm. The amount of material removed from this process is very less.

4.2 Types of grinding machines

According to the accuracy of the work to be done on a grinding machine, they are classified as

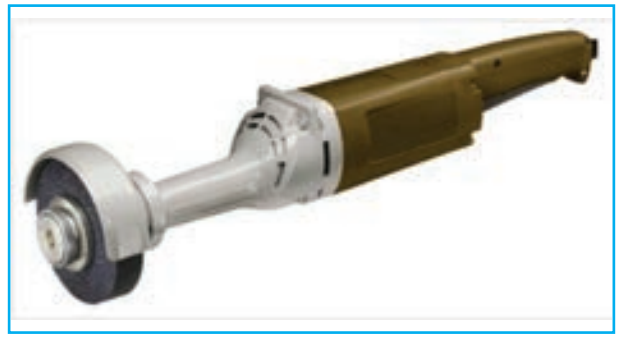
1. Rough grinding machines or Non-Precision grinding machines
2. Precision grinding machines

4.3 Non-Precision grinding machine

The non-precision grinding machines are used to remove unwanted projections from casting and welding, when the surface finish is not important. The main types of non-precision grinders are

1. Hand grinding machine
2. Bench grinding machine
3. Floor stand grinding machine
4. Flexible shaft grinding machine
5. Swing frame grinding machine
6. Abrasive belt grinding machine

Hand grinding machine



It is a small grinder which can be carried from one place to another place easily. A small grinding wheel is mounted at the end of motor shaft. The motor is connected by along wire to the main switch box. It is used for grinding large forgings, casting, welded joints and sheet metal work etc.

Bench grinding machine

This grinder is mounted on a bench. Two grinding wheels are connected to both ends of the motor shaft. The wheels are covered by guards. Work rest is provided for supporting the work piece while grinding.

Bench grinding machine

4.4 Precision Grinding Machine

Precision grinders are used for finishing parts to a very accurate dimension. The main types of precision grinders are

1. Cylindrical grinding machines
2. Internal grinding machines
3. Surface grinding machines
4. Tool and cutter grinding machines
5. Special grinding machines

Cylindrical grinding machine

The workpiece is held between two centres and used to grind external surfaces like cylinders, taper cylinders and cylindrical faces is called cylindrical grinding machine. There are two types of cylindrical grinding machines, they are

1. External cylindrical grinding machine
2. Internal cylindrical grinding machine

External cylindrical machine

In a cylindrical work piece to grind external surface like cylindrical and taper cylinders is called external cylindrical grinding machine.

Base

The base is made of cast iron and rest on the floor. It supports all other parts of the grinder. The top of the base is accurately machined and provides guideways for the table to slide on. The base houses the table driving mechanism.

Tables

The tables are mounted on top of the base. There are two tables namely upper table and lower table. The lower table slides on the guideways on the bed. Table can be moved by hand or power.

Upper table is mounted on the lower table. Upper table can be swiveled upto ±10° and clamped in position. Adjustable trip dogs are clamped in longitudinal slots at the side of the lower bed. These trip dogs actuate the table reversing lever, to control table movement.

Head stocks

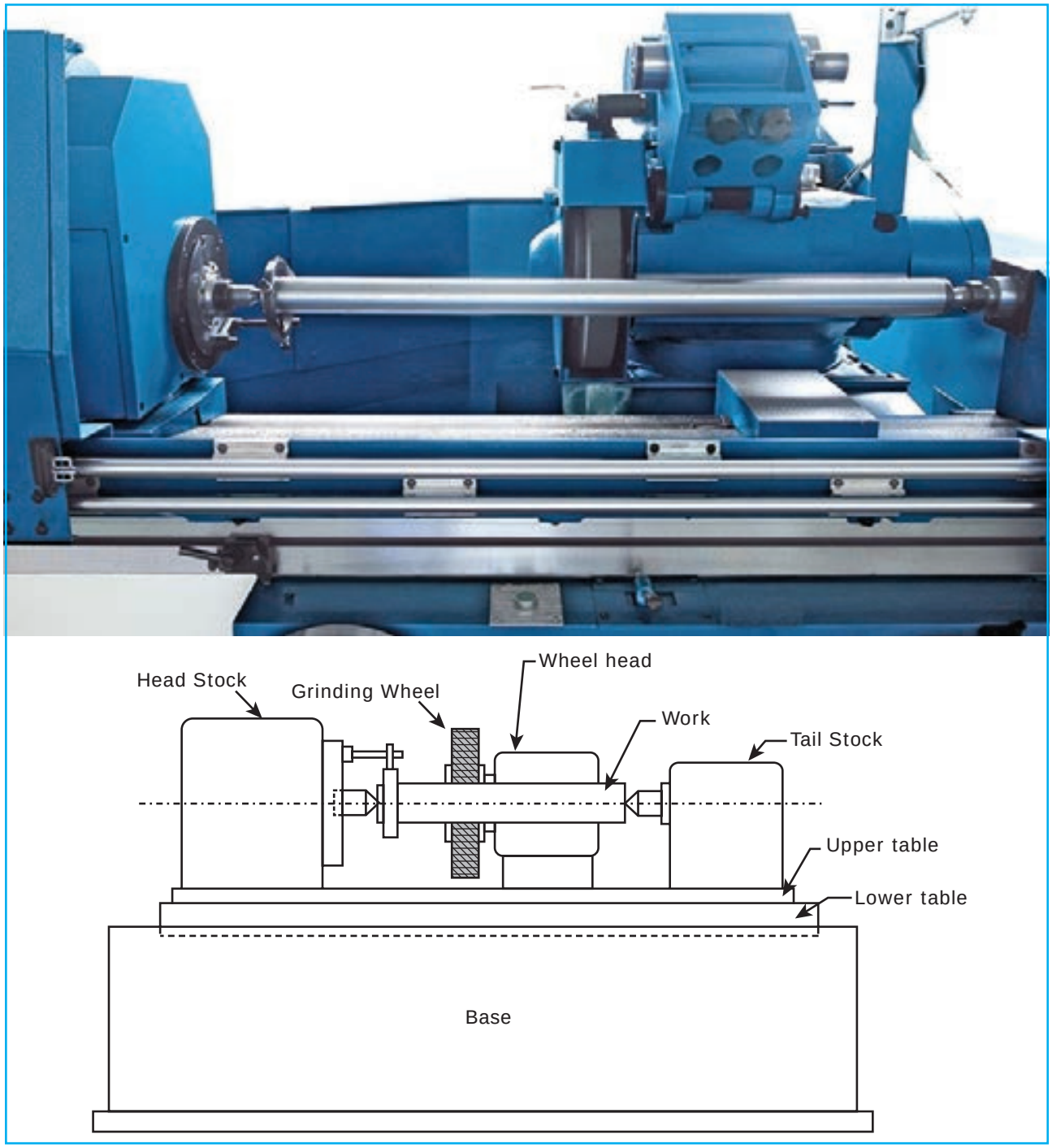
The head stock is situated at the leftside of the upper table. It supports the workpiece by means of a centre and drives it by means of a dog. It may hold and drive the workpiece in a chuck. It houses the mechanism meant for driving the work. The head stock of a universal grinding machine can be swiveled to any required angle.

Tailstock

The tailstock is situated at the rightside of the table. It can be adjusted and clamped in various positions to accommodate different lengths of workpieces.

Wheel head

The wheel head is placed over the bed at its backside. The wheel head may be moved at right angles to the table guideways. It is operated by hand or by power to feed the wheel to work. The wheel head carries a grinding wheel.



Cylindrical grinding machines

Separated motor is used for driving the grinding wheel. The grinding wheel rotates at about 1500 to 2000 r.p.m.

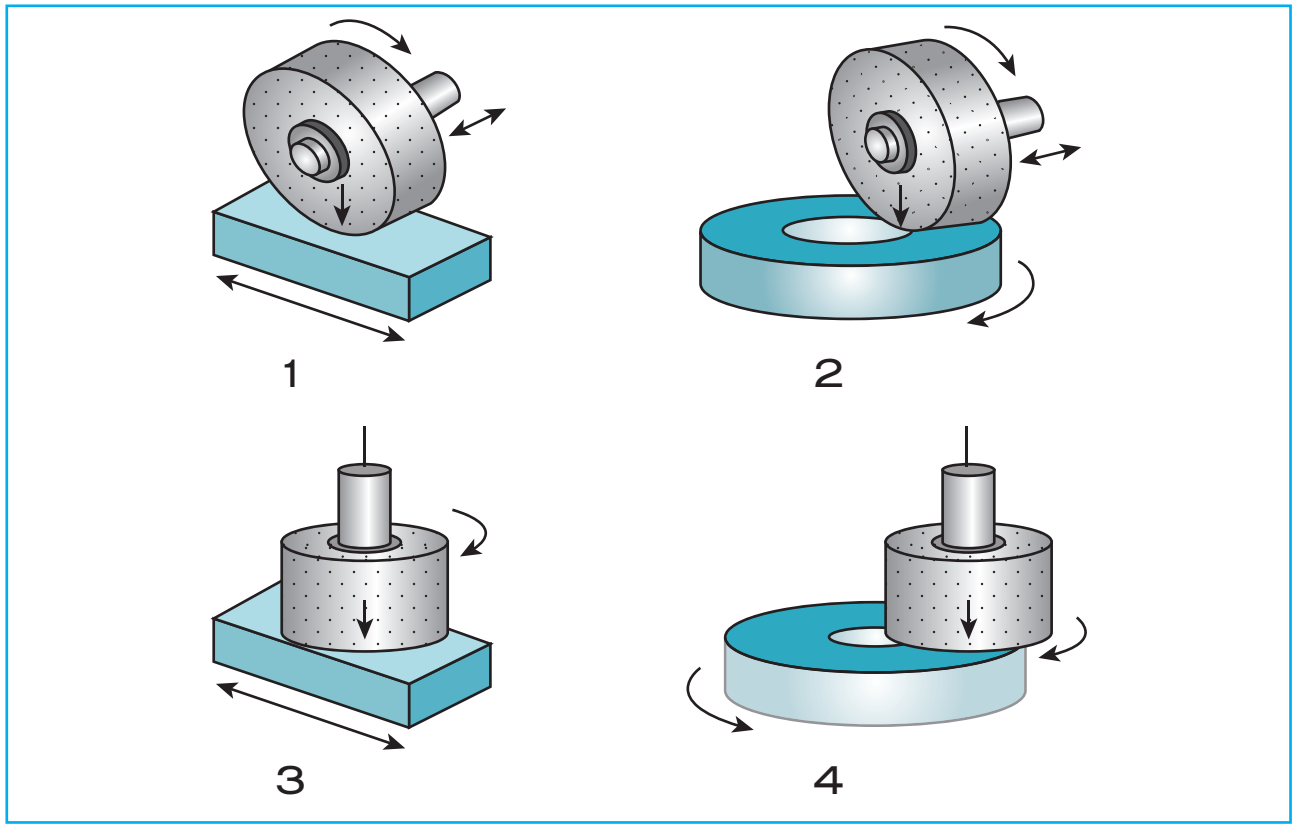
Internal cylindrical grinding machine

Internal grinders are used to grinding internal surfaces of straight and tapered holes.

Surface grinding machine

Surface grinding machines are employed to finish plain or flat surfaces horizontally or at any angle. There are four different types of surface grinders. They are

1. Horizontal spindle and reciprocating table type.
2. Horizontal spindle and rotary table type.



Surface Grinding Machine

3. Vertical spindle and reciprocating table type.
4. Vertical spindle and rotary table type.

Horizontal spindle surface grinding machine

The majority of surface grinders are of horizontal spindle type. In the horizontal type of the machine, grinding is performed by the abrasives on the periphery of the wheel. Though the area of contact between the wheel and the work is small, the speed is uniform over the grinding surface and the surface finish is good.

The grinding wheel is mounted on a horizontal spindle and the table is reciprocated to perform grinding operation.

Base

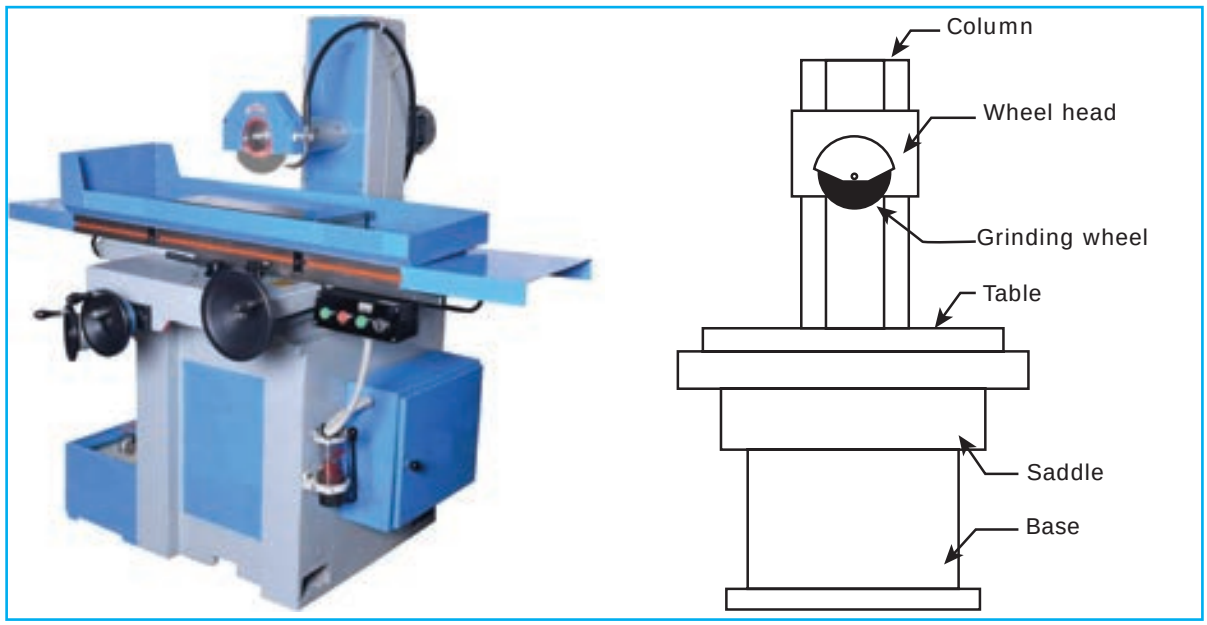
The base is made of cast iron. It is a box like casting which houses all the table drive mechanisms. The column is mounted at the back of the base which has guideways for the vertical adjustment of the wheel head.

Saddle

Saddle is mounted on the guideways provided on the top of the base. It can be moved at cross towards or away from the column.

Table

The table is fitted to the carefully machined guideways of the saddle. It reciprocates along the guideways to provide the longitudinal feed. The table is provided with 'T' slots for clamping



Horizontal Spindle Surface Grinding Machine

workpiece directly on the table or for clamping fixtures or magnetic chuck.

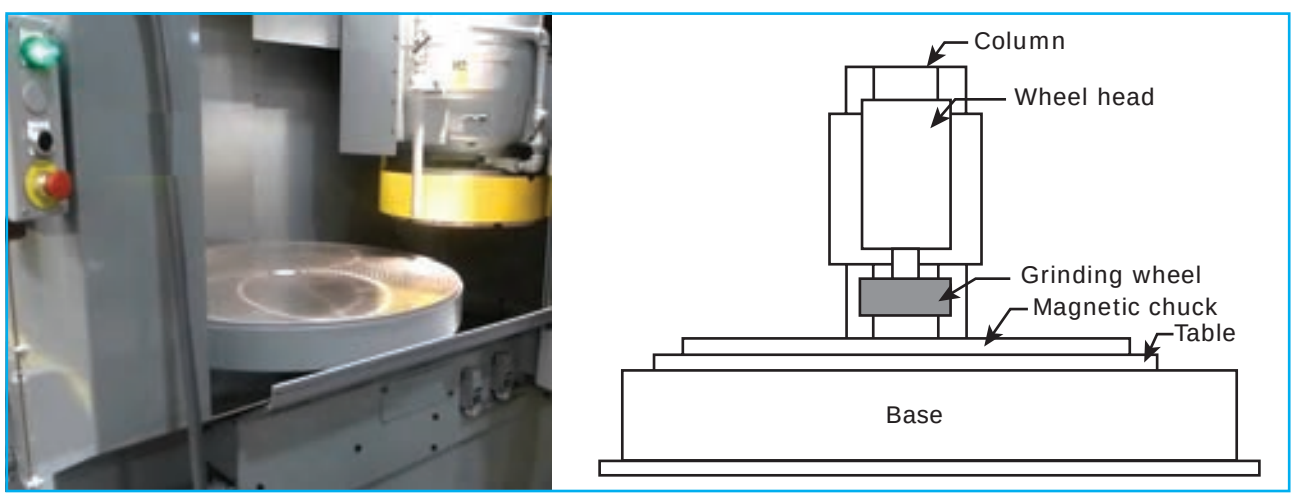
Wheel head

An electric motor is fitted on the wheel head to drive the grinding wheel. The wheel head is mounted on the guideways of the column, which is secured to the base. It can be raised or lowered with the grinding wheel to accommodate workpieces of different heights and to set the wheel for depth of cut.

Vertical spindle surface grinding machine

The face or slides of the wheel are used for grinding to the vertical type surface grinders. The area of contact is large and stock can be removed quickly. But a criss-cross patterns of grinding scratches are left on the work surface. Considering the quality of surface finish obtained, the horizontal spindle type machines are widely used.

The grinding wheel is mounted on the vertical spindle of the machine. The



Vertical spindle surface grinding machine

work is held on the table and grinding is done.

The base of the machine is a box like casting. The base is very similar to the one of the horizontal spindle grinding machine. It houses all the table drive mechanism.

The table is mounted on the base on top of the work table a magnetic chuck is mounted. A grinding wheel is mounted on the wheel head which slides vertically on the column. The table is made to reciprocate or rotate to bring the work surface below the grinding wheel to perform grinding.

Tool and cutter grinding machine

Tool and cutter grinders are used mainly to sharpen the cutting edges of various tools and cutters. They can also do light surface. Cylindrical and internal grinding to finish jigs, fixtures, dies and gauges.

Base

The base of the machine gives rigidity and stability to the machine. It is bolted rigidly to the floor. It supports all the other parts of the machine. The base is a box type and houses all the mechanisms for the saddle movements.

Saddle

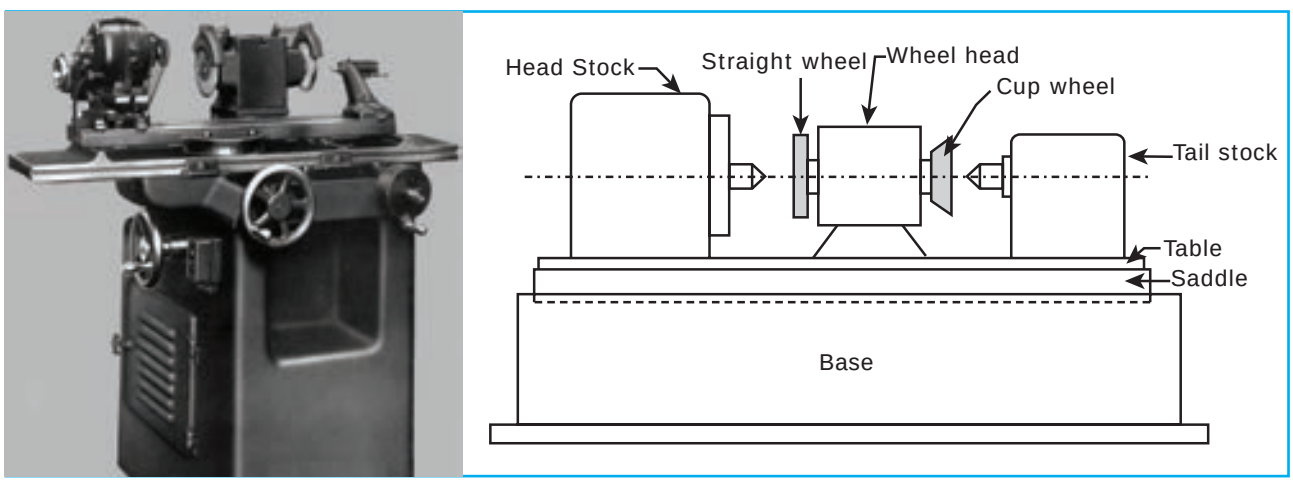
The saddle is mounted directly on the top of the base and slides over it. The column supporting the wheel head is mounted on the saddle. It can be moved up or down and swiveled to each side.

Table

The table rests and moves on a top base, which is mounted over the saddle. The table has two layers. The work table is mounted on the sub-table which has 'T' slots for mounting the work and attachments used on the machine. The work table can be swiveled while grinding tapers.

Wheel head

The wheel head is mounted on a column on the back of the machine. It can be swiveled and positioned in the base for different set-up. A straight wheel and a cup wheel are mounted on either sides of the wheel head.



Tool and cutter grinding machine

4.5 Size of grinding machine

The size of a grinding machine is specified according to the size of the largest work piece that can be mounted on the machine.

Cylindrical grinding machine, is specified by the diameter and length of the largest workpiece that can be held.

Internal cylindrical grinding machine is specified by the maximum diameter of the workpiece that can be held in the chuck and maximum stroke length of the wheel.

Surface grinding machine, is specified by the table area and the maximum height of the grinding wheel from the table surface.

Rotary table or chuck type grinding machine is specified by the maximum diameter of the table or chuck. Tool and cutter grinder is specified by the maximum size of tool and cutters that can be sharpened and dressed.

4.6 Centreless grinding

Centreless grinding is a method of grinding external, cylindrical, tapered and formed surfaces on workpieces, the workpiece is not held between the centres or in chucks. It is placed in a floating condition between two grinding wheels. There are two types of centreless grinding and they are

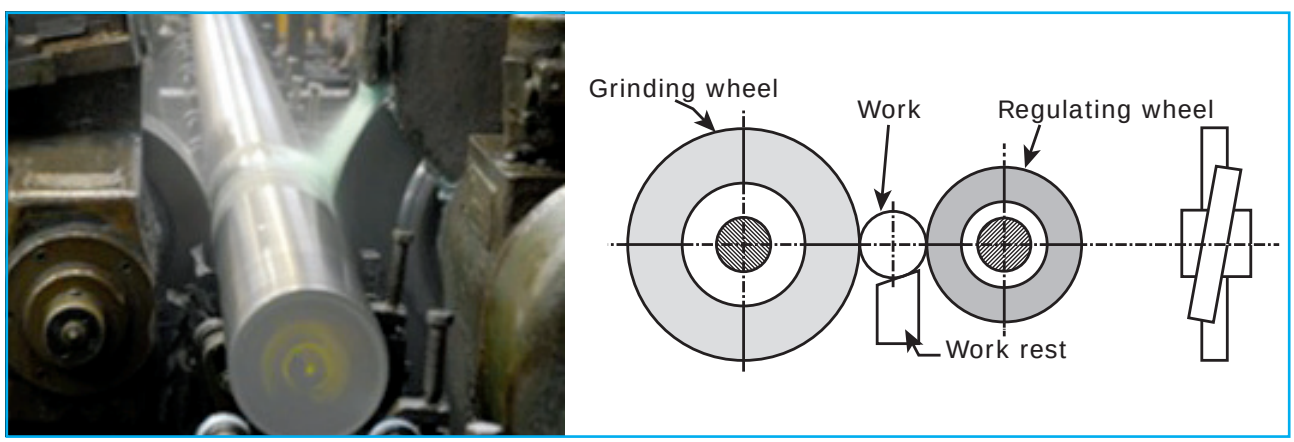
1. External centreless grinding
2. Internal centreless grinding

External centreless grinding

Two wheels – a grinding and regulating wheel are used in external centreless grinding. Both wheels are rotated in the same direction. The work is placed upon the work rest and rotated between the wheels. The axial movement of the work pass through grinding wheel is obtained by tilting the regulating wheel at a slight angle from horizontal. An angular adjustment of 0 to 10 degrees provided in the machine for this purpose.

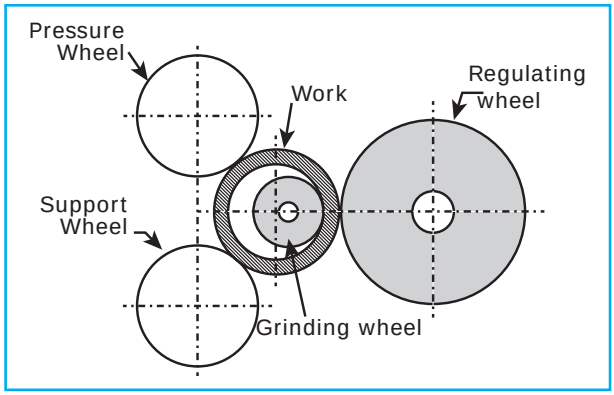
Internal centreless grinding

The principles of external centreless grinding are applied to internal centreless grinding also. Grinding is done on the inner surface of the holes. In internal centreless grinding, the work is supported by three rolls – a regulating roll, a supporting roll and a pressure roll. The grinding wheel contacts the inside surface of the workpiece directly opposite the regulating roll. The distance between



External centreless Grinding

the contours of these two wheels is the wall thickness of the work.



Internal Centreless Grinding

Advantage of centreless grinding

1. The workpiece is supported throughout the entire length, grinding is done very accurately.
2. Small, fragile or slender workpieces can be grind easily.
3. Work holding devices such as chucks, dogs, centres, mandrels are not required.
4. The process is continuous, it is best adapted for mass production.
5. The size of the work can easily be controlled.
6. Less skilled worker is sufficient.

Disadvantages of centreless grinding

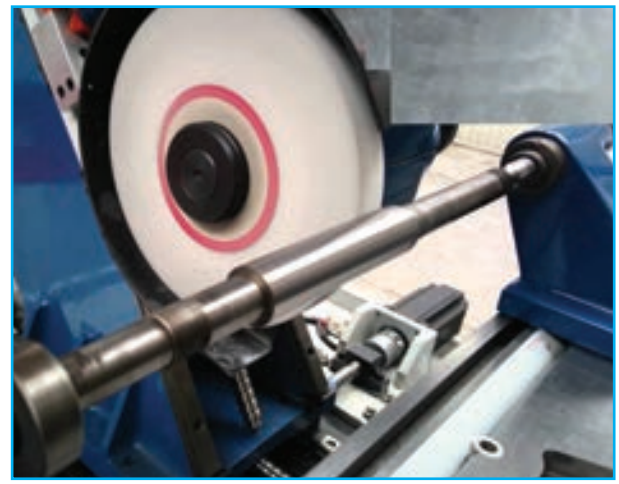
1. In hollow work, there is no certainty that the outer diameter will be concentric with the inside diameter.
2. Works having multiple diameters are not handled easily.

4.7 Grinding operations

Grinding is metal cutting operations of removing excess material from metal parts by means of a rotating hard abrasive wheel that act as a tool. The following operations are generally performed in a grinding machine.

1. Cylindrical grinding
2. Taper grinding
3. Gear grinding
4. Thread grinding

Cylindrical grinding



Cylindrical grinding is a metal cutting operation, where metal is cut by a rotating abrasive wheel in a cylindrical grinding is performed by mounting and rotating the work between two centres in a cylindrical grinding machine. The work is fed longitudinally against the rotating grinding wheel to perform grinding. The upper table of the grinding machine is set at 0^0 during the operation.

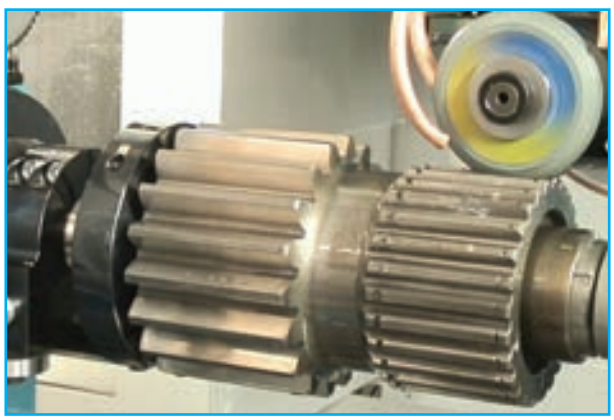
Taper Grinding

Taper grinding on long work pieces can be done by swiveling the upper table at required angle. If the work piece is short, the wheel hand may be swiveled by the taper angle. Another method of grinding external taper is to true the face of the grinding wheel by a diamond tool dresser to the required angle. In this case, the wheel head and the table are not swiveled.

Form Grinding

Gear grinding

The teeth of gears are ground accurately on gear grinding machines for their shape. Gear grinding is done by the generating process or by using a form grinding wheel.

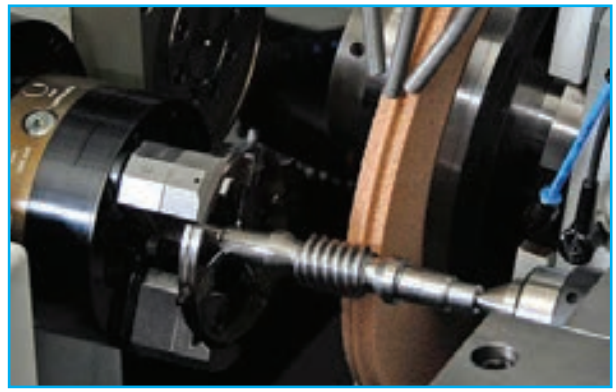


The generating process makes use of two saucer shaped grinding wheels. These wheels are used to grind two faces of successive teeth.

The forming process makes use of formed wheels to grind a tooth at a time. This is a very precise method of performing gear grinding.

Thread grinding

Thread grinding machines are used to grind threads accurately. The grinding wheel itself is shaped to the thread profile. These formed grinding wheels have one or multi threads on them.



Thread grinding

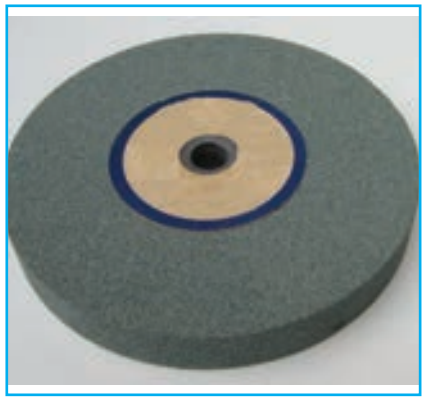
4.8 Wet and dry grinding

The method of spreading a good quantity of coolant over the work surface and wheel faces during grinding is known as 'wet grinding'. Soda water is used as a coolant. The process of grinding generates high amount of heat normally about 2000^0C. Various properties of the work material In order to reduce the heat generated during grinding, coolant is used. Wet grinding promotes long wheel life and better look of the ground surface. Coolant is pumped from the tank through pipelines.

Dry grinding is the method of doing grinding operation without applying coolant. Dry grinding produces undesirable effects on work surface. It leads to burring and discoloration of work surfaces. The cutting edges of the grinding wheel lose their cutting capacity. So, dry grinding should better be avoided.

4.9 Grinding wheel

A grinding wheel is a multi-tooth cutter made up thousands of hard particle known as abrasives having sharp edges. The abrasive grains are with a suitable bond, which act as a matrix to manufacture grinding wheels.



Solid grinding wheels

Segmented grinding wheels

Mounted grinding wheels

According to construction, grinding wheels are classified as follows.

1. Solid grinding wheels
2. Segmented grinding wheels
3. Mounted grinding wheels

4.10 Abrasive

Abrasives are used for grinding and polishing operations. It should be pure and have uniform physical properties of hardness, toughness and resistance to fracture. They are two types of abrasives

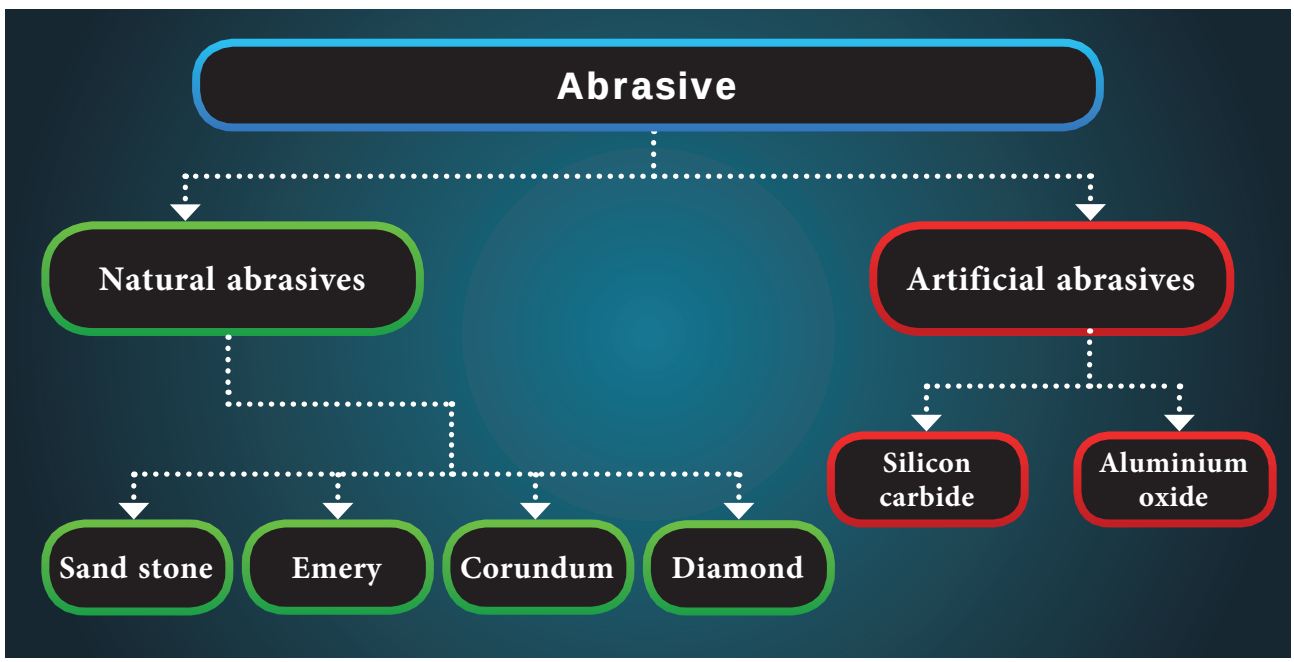
1. Natural abrasives
2. Artificial abrasives

Natural Abrasives

The natural abrasives are obtained from the Earth's crust. They include sand stone, emery, corundum and diamond.

Sandstone is used as abrasive to grind softer materials only. Emery is a natural aluminium oxide. It contains aluminium oxide, iron oxide and other impurities. Corundum is also a natural aluminium oxide. Emery and corundum have a greater hardness and better abrasive action than sandstone.

Diamond is the hardest natural abrasive. It is used in making grinding wheels to grain cemented carbide tools.



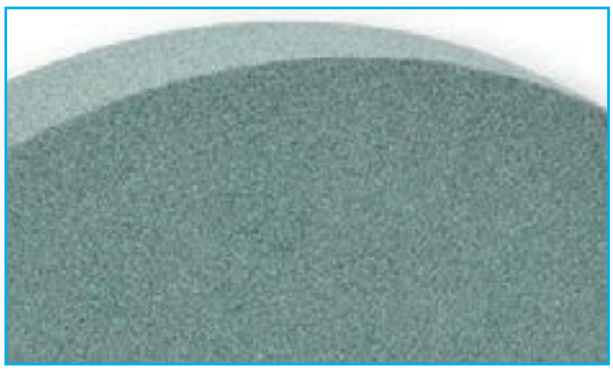
Artificial Abrasives

Artificial abrasives are classified as follows

1. Silicon carbide abrasives
2. Aluminium oxide abrasives.

Silicon carbide abrasives

Silicon carbide manufactured from 56% of silica, 34% of powdered coke, 2% of salt and 12% of saw dust in an electric furnace that is built of loose brick work. There are two types of silicon carbide abrasives green grit and black grit.



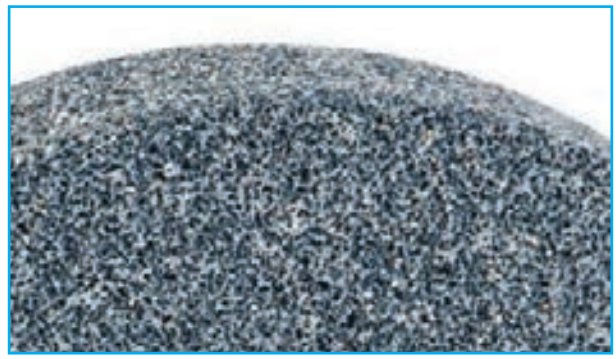
Silicon carbide

Silicon carbide is next to diamond in order of hardness, but it is not tough enough aluminium oxide. It is used for grinding materials of low tensile strength such as cemented carbides, ceramic materials, grey brass, bronze, copper, aluminium, vulcanized rubber etc. This is manufactured under trade names of carborundum. It is denoted by the letter 'S'.

Aluminum oxide

Aluminium oxide is manufactured by heating mineral bauxite, silica, iron oxide, titanium oxide etc mixed with ground coke and iron borings in an electric furnace.

Aluminum oxide is tough and not factured, so it is better adopted to grinding materials of high tensile such as most steels, carbon steels, high speed steels and tough bronzes. This is denoted by letter 'A'.



Aluminum oxide

Types of bond

A bond is an adhesive substance that is employed to hold abrasive grain together in the form of grinding wheels. There are several types of bonds. Different grinding wheels are manufactured by mixing hard abrasives with suitable bonds. The table containing the types of wheel manufactured using different types of bond and their symbols in given below.

Type of bond	Symbol	Grinding Wheel
Vitrified	V	Vitrified wheel
Silicate	S	Silicate wheel
Shellac	E	Elastic wheel
Resinoid	B	Resinoid wheel
Rubber	R	Vulcanized wheel
Oxychloride	O	Oxychloride wheel

Grit, Grade and structure

The grinding wheel is made of thousands of abrasives grains. The grain size or grit number indicated the size of the abrasive grains used in making a wheel or the size of the cutting teeth.

Grain size is denoted by a number indicating the number of meshes per

linear inch of the screen through which the grains pass when they are graded. There are four different groups of the grain size namely coarse, medium, fine and very fine. If the grit number is large, the size of the abrasive is fine and a small grit number indicates a large grain of abrasive.

Grain size	Grain numbers
Coarse	10 12 14 16 24
Medium	30 36 46 54
Fine	80 100 120 150
Very fine	220 240 280 320 500 600

Grade

The grade of grinding wheel refers to the hardness with which the wheel holds the abrasive grains in place. It does not refer to the hardness of the abrasive grains. The grade is indicated by a letter of the English alphabet. The term 'soft' or 'hard' refers to the resistance a bond offers to disruption of the abrasives. A wheel from which the abrasive grains can easily be dislodged is called soft whereas the one, which holds the grains more securely, is called hard. The grade of the bond can be classified in three categories.

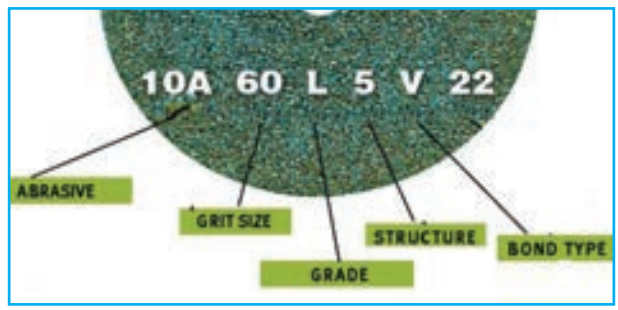
Grade	Denoted English letters
Soft	A B C D E F G H
Medium	I J K L M N O P
Hard	Q R S T U V W X Y Z

Structure

The relative spacing occupied by the abrasives and the bond is referred to as structure. It is denoted by the number and size of void spaces between grains. It may be 'dense' or 'open'. Open structured wheels are used to grinding soft and ductile materials. Dense wheels are useful in grinding brittle materials.

Structure	Identification number
Dense	1 2 3 4 5 6 7 8
Open	9 10 11 12 13 14 15 and above

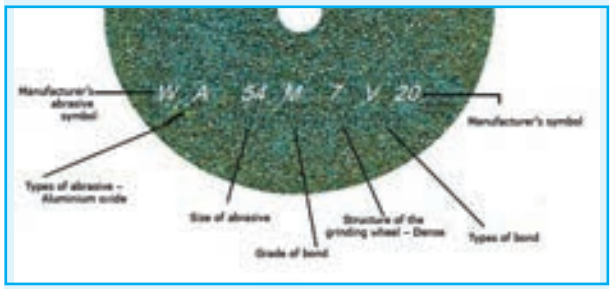
4.11 Grinding wheel specification



The Indian standard marking system of grinding wheels has been prepared with a view of establishing a uniform system of marking of grinding wheels to designate their various characteristics.

Prefix	Manufacturer's abrasive type symbol
First letter	Types of abrasive
First Number	Size of abrasive
Second letter	Grade of bond
Second number	Structure of the grinding wheel
Third letter	Types of bond

For specification of grinding wheel, outside diameter, width and centre hold diameter of the grinding wheel are also to be added. The meaning of the given marking on a grinding wheel



W A 54 M 7 V 20

W – Manufacturer's abrasive symbol

A – Types of abrasive – Aluminium oxide

54 – Size of abrasive – Medium

M – Grade of bond – Medium

7 – Structure of the grinding wheel – Dense

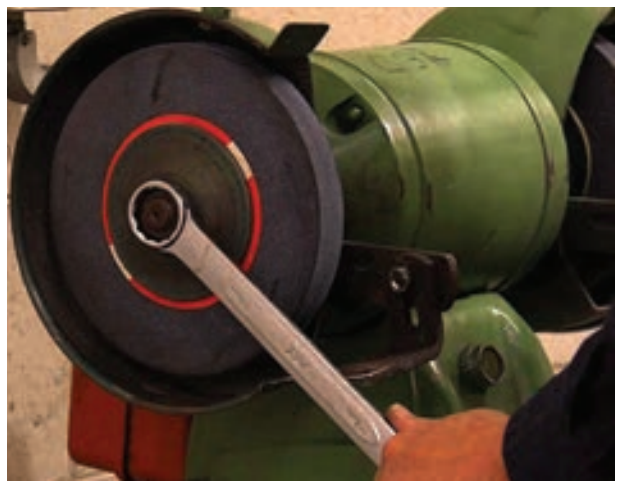
V – Types of bond – Vitrified

20 – Manufacturer's symbol

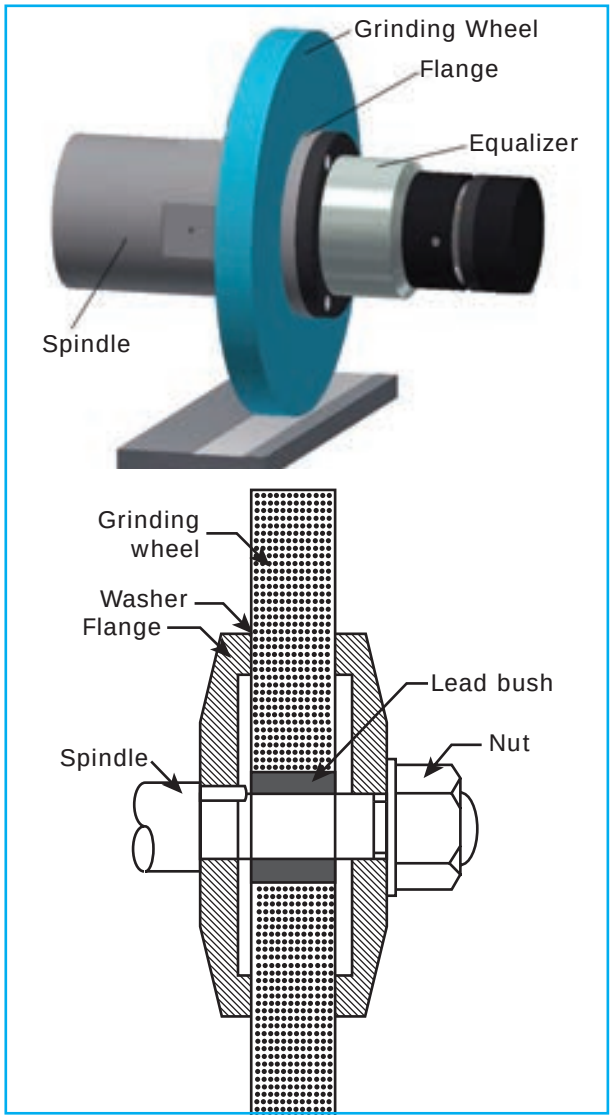
4.12 Mounting the grinding wheel

Great care must be take in mounting the grinding wheels on the spindle the following points are important in connection with mounting of grinding wheel.

1. All wheels should be inspected before mounting to make sure that they have not damaged. The wheel is put on an arbor and is subjected to slight hammer blows. A clear, ringing, vibrating sound must be heard.
2. The grinding wheel should not be forced on the spindle and they should have an easy fit on the spindle.
3. The length of the lead bush should not be more than the width of the wheel face.



4. Flanges of equal diameter are fitted at both sides of the wheel. The flange diameter should enough to hold the grinding wheel conveniently. Atleast the flange diameter must be equal to the half of the grinding wheel diameter.
5. The sides of the wheel and the flanges should be flat. Flanges contact the wheel only with the annular clamping area.
6. Washes of compressible materials such as cardboard, leather, rubber etc. Not over 1.5 mm thick should be fitted between the wheel and its flanges. The diameter of washers may be normally equal to the diameter of the flanges.



Method of Mounting Grinding Wheel

7. The inner flange should be keyed to the spindle, whereas the outer flange should have an easy sliding fit with the spindle.
8. The nut should be tightened to hold the wheel firmly.
9. Wheel guards should be fitted at required place before starting the grinding machine.
10. After mounting the grinding wheel, the wheel should be made to run idle for a period of about 10 to 15 minutes, grinding wheels must be dressed and trued before any work can be started.

4.13 Glazing, loading and chattering

Glazing

Glazing of the wheel is a condition in which the face cutting edge takes a glass like appearance. Glazing takes place if the wheel is rotated at very high speeds and is made with harder bonds. Rotating the wheel at lesser speeds and using soft bonds are the remedies. The glazed wheels are dressed to have fresh, sharp cutting edges.

Loading

The wheel is loaded in the particles of the metal being adhere to the wheel. The openings or pores of the wheel face are filled up with the metal. It is caused by grinding a softer material or by using a very hard bonded wheels and running it very slowly. It may also take place if very deep cuts are taken by not using the right type of coolant.

Chattering

Sometimes the way pattern of criss cross lines are visible on the ground surface. This condition is known as chattering. It takes place when the spindle bearings are not fitted correctly and because of the imbalance of the grinding wheel.

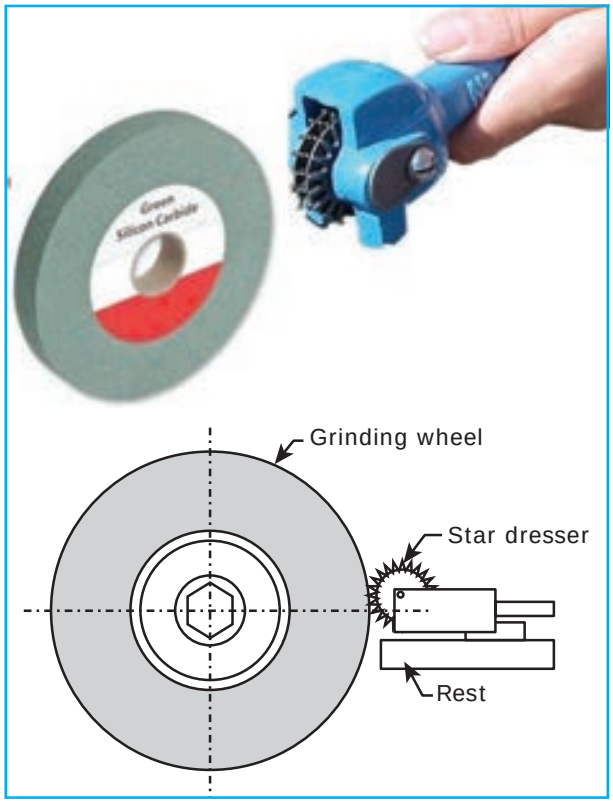
Dressing and truing of grinding wheel

If the grinding wheels are loaded or gone out of shape, they can be corrected by dressing or truing of the wheels.

Dressing

Dressing is the purpose of breaking away the glazed surface so that sharp particles

are again presented to the work. The common types of wheel dressers known as 'star'-dressers or diamond tool dressers are used for this purpose.



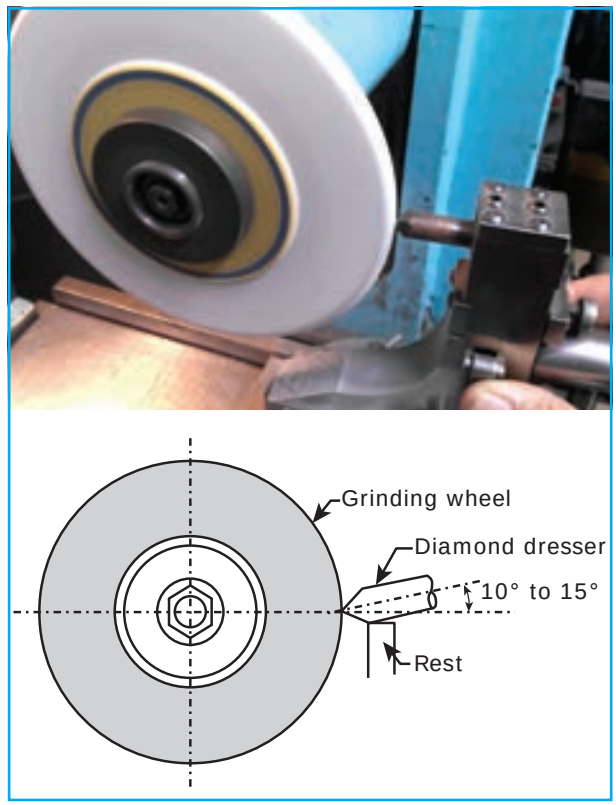
Dressing grinding wheel

Star dresser consists of a number of hardened steel wheels on its periphery. The dresser is held against the face of the revolving wheel and moved across the face to dress the wheel surface. This type of dresser is used particularly for coarse and rough grinding wheels.

For precision and high finish grinding, small industrial diamonds known as 'bort' are used. The diamonds are mounted in a holder. The diamond should be kept pointed down at an angle of 15^0 and good amount of coolant is applied while dressing very light cuts may be take with diamond tools.

Truing

The grinding wheel becomes worn from its original shape because of breaking away of the abrasive and bond. Sometimes the shape of the wheel is required to be changed for form grinding. For these purpose the shape of the wheel is corrected by means of diamond tool dressers. This is known as truing of grinding wheels.



Truing

In first, the diamond dresser is mounted on a work rest upon the work table. Diamond tool dressers are set on the wheels at 15^0 and moved across with a feed rate must not exceeds 0.02 mm. A good amount of coolant is applied during truing of grinding wheels.

4.14 Balancing of grinding wheels

The weight and density of the grinding wheel should be evenly distributed throughout the body of the wheel is known as balancing. Otherwise the wheel will rotate without balance. Wheel balancing is to be made by dressing and

Wheel Balancing

truing of grinding wheels. The grinding wheels are balanced by mounting them on test mandrels.

The wheel along with the mandrel is rolled on knife edges to test the balance and corrected.

4.15 Cutting speed, Feed and depth of cut

Cutting speed

Cutting speed of a grinding process is the relative speed of the grinding wheel and the workpiece. It is expressed in metre/minute.

Cutting speed (c.s) = πDN /1000 metre/min

π = 22/7 (or) 3.14

D = The diameter of the grinding wheel in mm

N = The speed of the grinding wheel in RPM.

Feed in a grinding process is the longitudinal movement of the work mounted on the table per revolution of the grinding wheel. It is express in mm per revolution.

The longitudinal feed during rough grinding is approximately 0.6 to 0.9 of the width of the wheel and 0.4 to 0.6 of the width of the wheel during finish grinding.

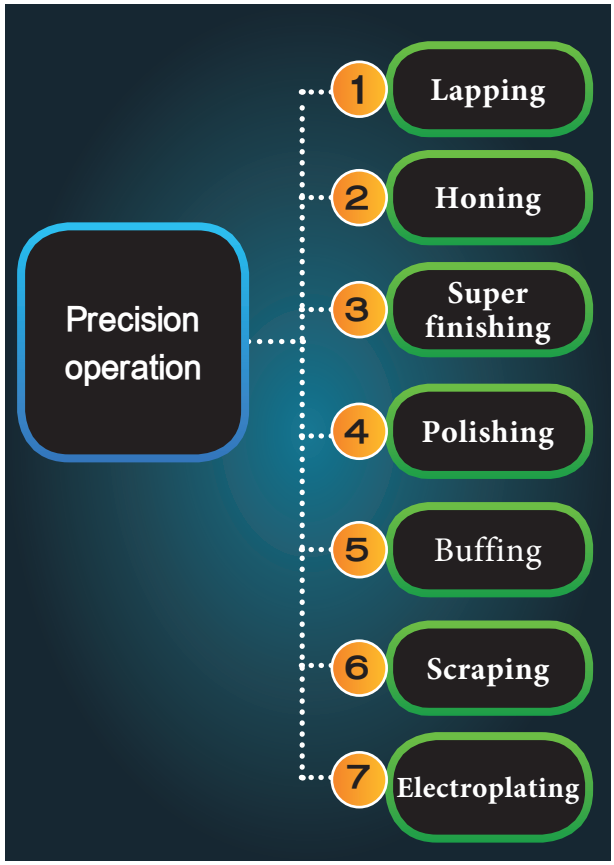
Depth of cut

The thickness of the metal layer removed from the work in one pass of the wheel is known as depth of cut. It is expressed in mm. Depth of cut is kept ranging from 0.005 to 0.04 mm

4.16 Precision Operations

In a workshop, metal parts are manufactured by performing different operations in lathe, shaping machine, milling machine, drilling machine or grinding machine. In order to enhance the quality of surfaces of these parts, several surface finishing processes are performed on them. However, if a better finish is desired for looks, for accuracy, for wearing qualities or for any other reasons, one of the following processes is employed.

1. Lapping
2. Honing
3. Super finishing
4. Polishing
5. Buffing
6. Scraping
7. Electroplating



Lapping

Lapping is the abrading process that is used to produces geometrically true surfaces correct minor surface imperfections, improve dimensional accuracy to provide a very close fit between two surface in contact. Very thin layers of metal (0.005 to 0.01 mm) are removed in lapping. Machining can be done to the accuracy of 0.1 micron.

Lapping

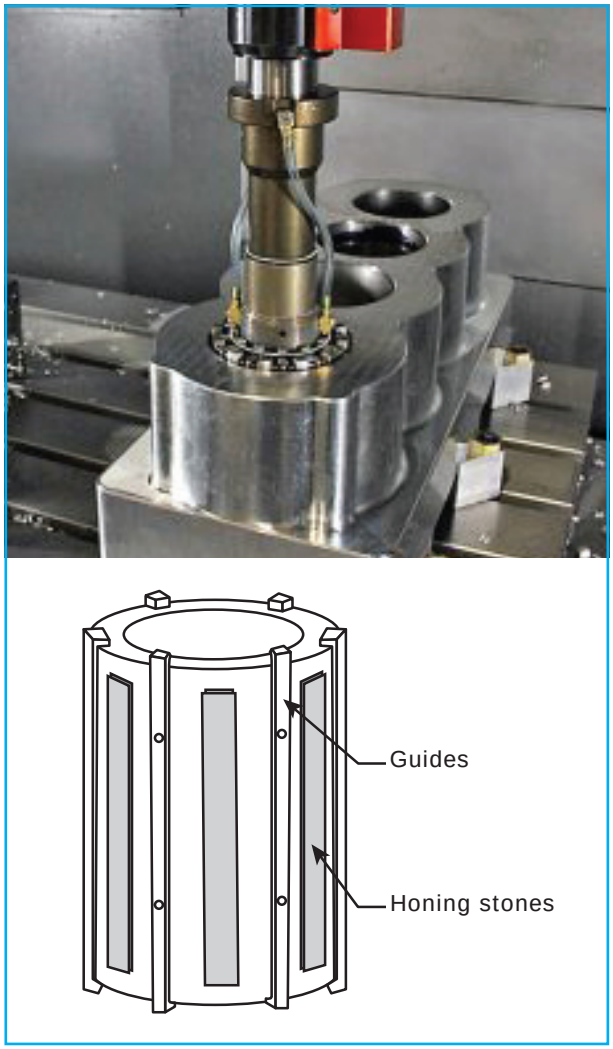
To perform lapping operations, lapping shoes and lapping mixture are needed. Laps may be made of almost any material soft enough to receive and retain the abrasive grains. They are made of cast iron, Brass, Copper lead or soft steel. It is made in different shapes. Lapping mixtures may be made abrasive power such as emery, corundum, iron oxide, chromium oxide mixed with oil or special pastes.

The face of the lap becomes charged with abrasive particles. Laps may be operated by hands or by machine. Cylindrical work may be lapped by rotating the work in a lathe and reciprocating the lap over the work. Flat surfaces may be lapped by holding the work against a rotating disc. Special lapping machines like vertical lapping machine, centreless lapping machine and abrasive belt lapping machines are also widely used.

Honing

Honing is the abrading process done mostly for finishing round holed produced by drilling, reaming or boring by means of bonded abrasive stones called 'hones'. Honing is a machining process and it is used to remove metal upto 0.25 mm. The surface roughness value can be maintained between 0.025 and 0.4 microns. So honing is used to correct some out af roundness, tapers, tool marks and axial distortion.

Honing stones are used for performing honing tool head fitted with honing stones is fitted on spindle and rotates. The parts having holes to be honed are mounted on vises or suitable fixtures. The spindle is moved vertically to abrade the walls of the holes. A good quantity of coolant should be applied while honing.



Honing

Honing can be done on materials like plastic, silver, brass, aluminium, cast iron, steel and cemented carbide. Journal bearings supporting the crank shafts and long holes found in the barrels of guns are generally honed. There are two types of honing machines namely vertical and horizontal.

Superfinishing

The process of superfinishing is an operation intended to produce an extremely high quality of surface finish. The surface roughness valve can be maintained between 0.015 and 0.32 microns. A very thin layer of metal (0.005 mm to 0.002 mm) is removed by using very fine size of abrasives (size of 400 to 600) in super finishing. It can be done on both external and internal surfaces.

The grinding stones are made to reciprocate and the work piece is made to rotate or reciprocate. A fine surface is obtained by admitting coolant mixed with kerosene. Using some special machines, super finishing is performed on crank shaft, journal bearings and cam shafts.

Polishing

Polishing is a surface finishing operation performed by a polishing wheel for the purpose of removing metal to take out scratches tool marks and other defects from rough surfaces. Polishing is performed only to provide better looks. Polishing wheels are made of leather, paper, canvas, felt or wool. The abrasive grains are setup sometimes on the faces of the wheel and work is held against it and rotated to give the desired finish.

Polishing

Buffing

Buffing is used to give a much higher, reflective finish that cannot be obtained by polishing. Buffing wheels are made of felt pressed and glued layers of a variety of cloth. The abrasive may consist of iron oxide, chromium oxide, emery, etc. The abrasive is mixed with a binder. The binder is a paste consisting of wax

mixed with grease, paraffin, kerosene and turpentine. It is applied either on the buffing wheel or on the work. Buffing wheels are rotated against the work to get a superior finish.

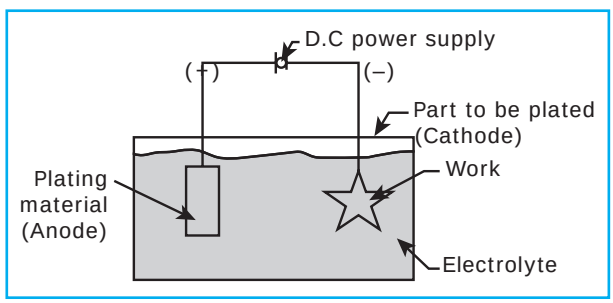
Scraping

There will be always some minor imperfections on the machined surfaces. They are removed by using hand tool called scraper. There are three types of scrapers-flat, half-round and triangular. The part to be scraped is fitted in a vise and thin layer of Persian blue is applied on the surface. Thin flakes of metal are removed. Persian blue is once again applied to check the flatness.

Scraping

Electro plating

Electro plating is the process of applying metallic coatings on the surfaces of metal parts. It can be done on parts of non-metals also.



Electroplating

This is done for protection against corrosion or against wear and tear and far better appearance. It is also done to slightly increase the size of worn out parts and to make parts easy to solder. It may also used to keep off selected areas on steel parts from being carburized during heat treatment.

Common plating materials are chromium, nickel, copper, zinc, cadmium, etc. The more precious metals like silver, gold, platinum and radium are also applied for plating. Door handles and automobile parts are chromium plated for appearance. The method of plating a layer of zinc is known as galvanizing.

Surface to be plated must be buffed smooth to eliminate scratches. The surface is cleaned by suitable cleaning solutions to remove all grease and dirt.

The four essential elements of a plating process are the cathode, anode, electrolyte and direct current. The current leaves the anode, which is a bar of plating metal and migrates through the electrolyte to the cathode which is the part to be plated.

4.17 Safety precautions

1. We should ensure that the work is held firmly and properly. The grinding wheel should be inspected and mounted on the spindle.
2. Proper work speed, wheel speed and table feed should be selected according to the nature of the work.
3. Safety goggles should be worn by the operator.
4. It should be checked whether the safety guards are fitted.

5. The operator should not touch the rotating work or the grinding wheel.
6. The operator should not wear loose shirts and neck tie.
7. The work rest of a bench grinder should be placed close to the grinding wheel.
8. The speed of the vitrified grinding wheels should not exceed 2000 meters per minute.
9. When new wheels are used, the wheels should be kept minimum.

ACTIVITY

1. Arrange the students to visit nearby industry, to demonstrate about the different types of grinding machines and its operation.

10. If the job is in a magnetic chuck, extra grips should be placed around the work pieces.

Questions

Part I.

Choose the correct option **1 Mark**

1. The accuracy obtained by precision grinding is
   a. 0.000025 mm
   b. 0.0025 mm
   c. 0.00125 mm
   d. 0.00625 mm

2. The cutting tool with several thousands of cutting edges is
   a. Lathe cutting tool
   b. Drill
   c. Grinding wheel
   d. Milling cutter
3. The heat generated during dry grinding will be
   a. 2000^0C
   b. 20^0C
   c. 1000^0C
   d. 1200^0C
4. Bond used for making elastic grinding wheel is
   a. Vitrified
   b. Silicate
   c. Shellac
   d. Resinoid
5. The grip with which the bond holds the abrasives is known as
   a. Grain size
   b. Grade of the grinding wheel
   c. Structure of the grinding wheel
   d. Type of abrasive

Part II.

Answer the following questions in one or two sentences **3 Marks**

6. What is meant by grinding?
7. Name any four types of grinding machines.
8. What is meant by centreless grinding?

9. What are the four types of surface grinders?
10. List out any four operations performed in a grinding machine.
11. What are the effects of dry grinding?
12. Mention any four types of bonds used in grinding wheel.
13. What is meant by "glazing"?
14. What is meant by "Loading" in a grinding wheel?
15. What are the reasons for chattering?

Part III.

Answer the following questions in about a page — 5 Marks

16. List out the various types of non-precision and precision grinding machines.
17. Explain the external centreless grinding machine with neat sketch.
18. A grinding wheel is specified as follows WA46K5V17. Explain the meaning of each symbol.
19. Explain with neat sketch of "Truing of a grinding wheel".
20. Explain "Dressing" of a grinding wheel with a diagram.
21. Write short notes on
    a. Lapping
    b. Honing

Part IV.

Answer the following Questions in detail. — 10 Marks

22. Sketch and explain important parts of an external cylindrical grinder.
23. Sketch and explain a surface grinder.
24. Explain 'mounting' of a grinding wheel with a suitable diagram.
25. Write notes on
    a. Precision grinding
    b. Polishing
    c. Buffing
    d. Scraping