

Grinding

Grinding is a metal cutting operation performed by means of rotating abrasive tool called grinding wheel

The wheel is made up of large no. of projected abrasive partial in the grinding wheel.

Abrasive particles have irregular shape and sharp edges. The work piece surface is machined by removing very tiny amounts of material at random points where a particle contacts it.

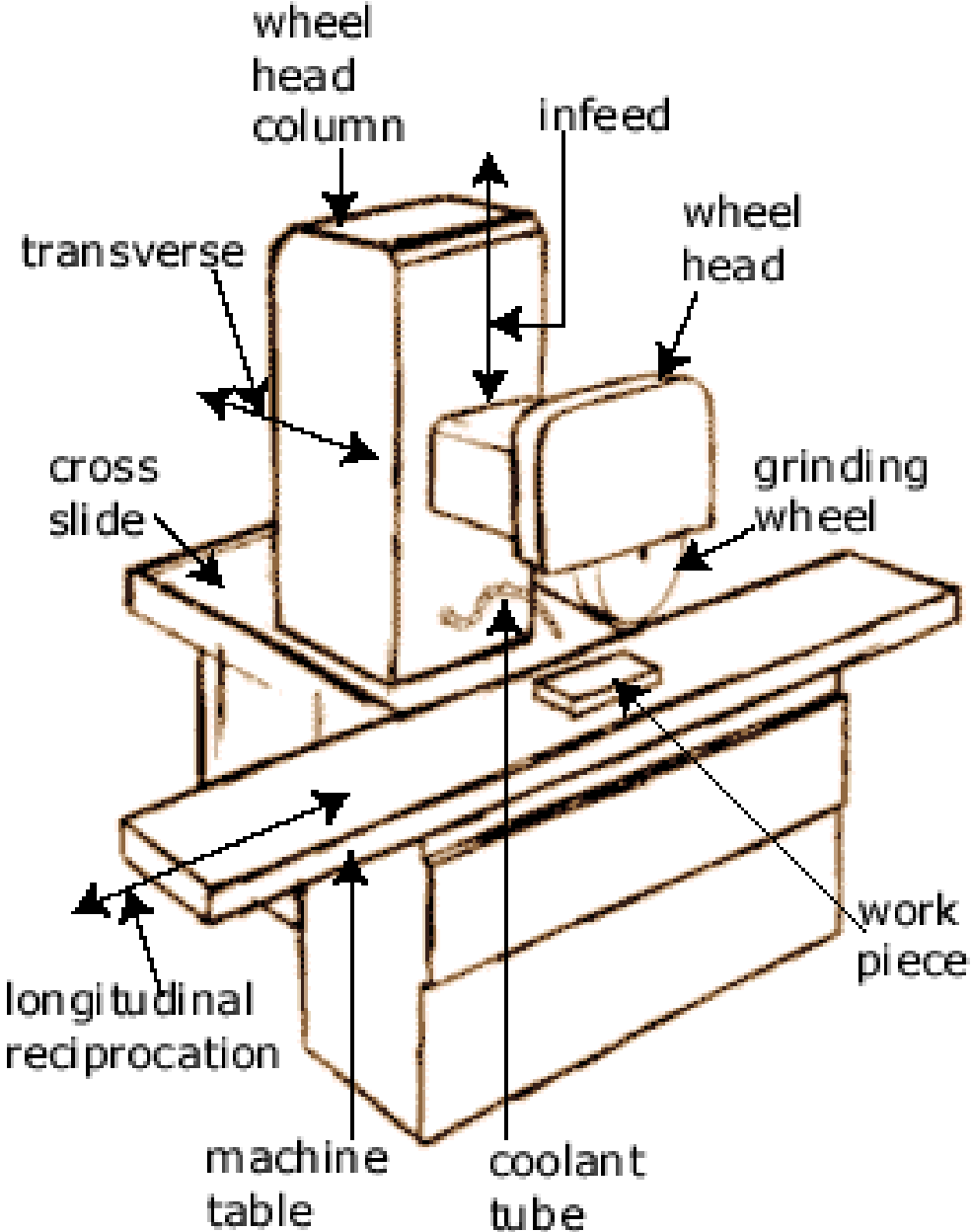
Conventional grinding machines can be broadly classified as:

- Belt Grinding
- Surface grinding machine
- Cylindrical grinding machine
- Internal grinding machine
- Tool and cutter grinding machine

Belt Grinding



Surface grinding machine

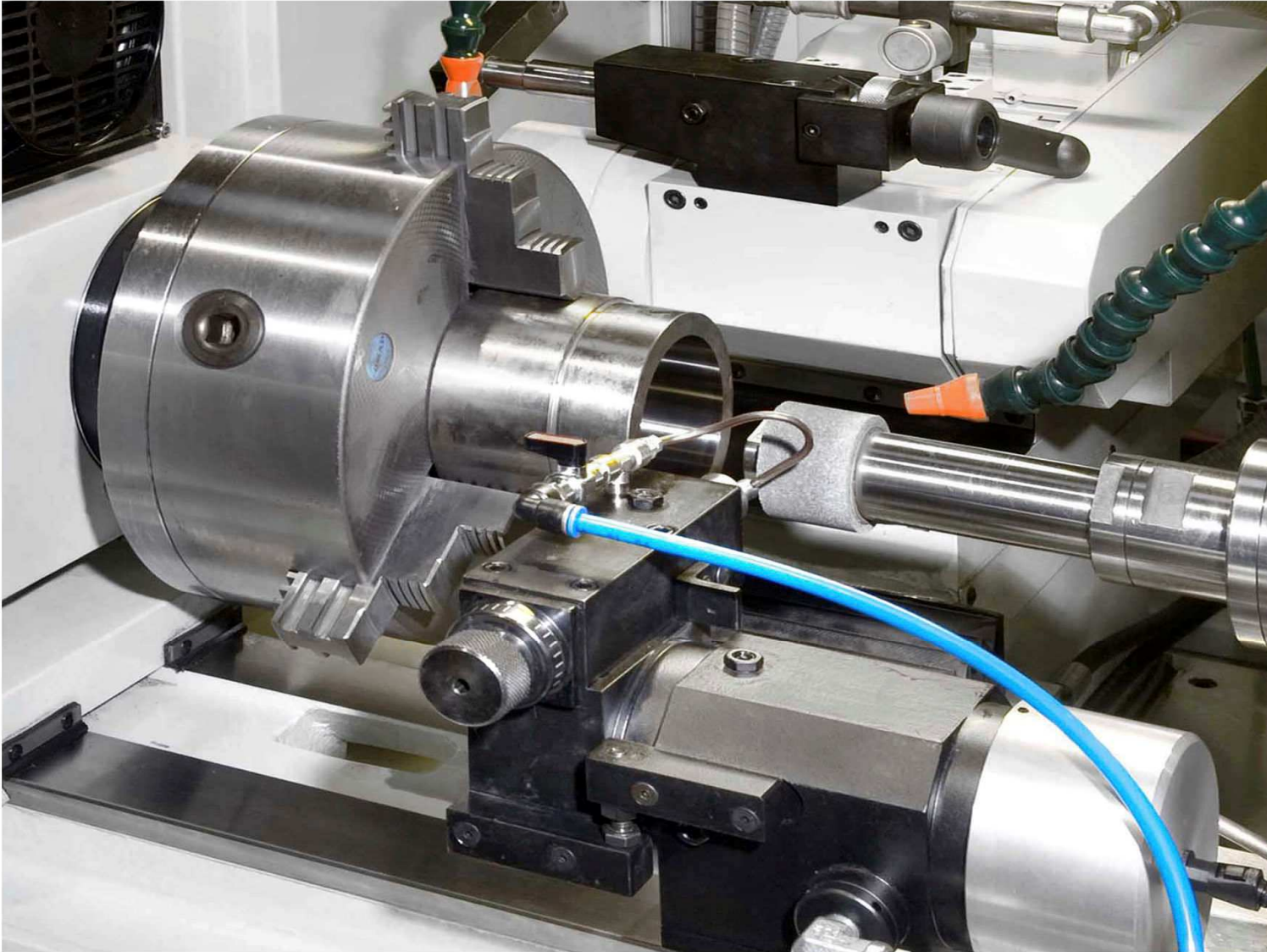




Cylindrical grinding machine

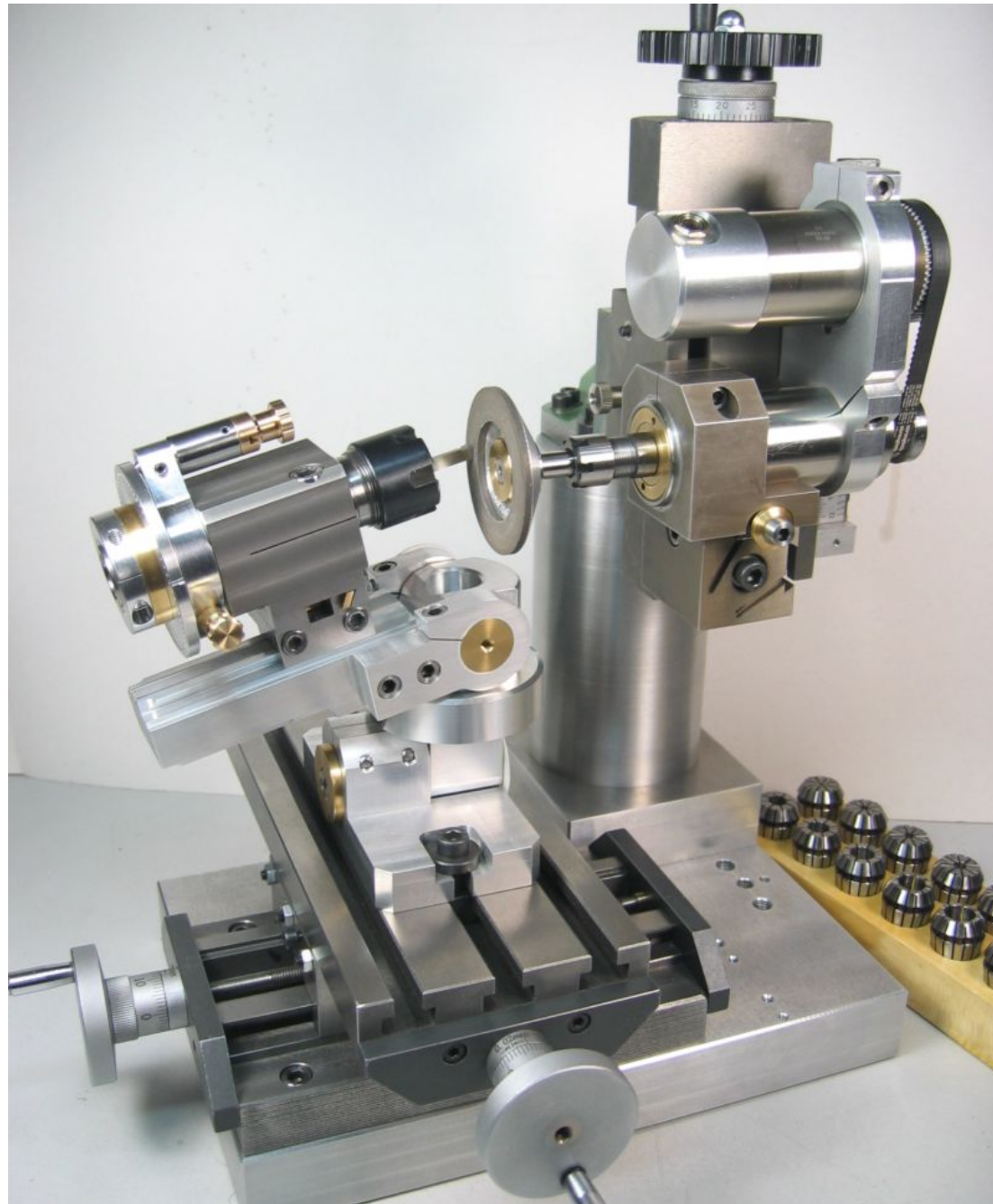


Internal grinding machine



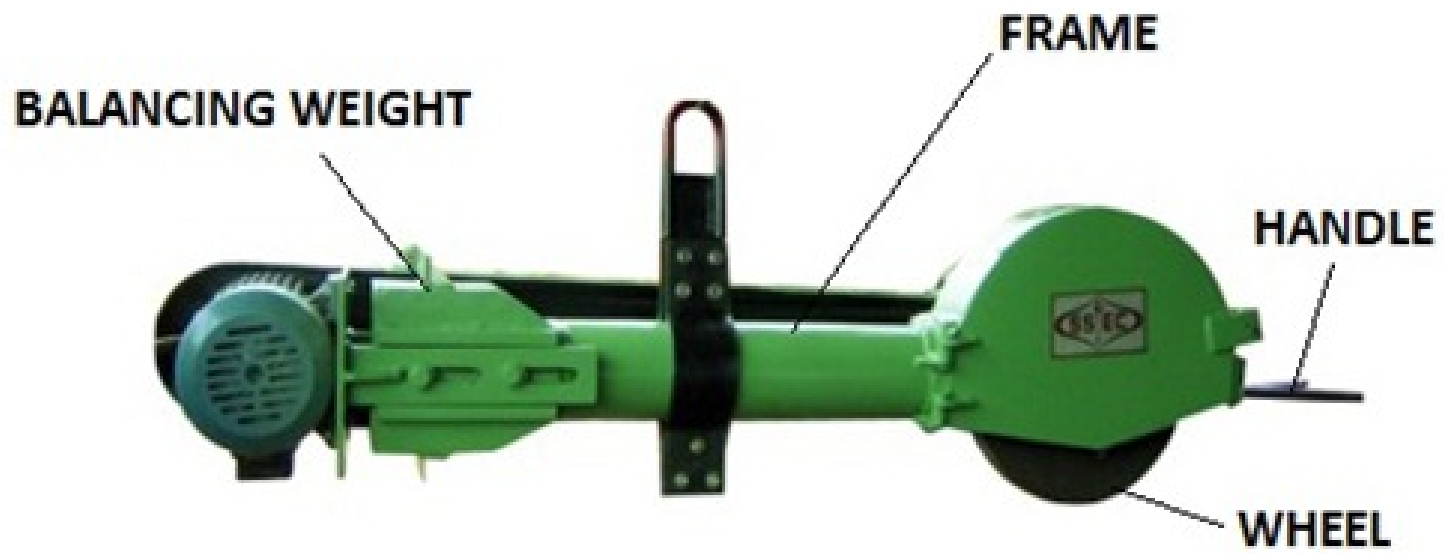
Tool and cutter grinding machine





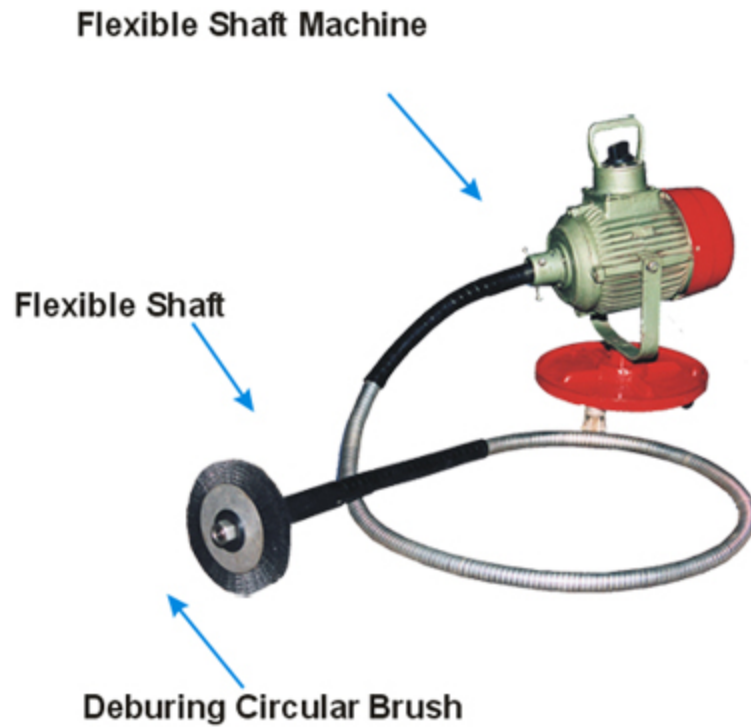
According to the quality of surface finish

- Bench , pedestal or floor grinders
- Swing frame grinders.
- Portable and flexible shaft grinder
- Belt Grinders.



SWING FRAME GRINDER

Portable and flexible shaft grinder



According to the type of the surface generated or work done

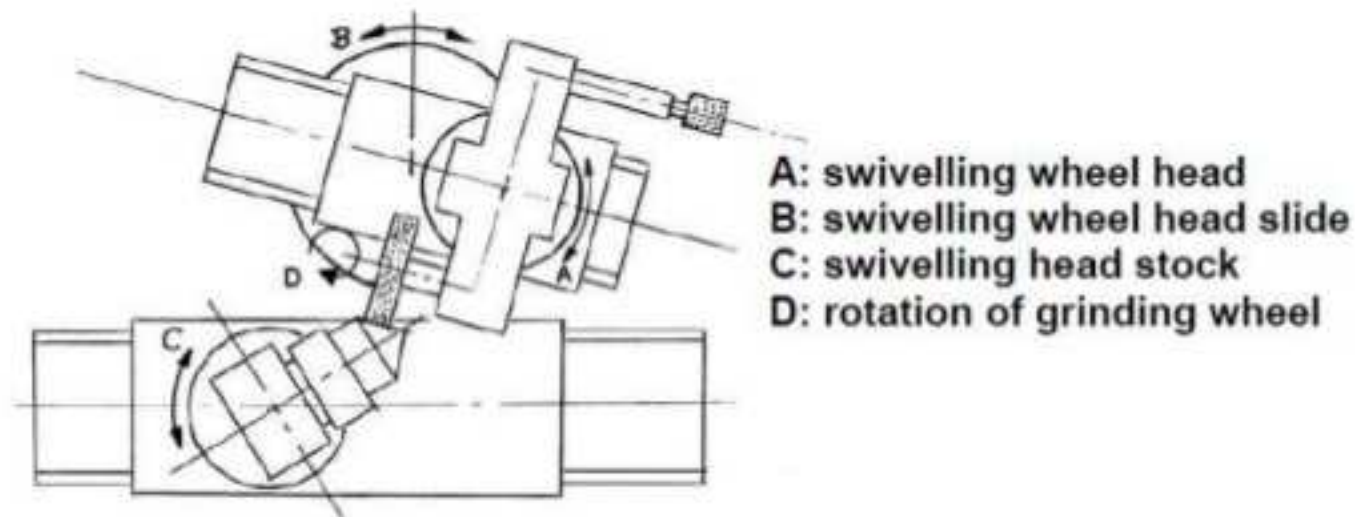
Cylindrical grinding

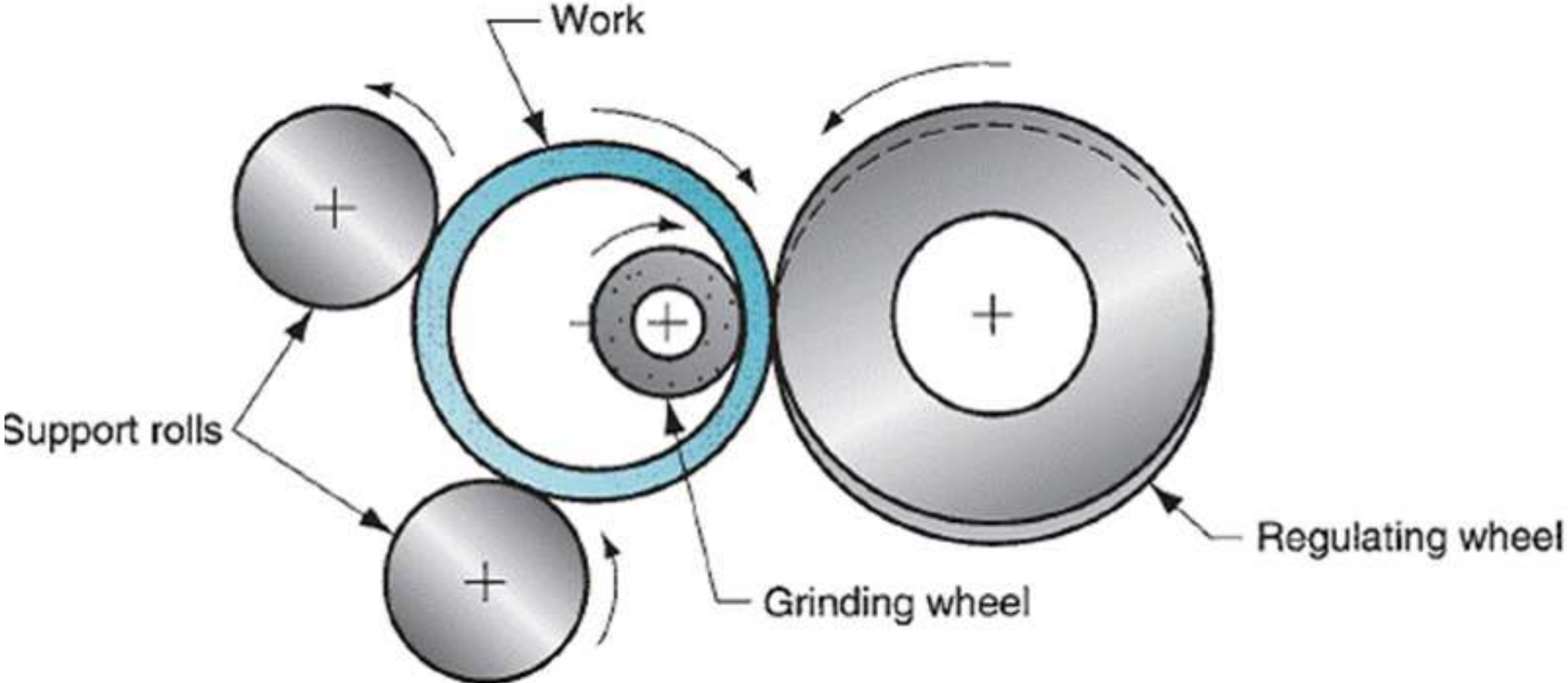
- Plane cylindrical grinder
- Centre less internal grinder
- Universal cylindrical grinder

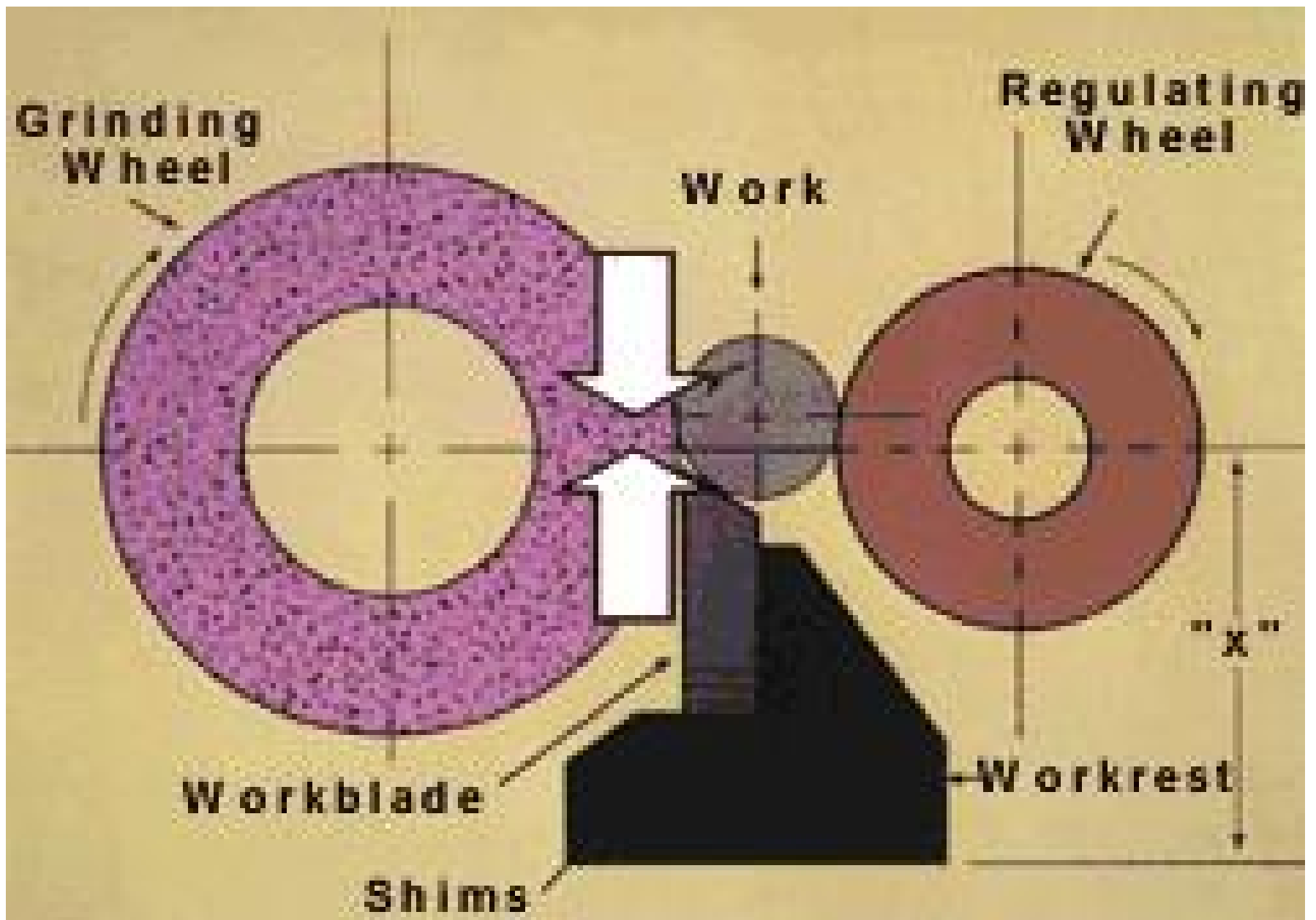
Internal grinder

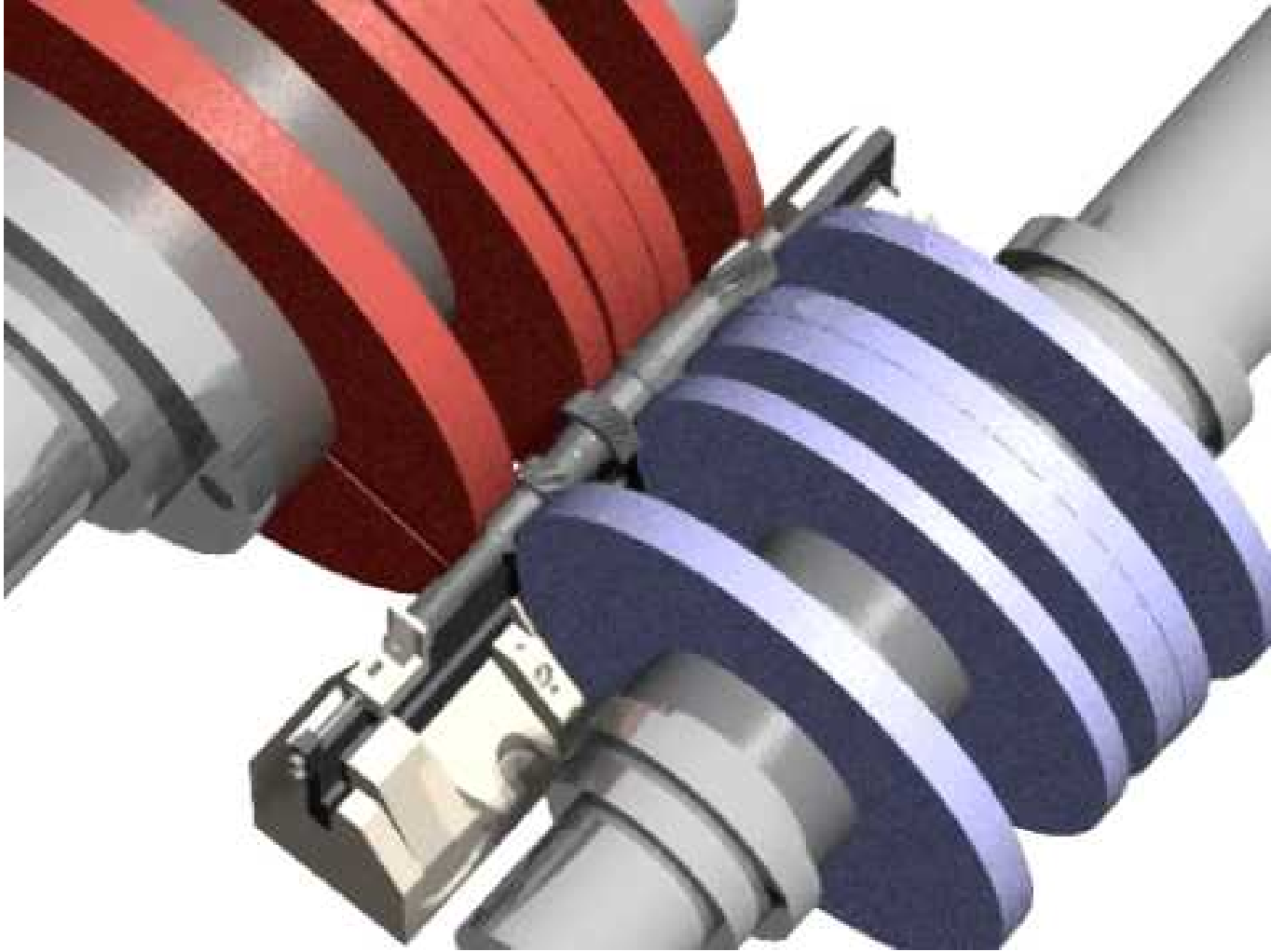
Universal cylindrical surface grinder

Universal cylindrical grinder is similar to a plain cylindrical one except that it is more versatile. In addition to small worktable swivel, this machine provides large swivel of head stock, wheel head slide and wheel head mount on the wheel head slide.









Grinding M/C

- Cylindrical grinder

Work between centers, Chucking type cylindrical grinder ,Centre less & Crank shaft and other special application

Internal grinder

Work rotated in chuck , work stationery ,work rotated and held by rolls

Surface grinder

(i)Plane type ,

(a)horizontal spindle,(b) vertical spindle ,

Rotating table

(a)horizontal spindle,(b) vertical spindle

Special grinding machine

1 Swinging frame

Construction of Grinding wheel

Grinding wheel consist of

- **Abrasive** is a small nonmetallic hard particle sharp edges and an irregular shape
- **Bond**
- **Grain Size**
- **Grade** of the wheel indicate the strength of the grain, and holding power of the bond or referred to as hardness of the wheel.
- **Structure of wheel**

- Abrasive materials
 - Aluminum oxide: grinding ferrous and high-strength alloys
 - Silicon carbide: grinding aluminum, brass, and stainless steel, cast irons and certain ceramics
 - Cubic boron nitride: grinding hardened steels and aerospace alloys
 - Diamond: grinding ceramics, cemented carbides, and glass

Bonding materials – requires strength, toughness, hardness, and temperature resistance.

Vitrified bond (V): In this process , after manufacturing of abrasives all types of grains are mixed with ceramic porcelain , molded in mould , dried set properly and fired at 715 C for 12 to 14 .

Silicate(S): In this process sodium silicate is mixed with abrasive grains mixture in a mould, dried for several hours and finally baked at temperature 270c for 20 – 80 hr

Rubber (R): In this bond material is pure rubber with some amount of sulphur which act as vulcanization agent .The abrasive grains are spread between rubber sheet and they are then rolled to desired thickness and finally vulcanized .

Shellac (E): Abrasive partial is coated with shellac and mixture headed to given uniform mixture and then mixture is rolled.

Bakelite or Resinoid bond (B):-In this process abrasive particle are powdered and mixed with synthetic resin and liquid solvent which dissolve resin. The mixture is rolled or pressed to the desired shape and baked for a few hr at temp. of 205 to 260 C

- **Grain Size** :- It influence the stock removal rate and surface finish.

Choice of grain size is determine by :-

Nature of grinding operation , material to be ground ,material removal rate and surface finish required.

For Soft material it is general practice to use coarser grain size and for hard material fine grain. Coarse grain- high rate of material remove.

Fine particle size 120-700,medium 30-100,coarse 6 -24

- **Grade**:- The hard material have high strength offer more resistance to wheel while grinding operation is performed . If hard grade of wheel is used the wheel will get blunt soon and grinding will not be good. For better result the abrasive particle should be break and fall quickly so that the new face of the particle do the work and never get blunt.

The hardness of grinding wheel is classified as very soft (A to G) , soft (H to K),medium (L to O) hard (P to S) and very hard (T to Z)

- Structure of Grinding wheel :- Refers to the voids between abrasive particle for a given bonding material thickness of void size is controlled by the spacing of the grains and this structure may be dense or open.

In case of hard material the chips are small size and rate of removal is low. Thus small reservoir needed to remove the chip from **the hard material** and thus **dense structure is desirable**.

Selection of grinding wheel

- Compulsory Element :-

1.Abrasive ,2.Grain Size ,3.Grade & 4.Type of bond

Optional Element are

1 Prefix ,2Structure 3 Suffix

Abrasive A- for Al_2O_3 , C- SiC , WA for white Al_2O_3

GC for Green SiC

Prefix it denote manufacturing symbol for exact nature of abrasive like GC . Here G is prefix and C stand for silicon carbide

Structure it is denoted by number from 1 – 15

1-8 Dense structure

9-15 open structure

Suffix it is manufacture own identification mark depend up on the process and type of manufacturing

WA46K5VBE

WA46K5VBE

W –white prefix

A-abrasive

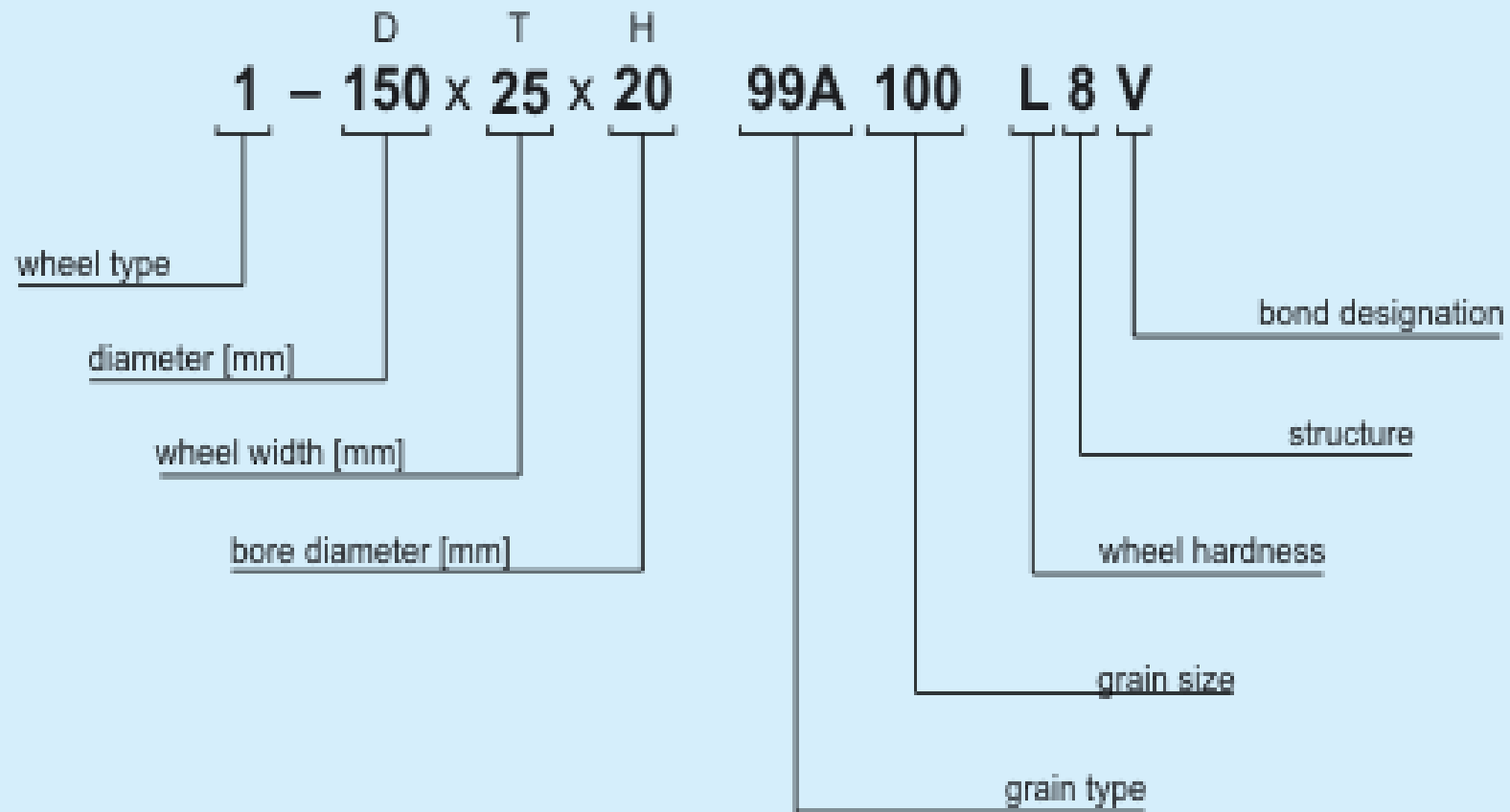
46 Grain size

K Grade

5 Structure (dense or open)

V bond

BE suffix



Geometric parameters

Abrasive parameters

64A60 H15VP

Grinding faults

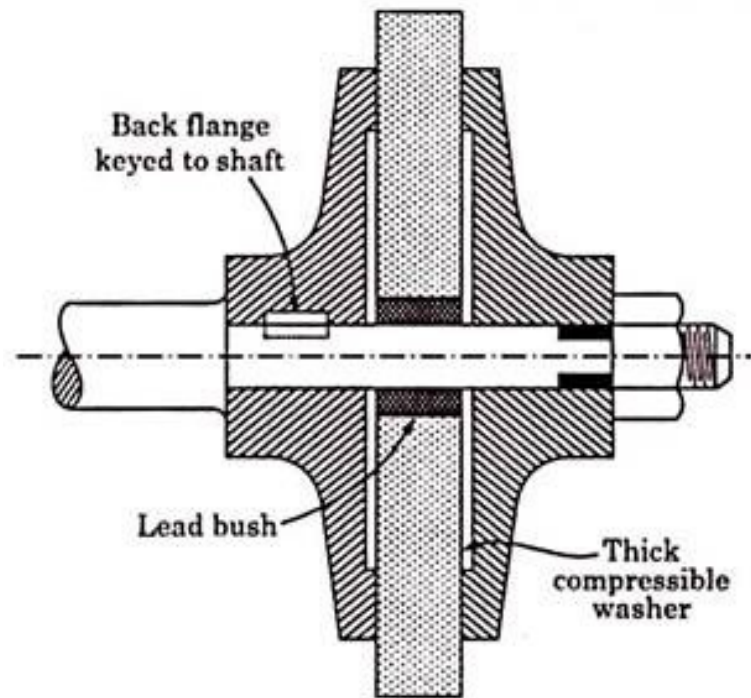
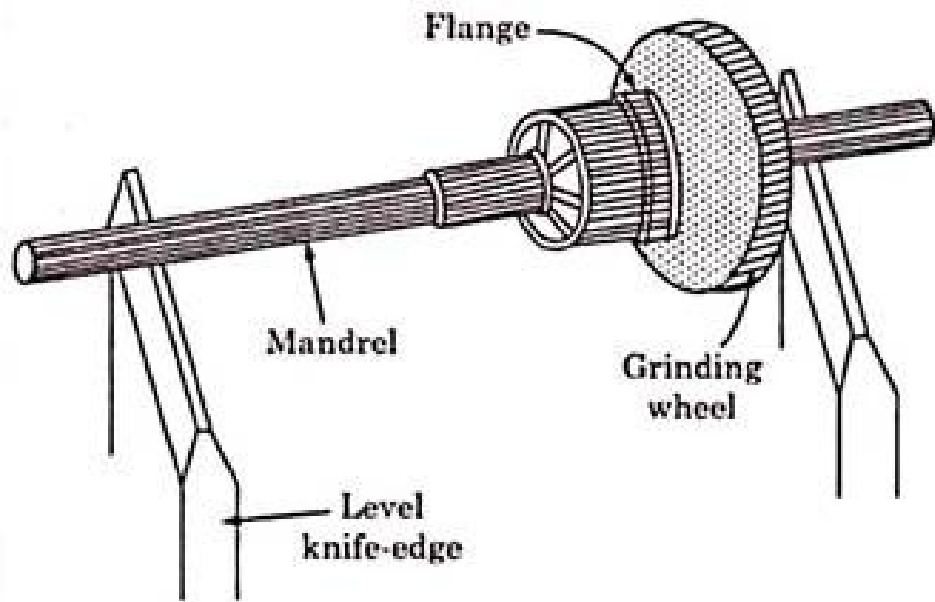
- 1 Loading
- 2 Glazing

Loading :- It occurs when space between the abrasive grains become clogged with particle of metal

Glazing :- It occurs due to abrasive become dull and not breaking away from the bond.

Precaution to be taken before Mounting a grinding wheel

- The wheel should be first examined for any flaw or crack
- Wheel Balance
- The side of the wheel and flanges which clamp the wheels should be flat and bear evenly all around
- The lead bushing should be an easy fit and not forced be used
- The back fixed flange should be keyed shrunk or otherwise fixed to the spindle in order to transmit the power from the spindle to the wheels



Wheel Truing and Dressing

Wheel Truing When the grinding wheel is mounted to the grinding wheel spindle, the run-out on wheel operating surface is removed, the wheel during contour grinding is trued or worn grinding wheel is corrected. Thus, these operations are for the truing.

Dressing When the sharpness of grinding wheel becomes dull because of glazing and loading, dulled grains and chips are removed (crushed or fallen) with a proper dressing tool to make sharp cutting edges and simultaneously, make recesses for chips by properly extruding to grain cutting edges.

Safety in Grinding

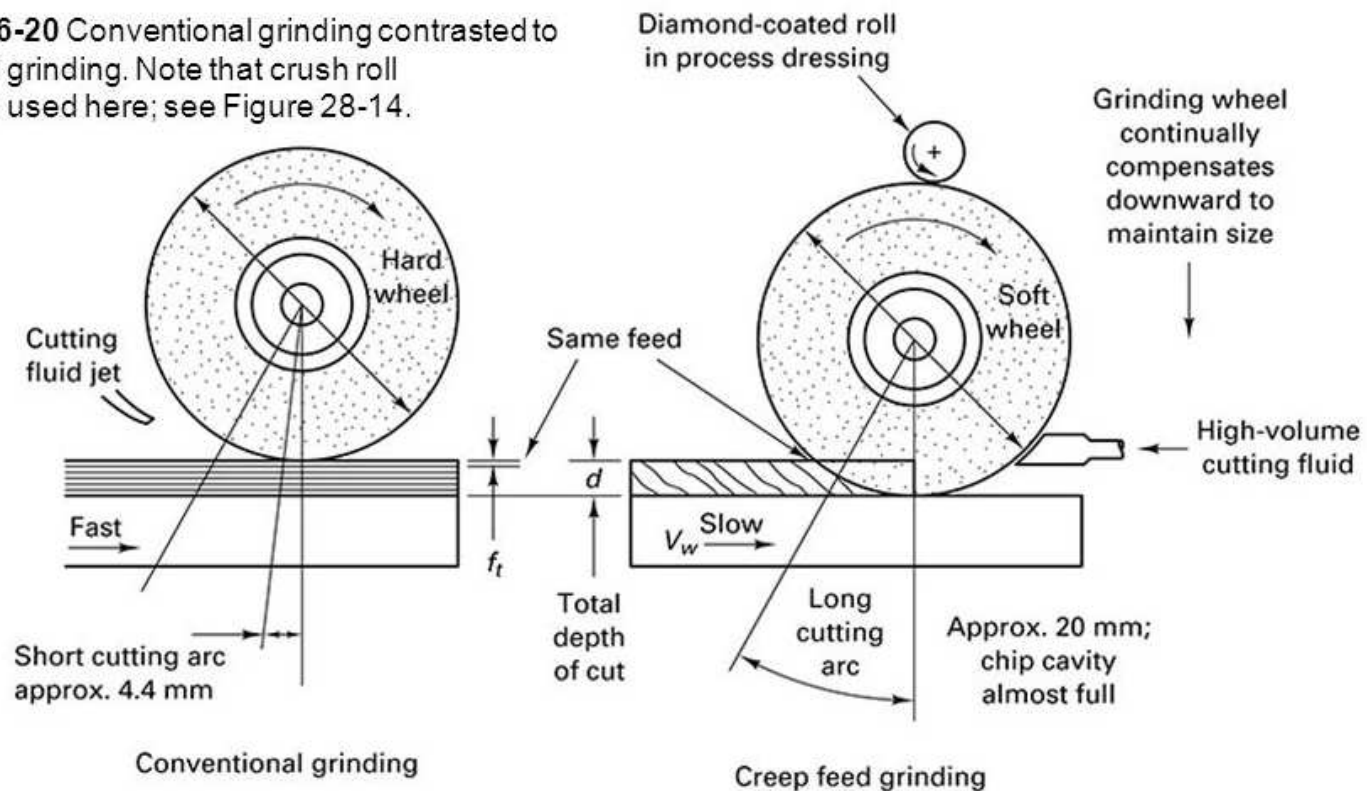
- Mounting of grinding wheel
- Wheel Speed
- Wheel inspection
- Wheel guards
- Dust collection and health precaution
- Wheel operation- If power is not adequate wheel will slow down and develop flat spots make wheel run out of balance

- **Traverse grinding** operation is when the wheel is fed parallel to the surface being machined.
- **Plunge grinding** operation is when the wheel is fed perpendicular to the surface being machined. and grinding wheel having face wider than the length of surface to be ground.

Creep feed grinding

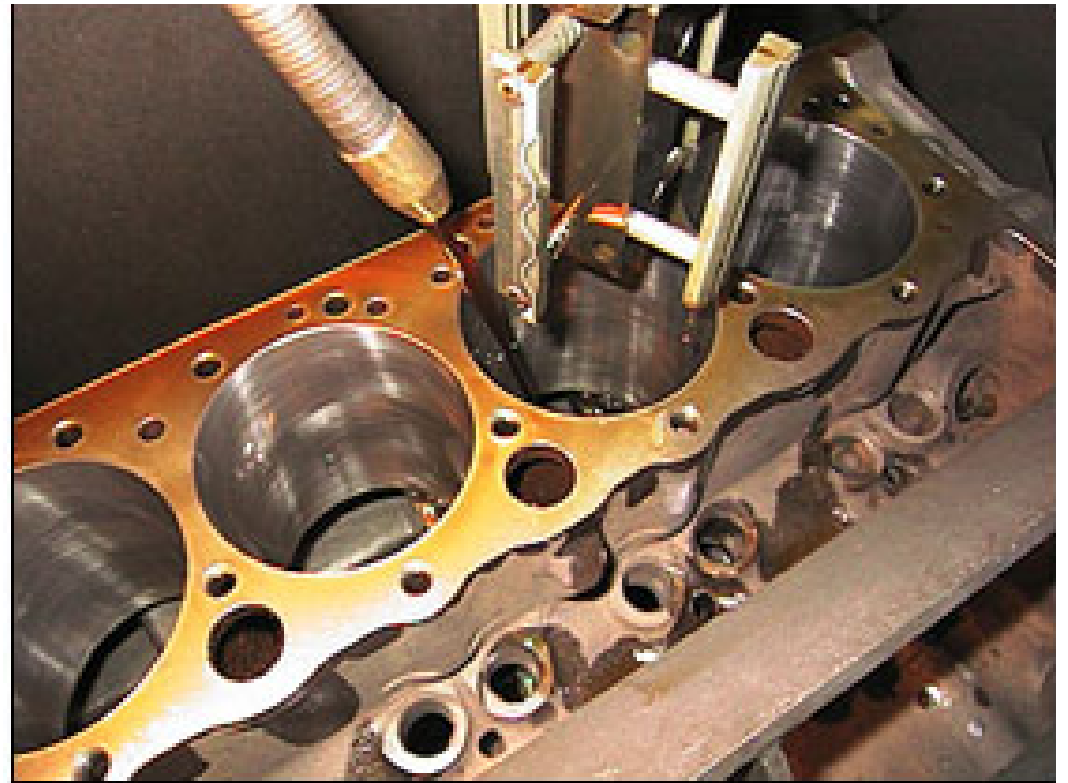
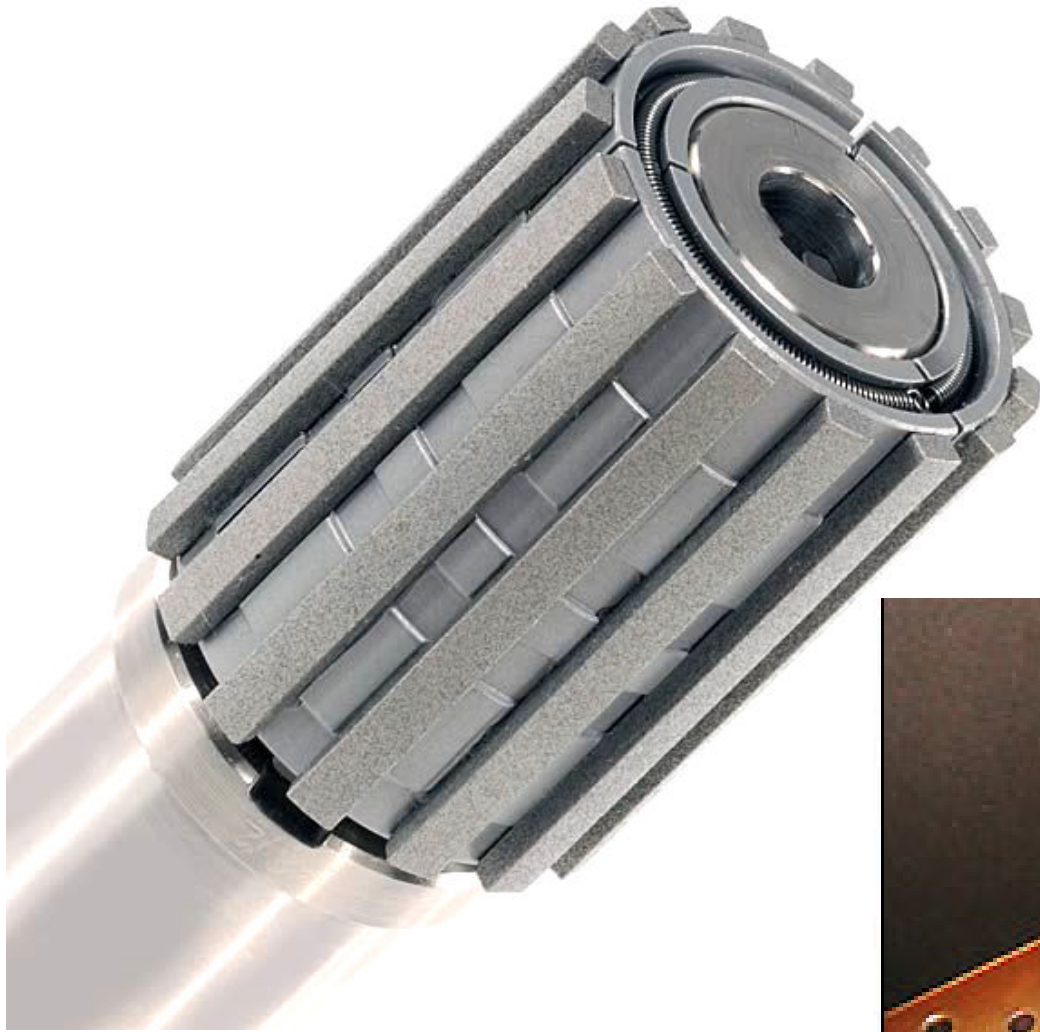
Conventional Grinding

FIGURE 26-20 Conventional grinding contrasted to creep feed grinding. Note that crush roll dressing is used here; see Figure 28-14.



Honing

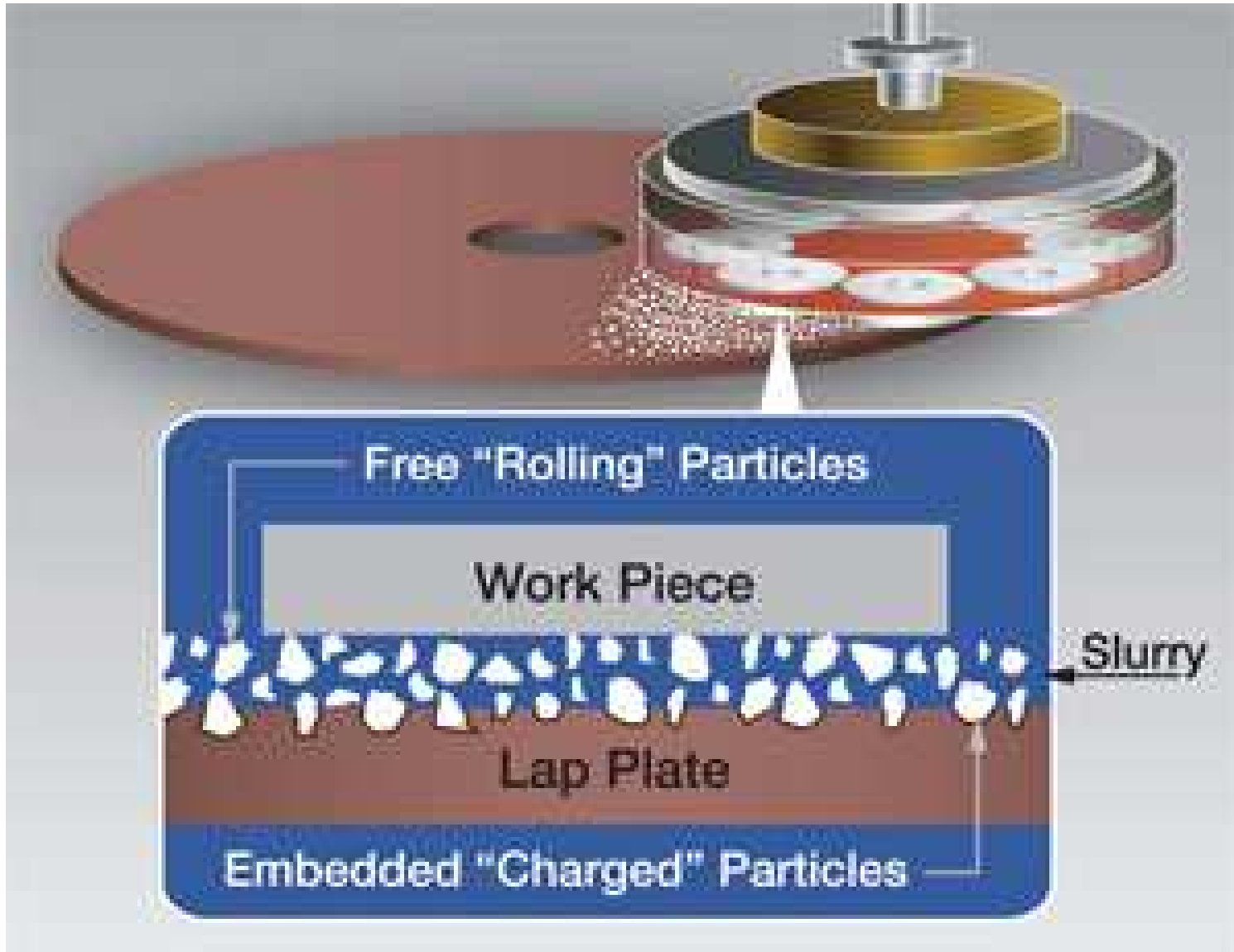
- **Honing** is an abrasive machining **process** that produces a precision surface on a metal work piece by scrubbing an abrasive stone against it along a controlled path. **Honing** is primarily used to improve the geometric form of a surface, but may also improve the surface texture (0.5 – 0.01 mm)
- This applies to parts such as Hydraulic Cylinders, Pistons, Bearing Bores, Pin Holes and to some external cylindrical surfaces. The honing process offers advantages of low capital equipment cost, high metal removal rates, and extreme accuracy in a wide variety of materials.



Lapping

- Lapping is a final abrasive finishing operation that produces extreme dimensional accuracy, corrects minor imperfections of shape, refines surface finish and produces close fit between mating surfaces. Most lapping is done with a tooling plate or wheel (the lap) and **fine-grained loose abrasive particles suspended in a viscous or liquid** vehicle such as soluble oil, mineral oil or grease.
- Material removal in lapping usually ranges from **.003 to .03 mm** but many reach 0.08 to 0.1mm in certain cases

- Cast iron is the mostly used lap material. However, soft steel, copper, brass, hardwood as well as hardened steel and glass are also used.
- Abrasives of lapping: • **Al₂O₃ and SiC, grain size 5~100μm** • **Cr₂O₃, grain size 1~2 μm** • **B₄C₃, grain size 5-60 μm** • **Diamond, grain size 0.5~5**
- Vehicle materials for lapping • Machine oil • Rape oil • grease
 Technical parameters affecting lapping processes are: • unit pressure • the grain size of abrasive • concentration of abrasive in the vehicle • lapping speed



Superfinishing

- After a metal piece is ground to an initial finish, it is superfinished with a finer grit solid abrasive.

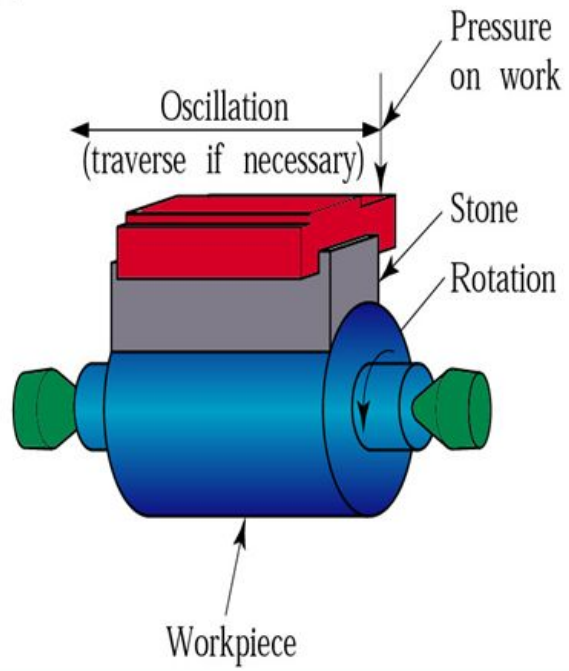
The abrasive is oscillated or rotated while the workpiece is rotated in the opposite direction; these motions are what causes the cross-hatching.

The geometry of the abrasive depends on the geometry of the workpiece surface; a stone (rectangular shape) is for cylindrical surfaces and cups and wheels are used for flat and spherical surfaces

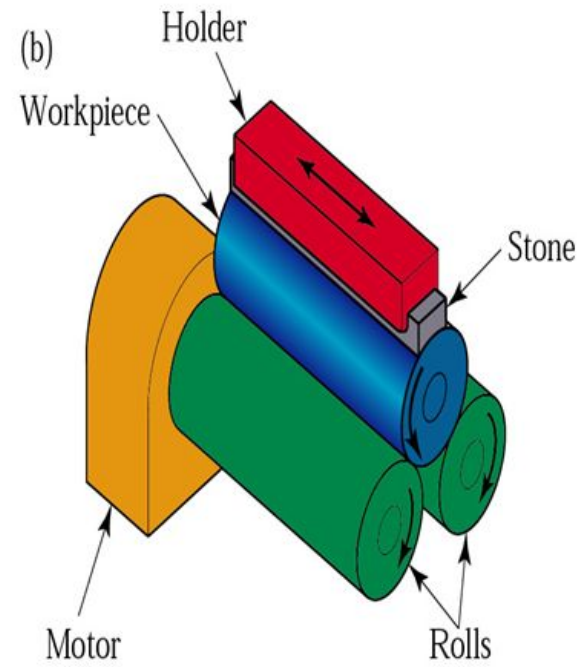
- Common abrasives used for superfinishing include aluminum oxide, silicon carbide, cubic boron nitride (CBN) and diamond.
- Abrasive grains must be very fine to be used with superfinishing; usually **5–8 μm**

Super finishing

(a)



(b)



Buffing and Polishing

- Polishing The smoothness on surface is produced by cutting action of abrasive particle adhering to the surface of the resilience wheel of wood , felt, lather ,canvas or fabric
- Buffing The smoothness and brightness process of a surface by the rubbing action of fine abrasive in lubricating binder applied intermittently to a moving wheel of wood ,cotton fabric, felt,

Material removal rate and Machining time

- Type of grinding include

Traverse grinding

Plunge grinding

Depth of cut $d = (D_i - D_f)/2$

D_i initial diameter of job

D_f is final dia of job

The value of $d =$

0.01 to 0.025 mm for rough grinding

0.005mm to 0.015 mm for finish grinding

Travel feed is longitudinal feed // to the axis of job mm/rev.

For rough grinding $f = (0.3 \text{ to } 0.5) \times \text{width of wheel for } D_i \text{ (dia of job)} < 20\text{mm}$
 $= (0.7 \text{ to } 0.85) \times \text{width of wheel for } D_i \text{ (dia of job)} > 20 \text{ mm}$

Finish grinding $f = (0.7 \text{ to } 0.85) \times \text{width of wheel}$

Table travel will be $f_t = f \times N_j = \text{job speed rev/min}$

Peripheral speed of job $V_j = \pi D_j N_j / 1000 \text{ m/min}$

- Peripheral speed of grinding wheel $V_g = \pi D_g N_g / 1000$ m/min

$$V_c = V_g + V_j$$

- $MRR = \pi D_j d f N_g$ mm³/min
- Machining time $T_m = (L n) / f N_j$

n is no. of passes

Plunge cutting grinding

$$MRR = \pi D_j W_g f_r$$
 mm³/min

W_g = Width of grinding wheel

f_r = Ratio of radial feed mm/min

Machining time $T_m =$

- Surface grinding :-
- Cutting speed V_c

$$V_c = \pi D_g N_g / 1000 \text{ m/min}$$

$$\text{MRR} = f_c \cdot V_t \cdot d$$

f_c cross feed per stroke mm/stroke

V_t table traverse rate mm/min

d = depth of cut per pass

$$\text{Machining timing } t_m = (L_j \cdot B_j \cdot n) / (V_t \cdot f_c \cdot 1000)$$

V_t is traverse velocity of table