Grinding & super finishing :-

Grinding :- Grinding can also be considered as a machining process i.e process of removing metal, but comparatively in smaller volume. To grind means to abrade to wear away by friction or to sharpen. In grinding the material is removed by means of a rotating abrasive wheel. The action of grinding wheel is verry similar to that of a milling cutter. Now days Grinding is mainly used for the following purposes:

1- To remove a very small amount of metal from the workpiece to bring its dimensions within very close tolerances after all the rough finishing and heat treatment operations have been carried out.
11- It is sometimes used to obtain better finish on the surface.
111- sometime it is used for verry hard surfaces which is not possible by carbide cutters or steel tools
(iv) sometime it is also applied for higher material removal rate
(v) It is very suitable for cutting the hardened steel
(vi) verry accurate dimensions and smoother surface finish can be achieved in verry short time.

Abrasives → A Grinding wheel having multiple cutting edges made up of many hard a particle called as abrasive. the abrasives are crushed to have sharp edges for cutting operations. The abrasive grains are properly mixed with a suitable bond, which acts as a holder when the wheel in use the greending wheel may be manufactured in one piece or of segments of abrassive blocks build up into a solid wheel grinding wheels are manufactured with higher geometrical accuracy results in a more uniform and consistent wheel

"Abrasive is material that helps to provide a shiny look on a surface. Abrasive are two types.

1- Natural Abrasive :- (Diamond, Quartz, Sand)

2- Artificial Abrasive → (Synthetic diamond, tin oxide, Aluminium oxide, silicon carbide)

3- Super Abrasive → make a special cattegory of bonded abrasive delighted for grinding the hardest most challenging work material.

Grinding wheel bonds → A bond is an abrasive material used to held Abrasive particles together the bonding material does not cut during the grinding operations. Its main function is to hold the grains together with varrying degree of strength. The different Standard grinding wheel bonds are vitrified, resinoid, silicate, shellac, rubber, and metallic

Cutting action in Grinding :- It will be observed from given figure that a grinding wheel consists of a abrasive particles, Bonding materials & voids. As already pointed the projecting abrasive particle act like cutting tool

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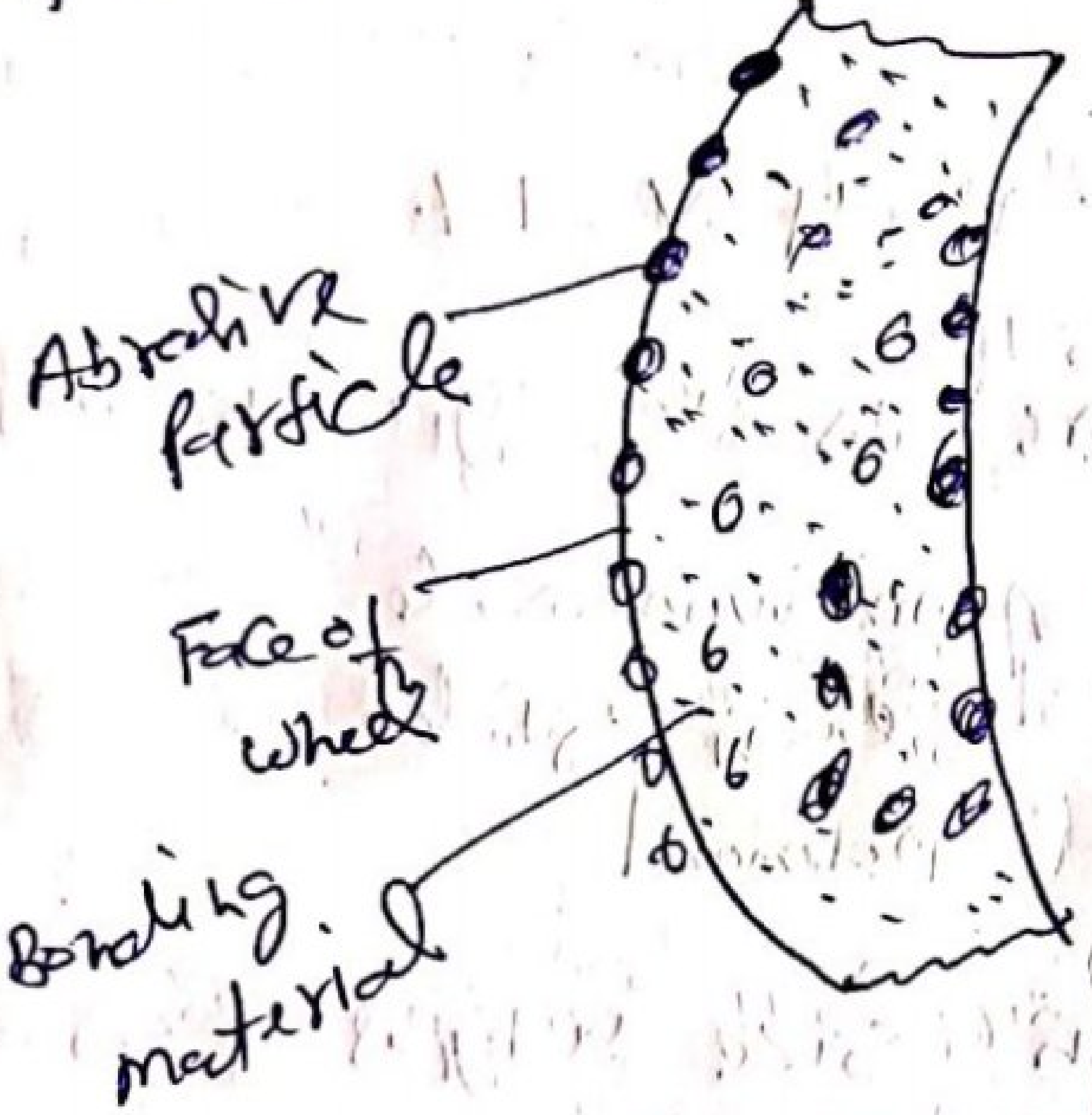
tips & remove the material. A properly selected grinding wheel exhibits self sharpening action. As cutting proceeds the abrasive particles at cutting edge become dulled and eventually these become cracked along the cleavage planes due to resistance offered by workpiece material which resists the cutting action thus new cutting points are produced which carried out further in cutting action. this process continous till the abrasive grains get worn down till the level of bond.



Two problem are often encounterd either by wrong selection of grinding or by improper cutting condition are wheel grazing & wheel loading. Thus the selection of grinding wheel for correct condition & correct abbrasive & correct bond for the application

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Grinding wheel specifications or Nomenclature :-

The Indian standard marking system (IS: 551-1954) has been used to indicate the various characterstic of a grinding wheel. Each marking consist of 6 symbols denoting the following characterstics:

1- Abrasive
2- Grain size
3- Grade
4- structure
5- Bond Type
6- manufactured record

As Exam

WA 30 I 4 V 17

W (Prefix) = manufacture abrasive type symbols

A (Abrasive) = A = Aluminium oxide
C = Silicon Carbide
D = Diamond

30 = Grain size 4 Types of Grain size

Coarse = 10, 12, 14, 16, 20, 24
medium = 30, 36, 46, 54, 60
Fine = 80, 100, 120, 150, 180
very Fine = 220, 240, 280, 320, 400, 500, 600

I (Grade) = Grade Categorised into 3 parts

- Soft = A, B, C, D, E, F, G, H.
- mediam = I, J, K, L, M, N, O, P
- Hard = Q, R, S, T, U, V, W, X, Y, Z

4 (structure) = structure categorized in 2 parts

- Dense - 1, 2, 3, 4, 5, 6, 7, 8
- open - 9, 10, 11, 12, 13, 14, 15

V (Bond Type) = vertified Bond

V = vertified   B = Resinoid
R = Rubber   E = shellac
S = silicon   O = oxychloride

17 (suffix = manufacturing abrasive type symbol.

Dressing & Truing :- The key to maximizing the performance of a production grinding application is having the right truing and dressing tooling using it correctly. In fact a skilful operator with a quality dressing tool and good dressing techniques can often improve the performance of a wheel that may not be the optimum wheel for the application.

Dressing ⇒ Dressing is the process of sharpening the abrasive elements of the wheel. The process breaks down the bond and remove dull abrasive grains to expose New and sharp Abrasive particles Dressing Also removes tiny pieces of material from the porel of the wheel face to prevent wheel loading, which can cause vibration and leave burn marks on the workpiece the objective of dressing the wheel is to The given three types of Dressing techniques.

1- Star dressers → A long handled tool with a row of free running. hardened and serrated discs running at right angles to the handle

2- Diamond dressers → shorter handled tool that have a small matrix of diamond work as dressers

3- Dressing sticks → A stick of hard material usually made from same material (silicon carbide) but strong Bonding agent is used.

Truing → Truing is the process of aligning the periphery of the grinding wheel so that it runs concentric with its axis of rotation. this allows accurate and precise relative motion between the grinding wheel and the part being ground. Truing & dressing occur simultaneously with regard to conventional wheel. with super abrasive wheels, the two processes are accomplished separately with truing performed first.

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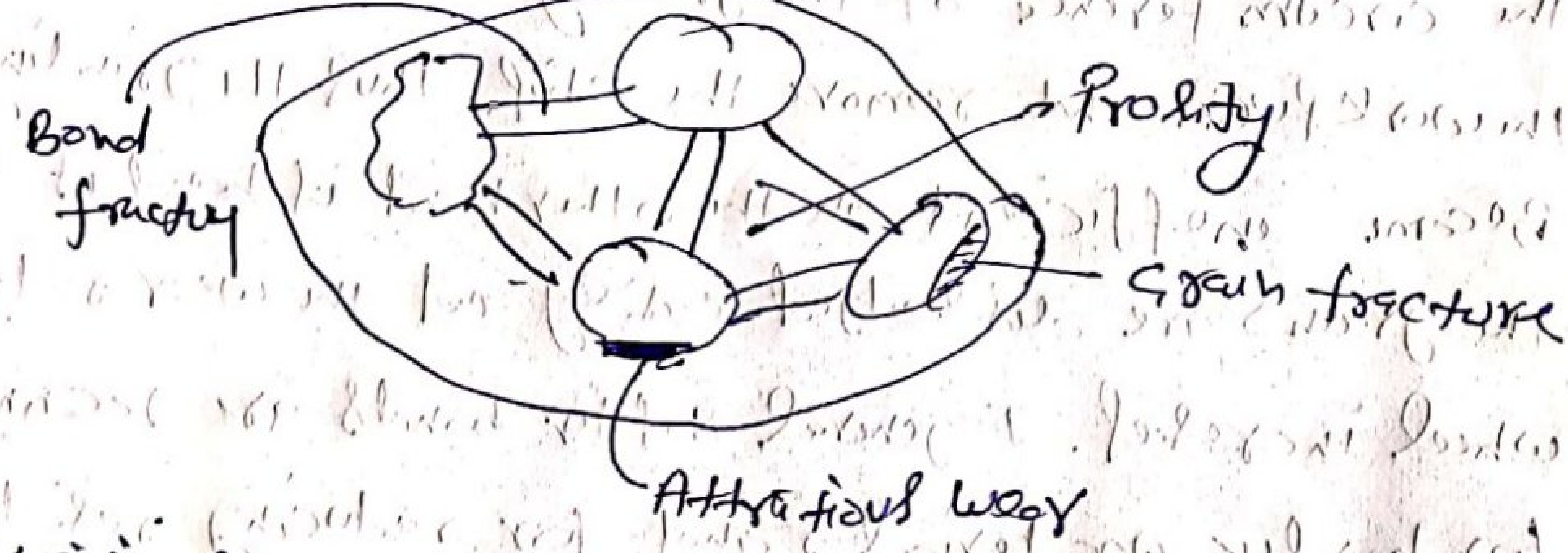
Grinding wheel wear :- Grinding wheel wear is an important measured factor of grinding in the manufacturing parts of engineering parts & tool. Grinding involves the removal process of material & modifying the surface of a workpiece to some desired finish which might otherwise be on achievable through conventional machining process.

" Grinding wheel wear is an important consideration because it affects the shape & accuracy of ground surfaces as is the case with cutting tools. Grinding wheels wear by three different conditions attritious grain wear, grain fracture & Bond fracture



(i) Attritious wear :- In attritious wear the cutting edges of a sharp grain become dull by attrition developing wear flat that is similar to flank wear in cutting tools wear is caused by intraction of the grain with the workpiece material involving both physical & chemical reaction. Chemical digradation or decomposition of the grain fracture at a microstructure level.

(II-) Grain fracture → Because Abrasive grains are brittle their fracture characteristics in grinding are important at the wear flat caused by attritious wear is excessive the grain becomes inefficient and produces undesirably high temp. optimally, the grain should fracture or fragment at a moderate rate so that new sharp edge or produced continuously during grinding.

III-) Bond Fracture → The strength of Bond is significant parameter in grinding. if the bond is too strong, dull grains cannot be dislodged so that other sharp grains along the circumference of the grinding wheel can begin to contact the workpiece. and remove the chip. thus the grinding process become inefficient on the other hand if bond is too weak the grains are dislodged easily and the wear rate of the wheel increases. I general softer bonds are recommended for harder materials and for reducing residual stresses and thermal damage to the workpiece. Hard grade wheels are used for softer materials and for removing large amount of material at high rates.

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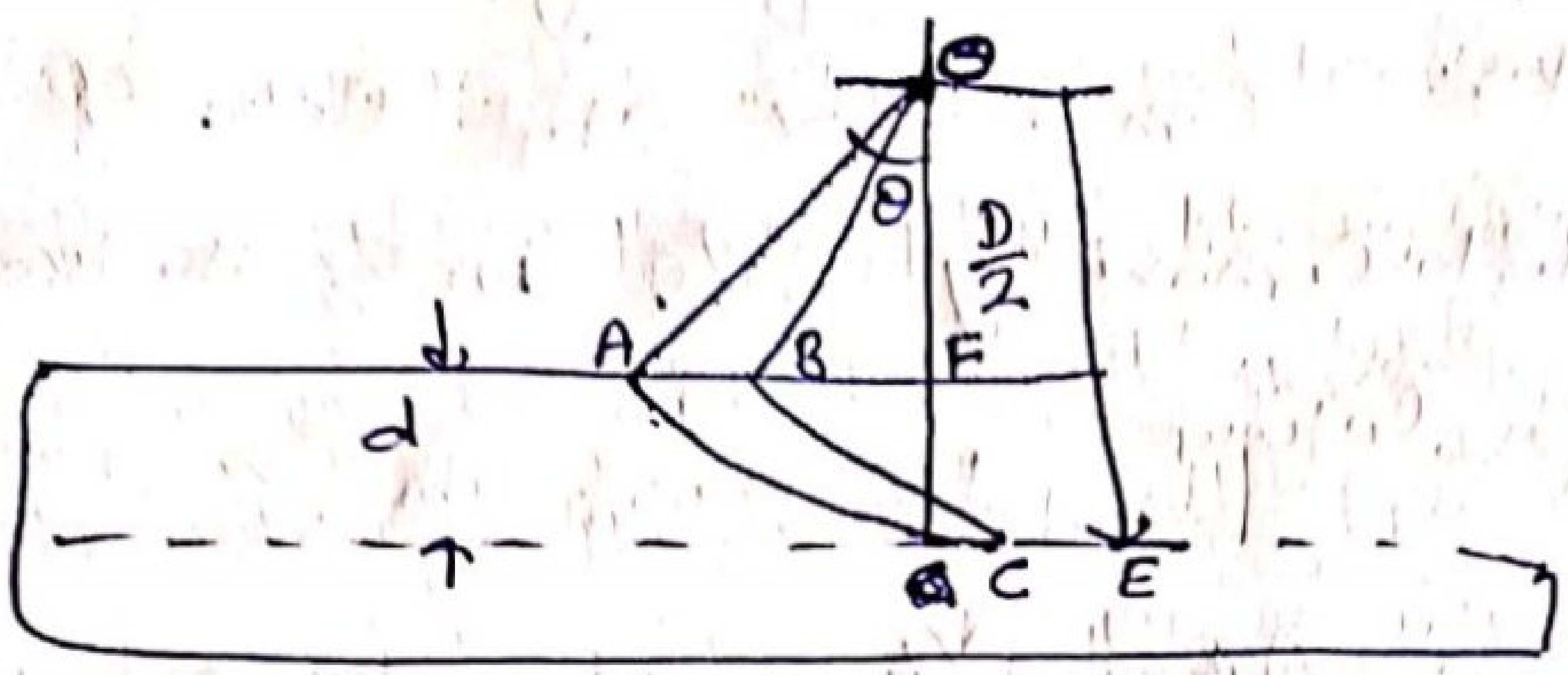
Maximum chip thickness -! (surface grinder)



$$\cos\theta = \frac{A}{K} \quad \frac{OF}{OA} = \frac{OC - FC}{OA} \quad \frac{\frac{D}{2} - \frac{d}{2}}{D/2}$$

$$d = \frac{D}{2}(1 - \cos\theta)$$

$$AF = \frac{D}{2}\sin\theta = \frac{D}{2}\sqrt{1 - \cos^2\theta}$$

$$AF = \frac{D}{2}\sqrt{\left(1 - \left(1 - \frac{d}{D/2}\right)^2\right)}$$

$$AF = \sqrt{Dd - d^2}$$

l_s = arc length of AC ≃ Chord length AC

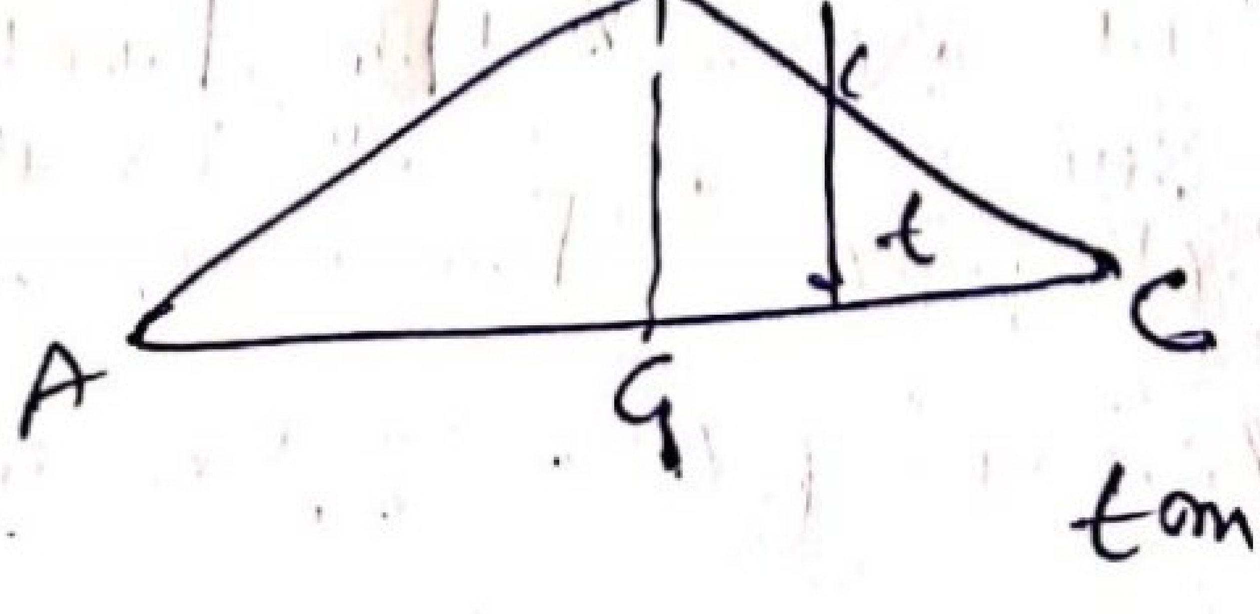
$$l_s = AC = \sqrt{AF^2 + d^2} = \sqrt{Dd}$$

The above equation is valid when $v < v_w$

v_w = velocity of grinding v = workpiece velocity

$$l_s = \left(1 + \frac{v}{v_w}\right)\sqrt{Dd}$$

the shape of chip approximate triangle so



t_{max} = AB $\sin\theta$

$$= 2AB\sqrt{\frac{d}{D} - \left(\frac{d}{D}\right)^2}$$

where t_{m} = max chip thickness

AB distance move by table during the time needed

$\frac{1}{K}$ revolutions   K = no of abrasive grain on surface

$$AB = \frac{V_t}{KN}$$

V_t = table speed

N = grinding wheel rpm

$$t_{m} = \frac{2V_t}{KN}\sqrt{\frac{d}{D}}$$

If there are C grain per cutting unit spacing of the surface of the wheel & if the average width of each cut is b then

$$K\pi DbC$$

max chip thickness

$$t_{m} = \frac{2V_t}{bCV_w}\sqrt{\frac{d}{D}}$$

for cylindrical grinding

$$t_{m} = \frac{2v}{V}\sqrt{C\left(\frac{1}{d}+\frac{1}{D}\right)}$$

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Types of Grinding →

1- Surface grinding → The surface grinder is used in the toolroom for the production of accurate flat surfaces this machine has a similar layout to the horizontal milling machine but only removes small thickness of material on the grinding passes. surface grinding can be manually operated or have CNC control. surface grinders are classified as.

1- Horizontal spindle with Reciprocating table
2- Horizontal spindle with Rotary Table
3- verticle spindle with Rotary table
4- verticle spindle with Reciprocating table

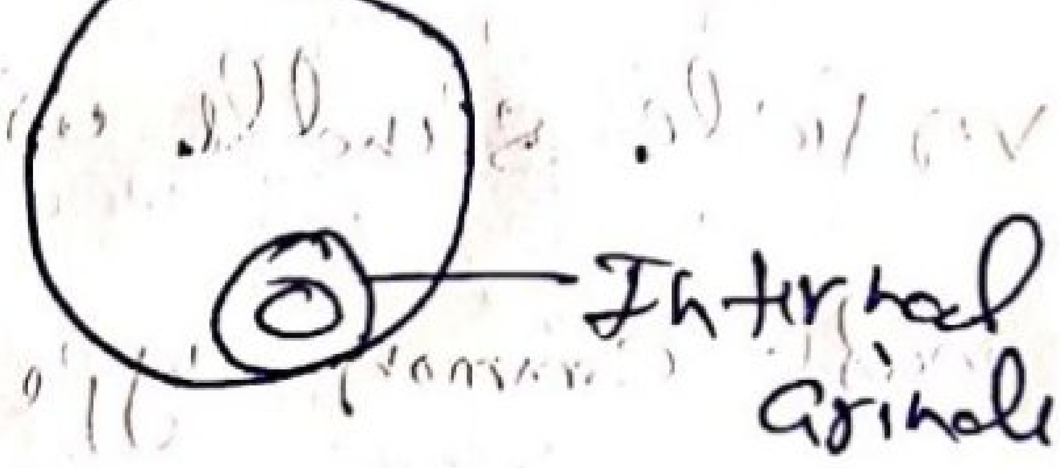
The most common type of surface grinding machine has a reciprocating table and horizontal spindle

Horizontal spindle reciprocating table

Horizontal Spindle rotary table

Cylindrical Grinding → This machine is used to generate cylindrical surfaces and is similar to a centre lathe in apperance the main diffrence is that the tool is replaced By a rotating grinding wheel

Internal Grinding → It is same but Diffrent is that have a smaller grinder and griend internal parts.



Centered Grinding → Centered grinding involves fixturing the part on a spindle axis as it is ground as illustrated

Centerless grinding → centerless grinding is popular as a high speed, low cost operation. This type of grinding machine is for pure cylindrical prism shapes which do not require mounting. In this operation there is a grinding wheel and a governing wheel. The part sits between the wheels and is ground by the grinding wheel.

Some Super finishing operations :-

1- Honing :- Honing is a controlled, low velocity, stock removal process that uses fine abrasive stones to remove very small amounts of metal. The cutting speed is very slow as compare to grinding remove common errors left by boring. taper, wavines and tool marks) or remove the tool marks left by grinding. There are two types of

Honning machine

1- Horizontal honing machines
2- vertical Honing machines

Two method for Honning

1. manual stroking
2. power stroking

Honning stone :- Honning is usually done with stones made by bonding together various fine artificial abrasive.

Honning conditions

1- spindle speed
2- reciprocating speed
3- cross hatch angle.

Advantages

- Highly accurate, little heat is generated. Hole of any dimension can be honed
- High productivity at low cost.

Application

It used for Both honed as soft material & hard material.

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Lapping → Lapping is an ancient machining (48)

techniques It is precision process or combination of processes used to provide flatness, parallelism, size and surface finishes to extremely demanding tolerances. The process is a manufacturing method that employs particles of an abrasive material to remove stock from a surfaces

Lapping method

1- Hand Lapping
(i) Flat work hand lapping
(ii) External cylindrical hand lapping or ring lapping

2- Machine Lapping
(i) vertical lapping M/C
(ii) Flat lapping M/C
(iii) Center less roll lapping M/C
(iv) Centerless lapping M/C
(v) Lapping spherical surfaces

Polishing → Polishing is an intermediate abrading operation which follows grinding and proceeds buffing, cloth wheels or belts coated with abrasive particles are used for polishing operations.

Applications

1- Cutlery and small hand tools
2- Internal work on tool & dies
3- Bicycle parts.

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