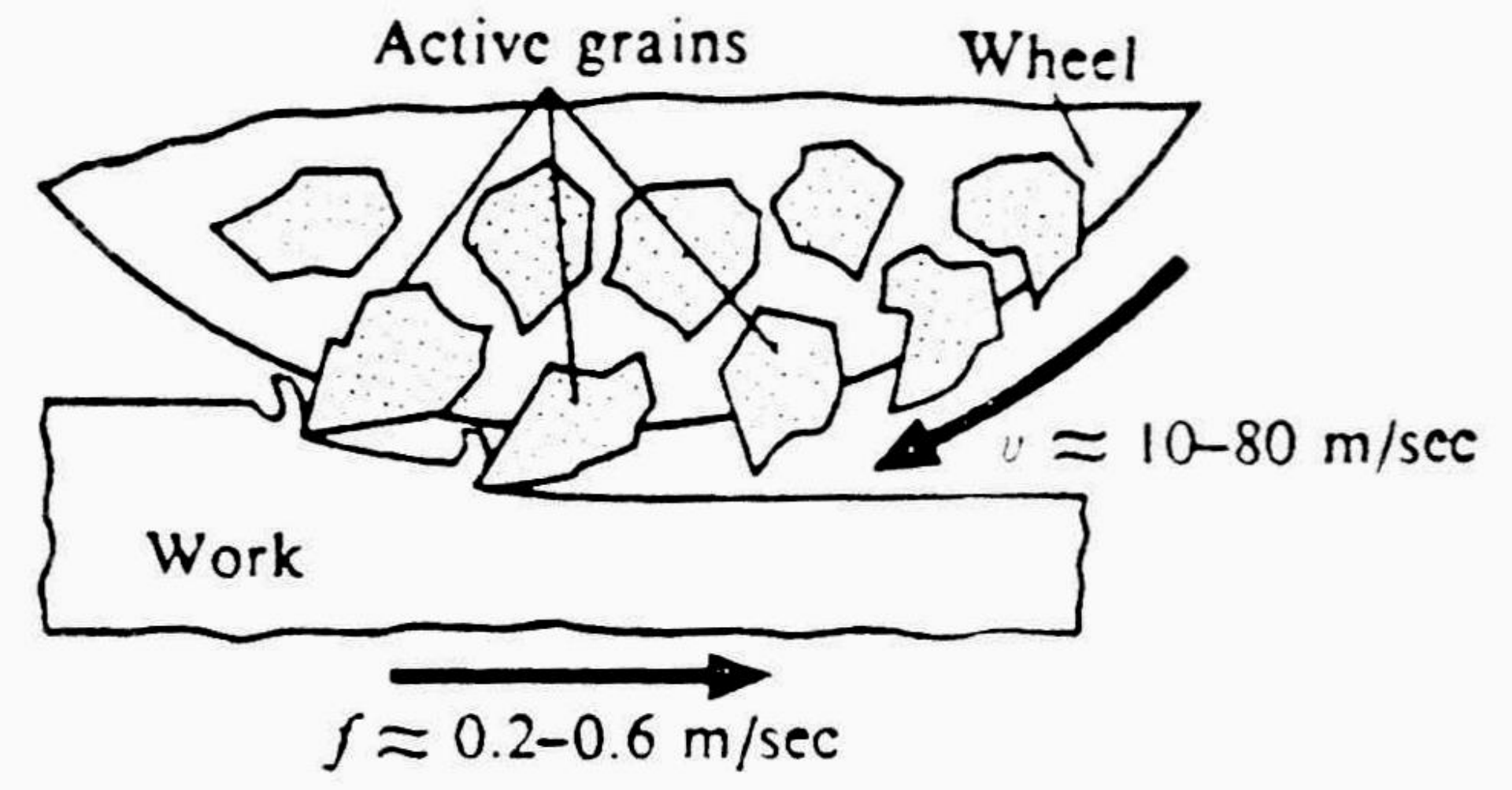
Grinding

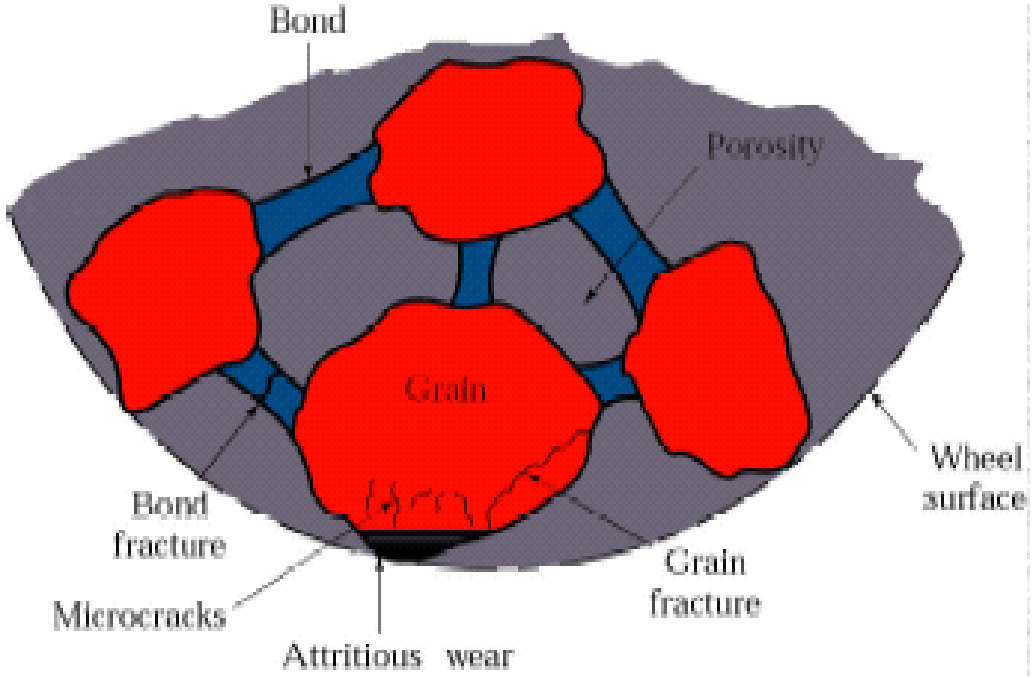
Grinding – material removal by an abrasive bonded grinding wheel rotating with a high speed.

Grinding Wheel – basic parameters:

- Abrasive material
- Grain size
- Bonding material
- Wheel grade
- Wheel structure


Active grains
Wheel
$v \approx$ 10–80 m/sec
Work
$f \approx$ 0.2–0.6 m/sec

Grinding Wheel



Physical model of a grinding wheel, showing is structure and wear and fracture patterns.

Grinding Wheel Surface

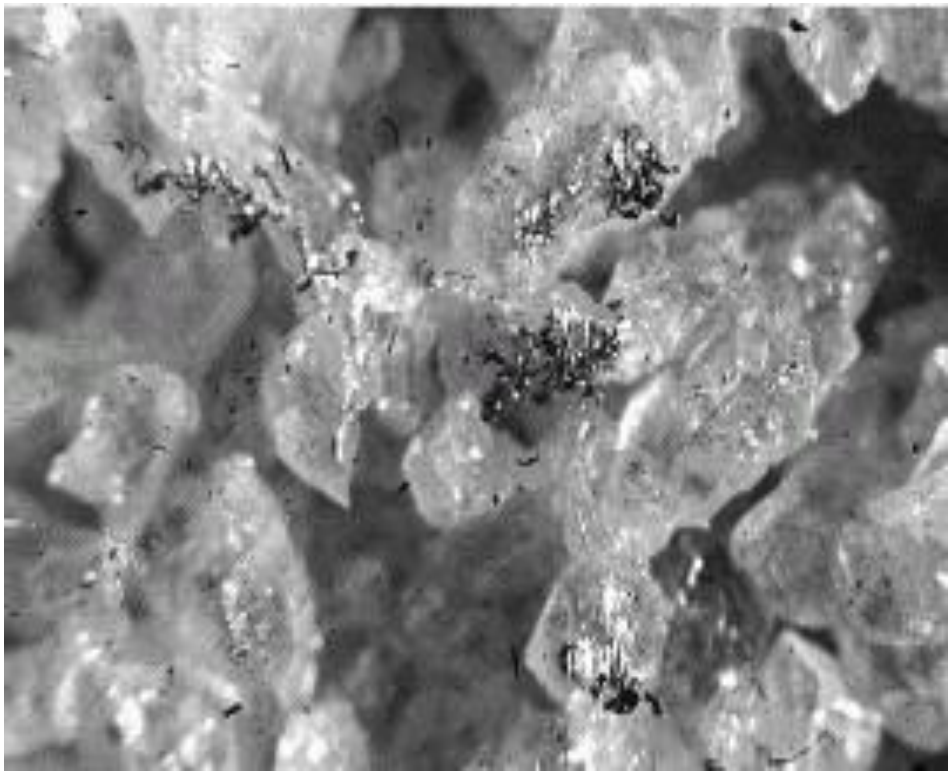


Fig: The surface of a grinding wheel showing abrasive grains, wheel porosity, wear flats on grains, and metal chips from the workpiece adhering to the grains. Note the random distribution and shape of abrasive grains.

Abrasives are of two types:

1- Conventional abrasives:
   - Aluminum oxides
   - Silicon carbides
2- Superabrasives
   - Cubic boron nitride
   - Diamond

Material	HK
Common Glass	350-500
Quartz	800-1100
Hardened Steel	700-1300
Silicon Carbide	2100-3000
Aluminum Oxide	2000-3000
Cubic boron nitride	4000-5000
Diamond	7000-8000

HK: Knoop hardness number

$$HK = \frac{load(\mathrm{kgf})}{impressionarea(\mathrm{mm}^2)}$$

Grinding Wheel

- Abrasive materials
  - Aluminum oxide: grinding ferrous and high-strength alloys (Knoop hardness ~ 2100)
  - Silicon carbide: grinding aluminum, brass, and stainless steel, cast irons and certain ceramics (Knoop hardness ~ 2500)
  - Cubic boron nitride: grinding hardened steels and aerospace alloys (Knoop hardness ~ 5000)
  - Diamond: grinding ceramics, cemented carbides, and glass (Knoop hardness ~ 7000)

Grinding Wheel

Grain size – size of the abrasive particles

Typical grain size: 8-250 (mesh size: lines/in)

Grit size 8: coarse grain – for harder material

Grit size 250: fine grain – for soft material, and for lapping and superfinishing

Grinding Wheel

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

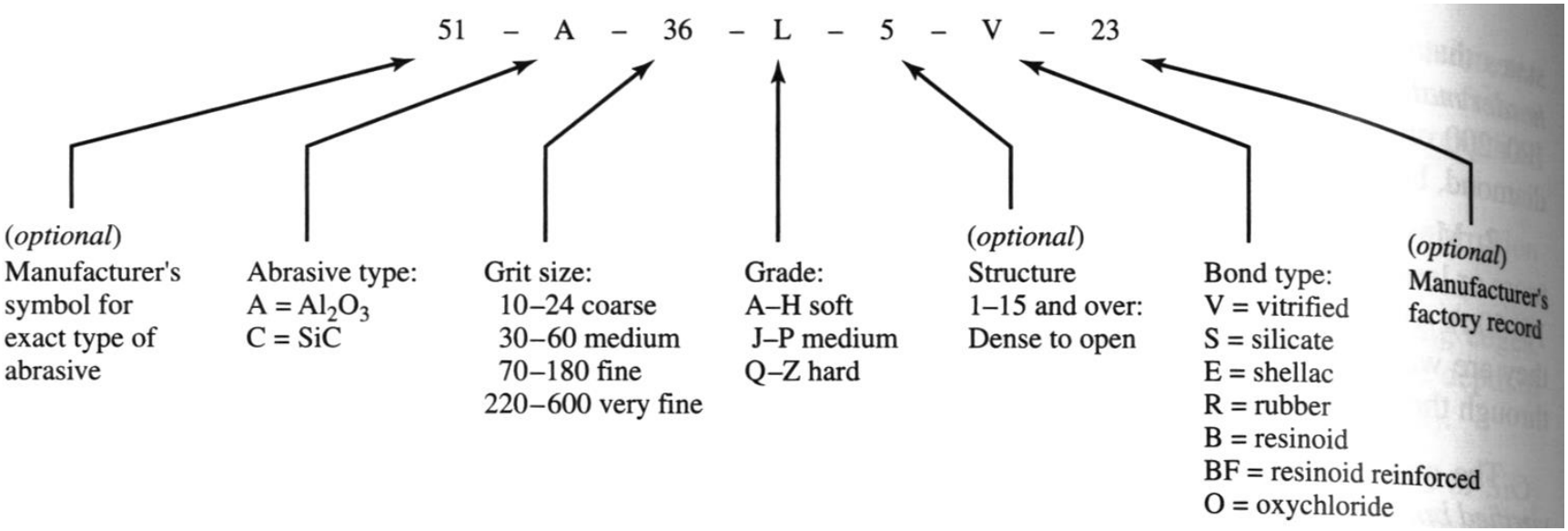
- Vitrified bond: baked clay and ceramics (feldspar), most common
- Resinoid: liquid or powdered phenolic resins and additives are mixed with the abrasive then pressed and cured at 174 ˚C low heat generation, tool grinding
- Rubber: flexible, cutoff operation
- Resin: thermosets, rough grinding and cuttoff
- Shellac: Varnish, strong but not rigid, good finish
- Metallic: bonding diamond and cubic boron nitride abrasives using powder metallurgy

Grinding Wheel

Wheel structure and Wheel grade

- Wheel structure – relative spacing of the abrasive grains in the wheel
  - $V_g + V_b + V_p = 1.0$
  - V_g - proportion of abrasive grain in the wheel
  - V_b - proportion of bond material in the wheel
  - V_p - proportion of pores in the wheel
- Wheel grade – bond strength between abrasive grits, largely depending on V_b. Grade is measured on a scale between soft (A) and hard (Z).

Grinding Wheel Specification



Wheel specificationusing Aluminum oxide and Silicon Carbide as the bonding material:

Ex: 30A46H6VXX

30 – Prefix (manufacturer's symbol for abrasive, optional)

A – Abrasive type (A – aluminum oxide, C – silicon carbide)

46 – Grain size (coarse = 8,10,12,14,16,20,24; medium = 30,36,46,54,60; fine = 70,80,…,180; very fine = 220,240,….,600)

H – Grade (A = soft, M = medium, Z = hard)

6 – Structure (1 = very dense, 15 = very open)

V – bond type (B-resinoid, E-shellac, R-rubber, S-silicate, V-vitrified, O- oxychloride)

XX – Manufacturer's record (optional)

Wheel specification using Diamond or Cubic boron nitride

Ex: XXD150P100MZZ1/8

XX – Prefix (manufacturer's symbol for abrasive, optional)

D – Abrasive type (D – diamond, B – cubic boron nitride)

150 – Grain size (coarse = 8,10,12,14,16,20,24; medium = 30,36,46,54,60; fine = 70,80,…,180; very fine = 220,240,….,600)

P – Grade (A = soft, M = medium, Z = hard)

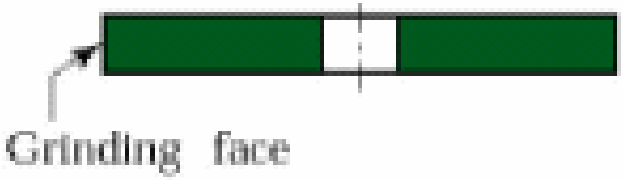
100 – Concentration (manufacturer's designation)

25 (low)-100(high)

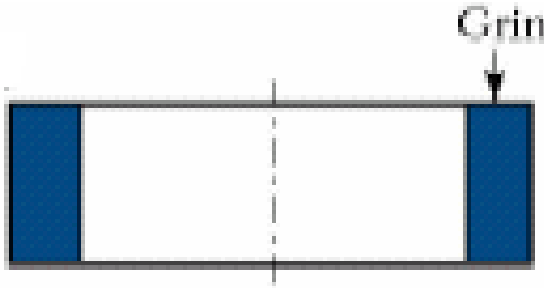
M – Bond type (B-resin, M-metal, V-vitrified)

ZZ – Bond modification (manufacturer's notation)

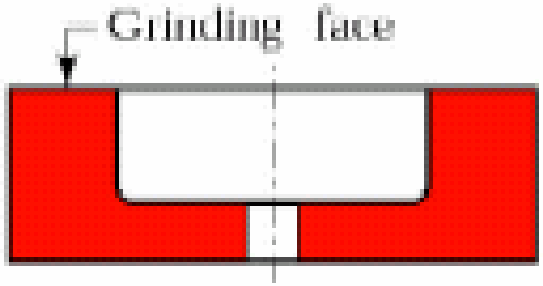
1/8 – Depth of abrasive (in inches or mm)



Type 1–straight

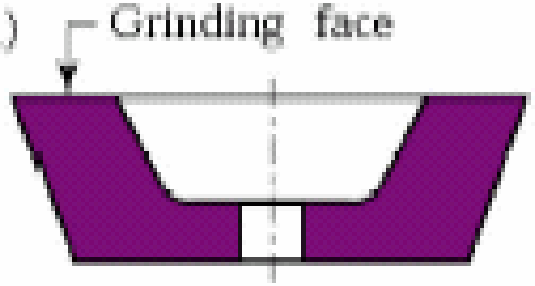


Type 2–cylinder

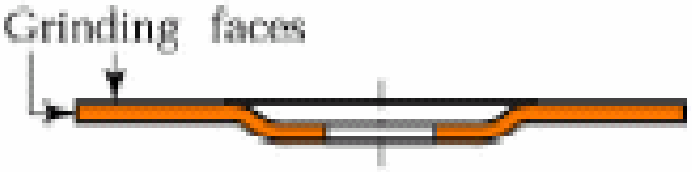


Type 6–straight cup

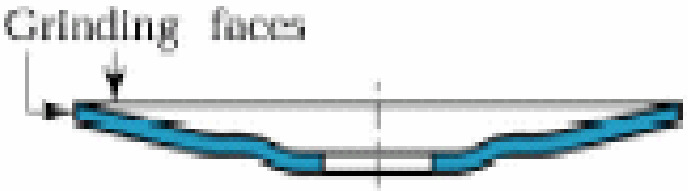
(d)



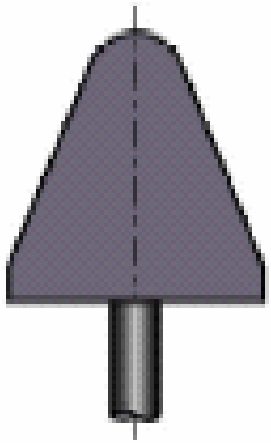
Type 11–flaring cup



Type 27–depressed center

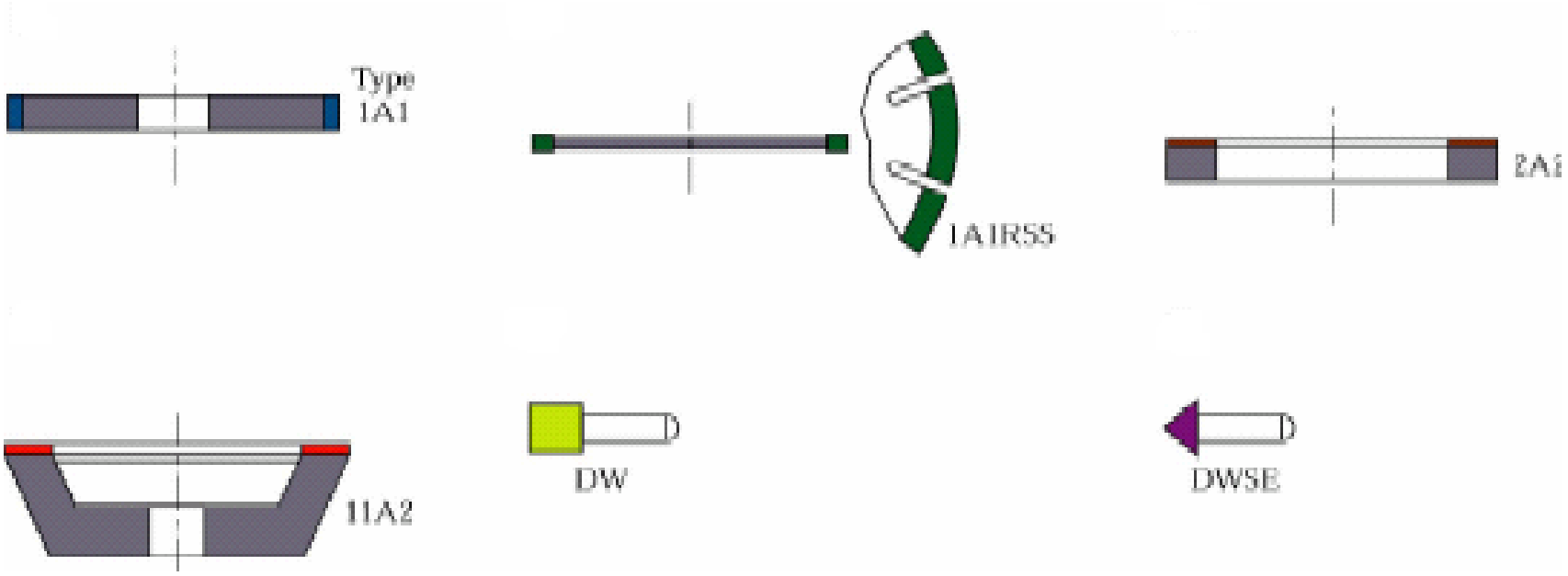


Type 28–depressed center

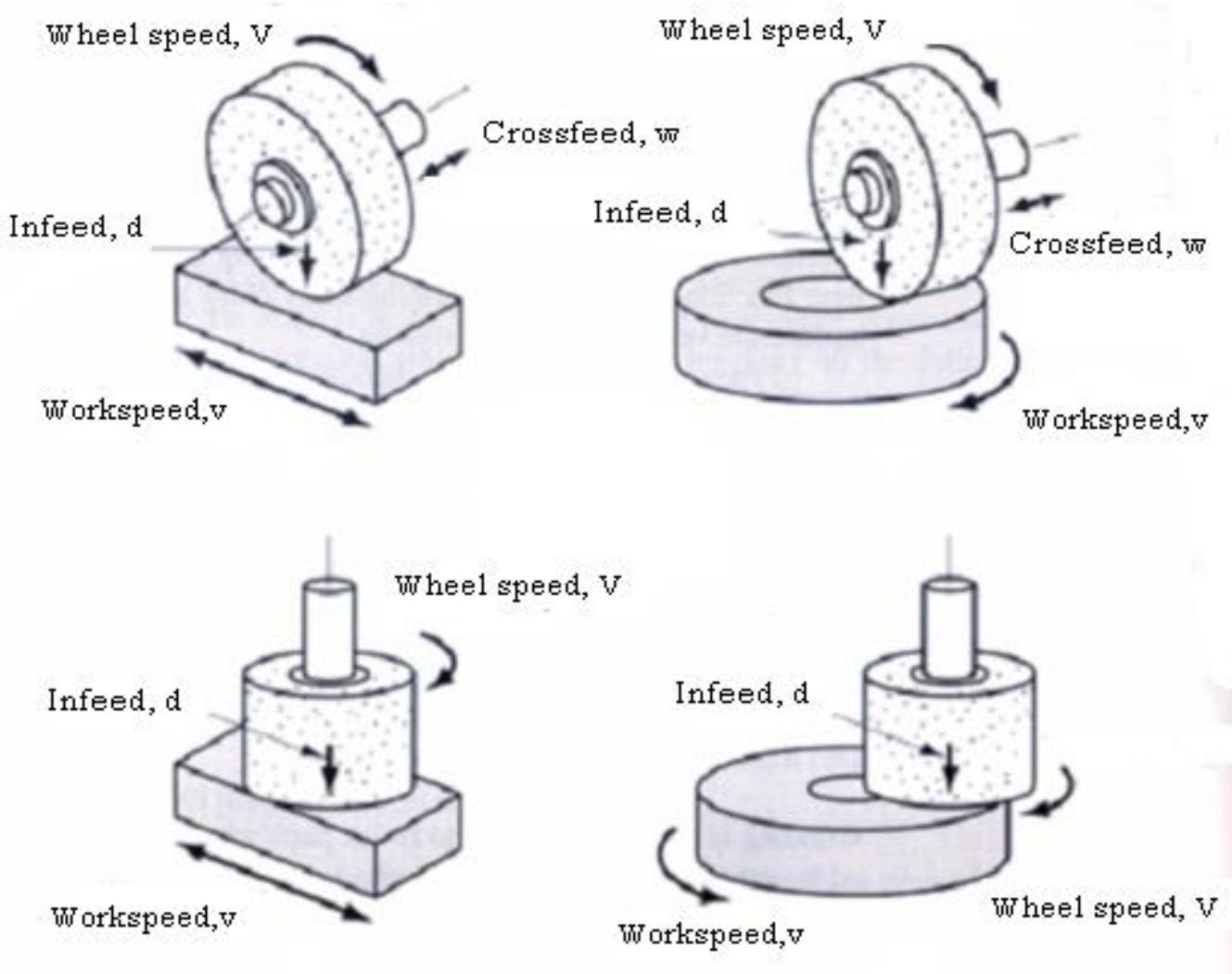


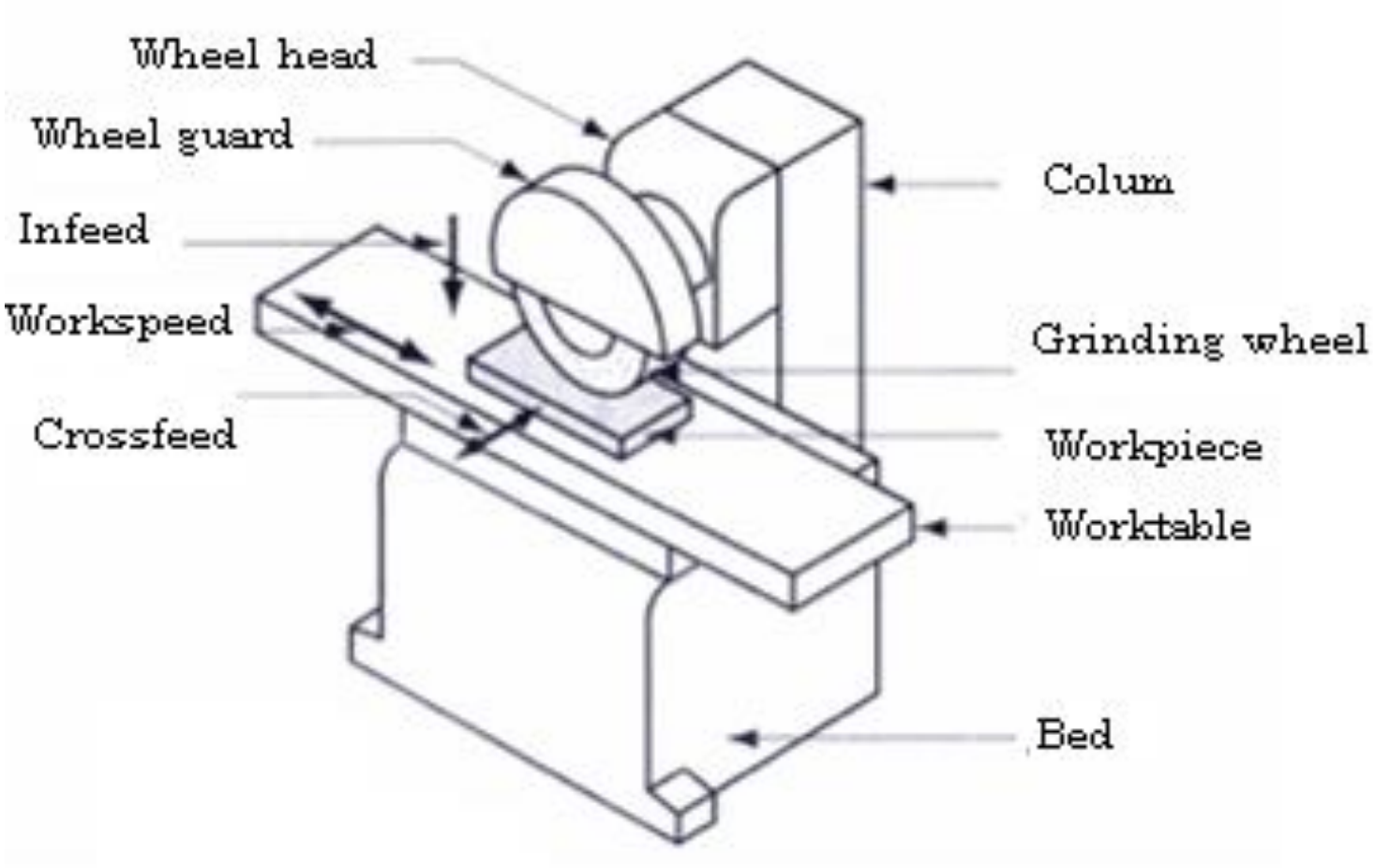
Mounted

Superabrasive Wheel Configuration

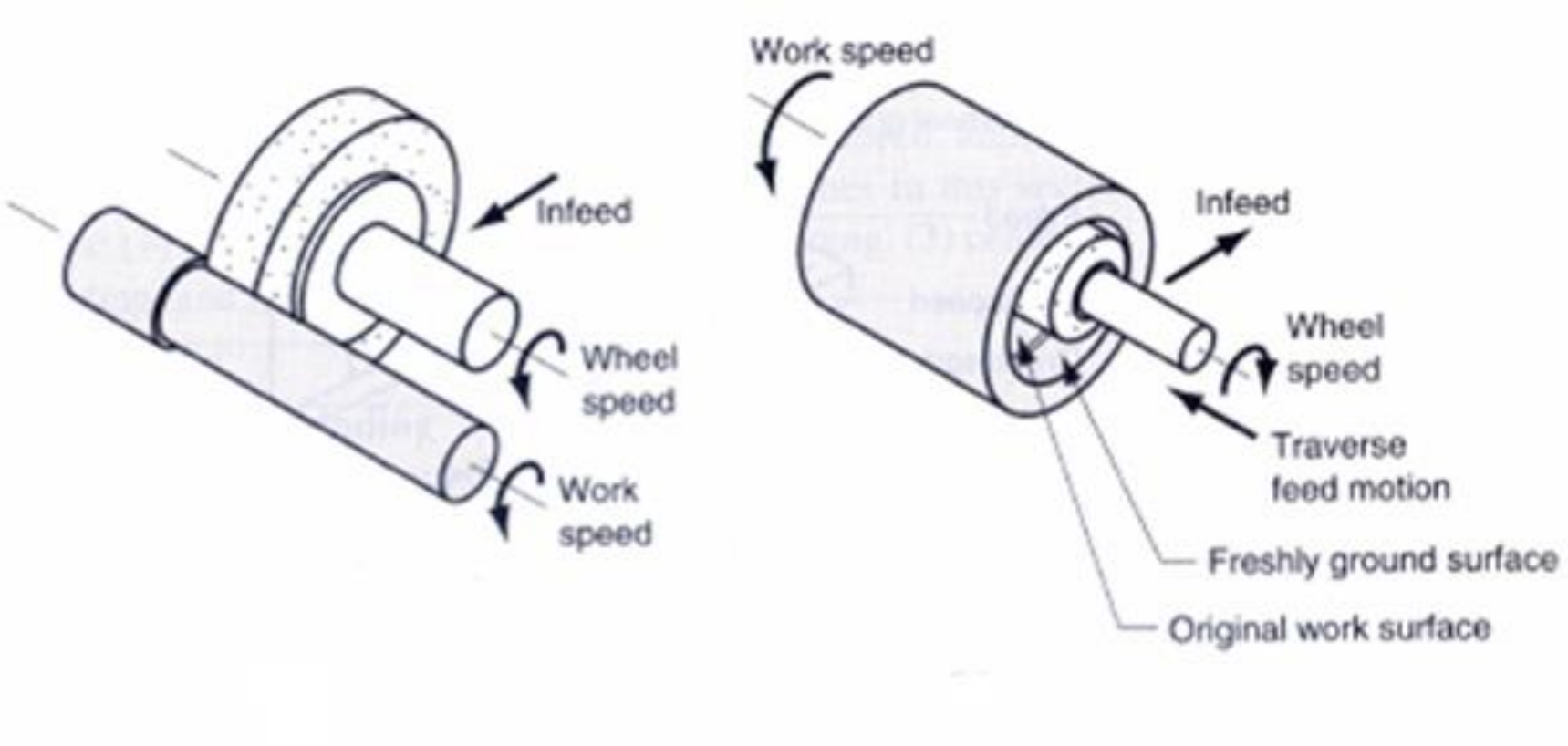


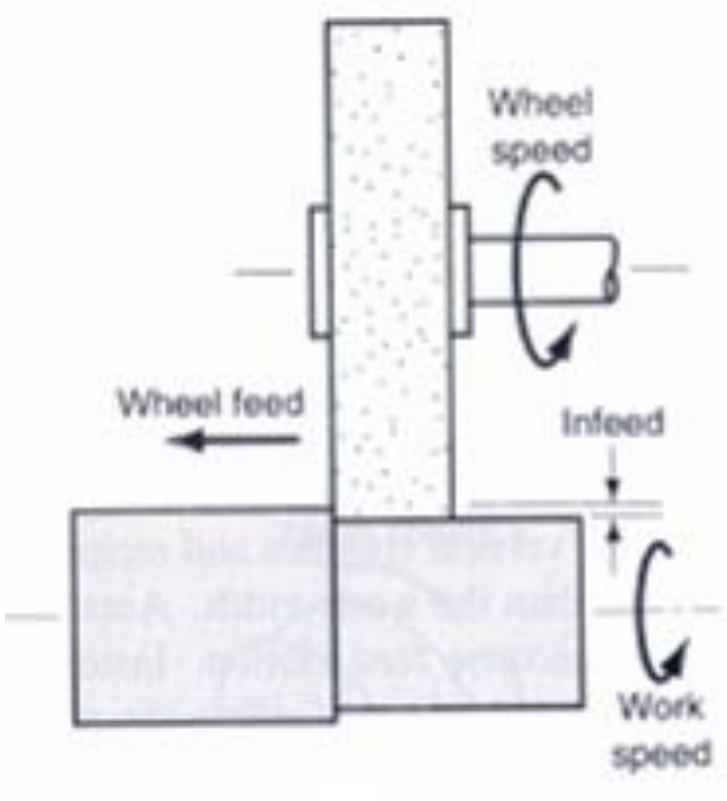
Surface Grinding

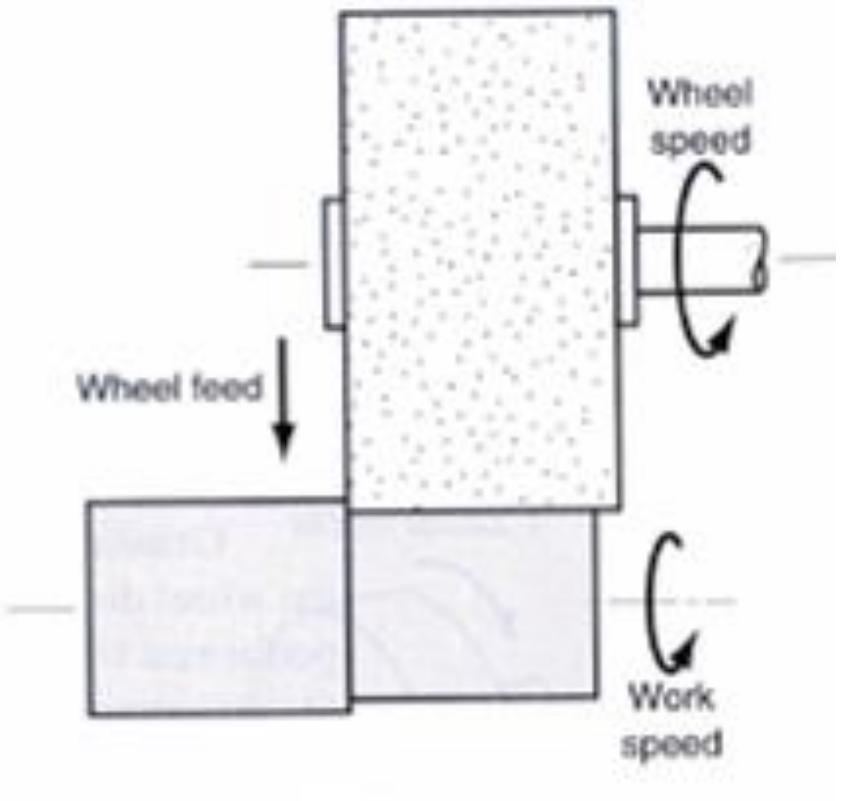



Wheel head
Wheel guard
Infeed
Workspeed
Crossfeed
Colum
Grinding wheel
Workpiece
Worktable
Bed

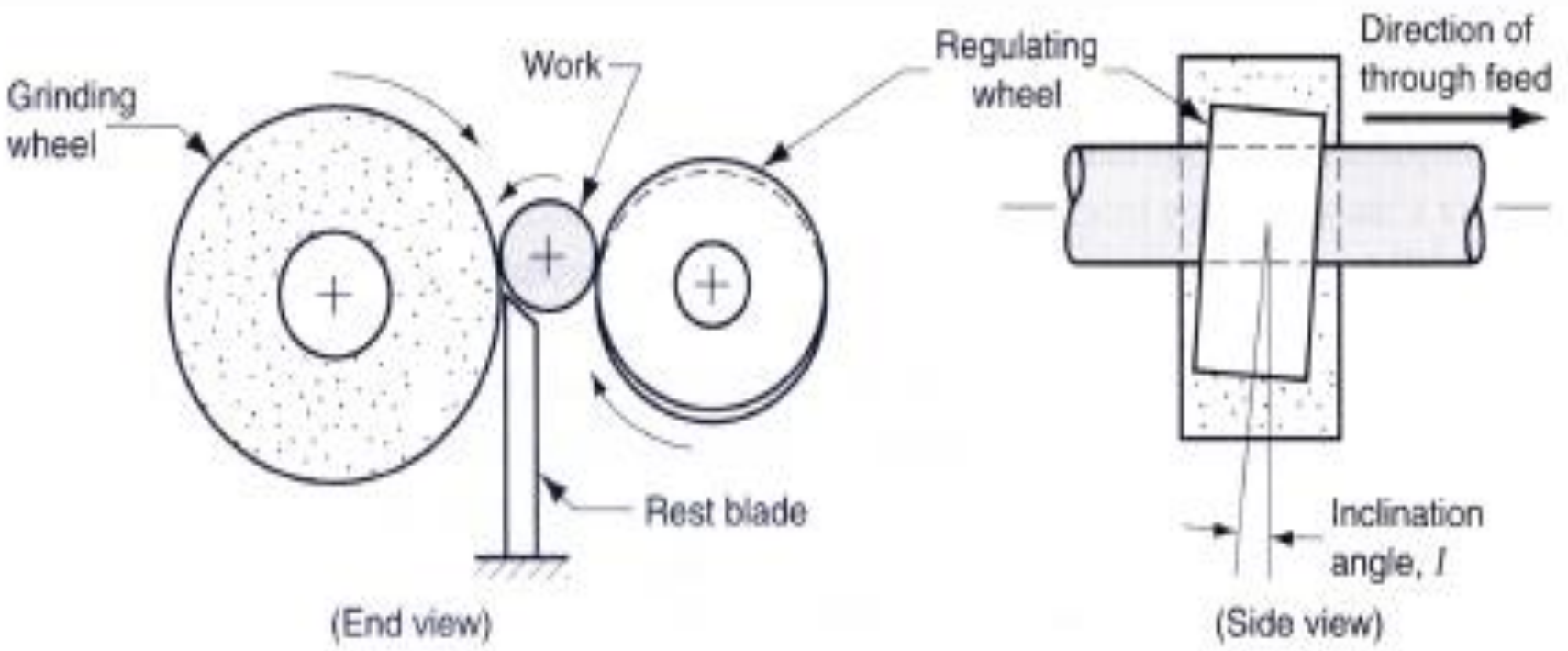
Cylindrical Grinding Operations

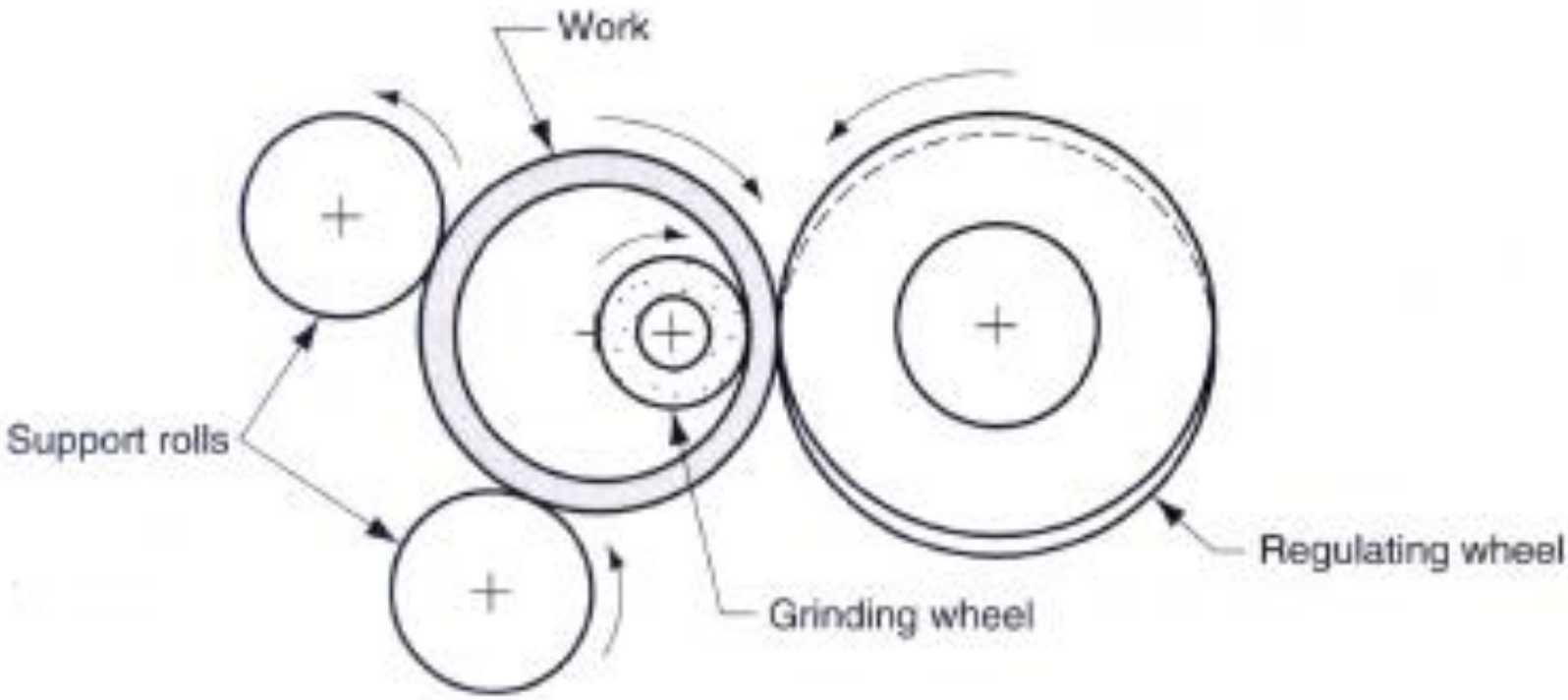



Wheel
speed
Wheel feed
Infeed
Work
speed


Wheel
speed
Wheel feed
Work
speed

Centerless Grinding

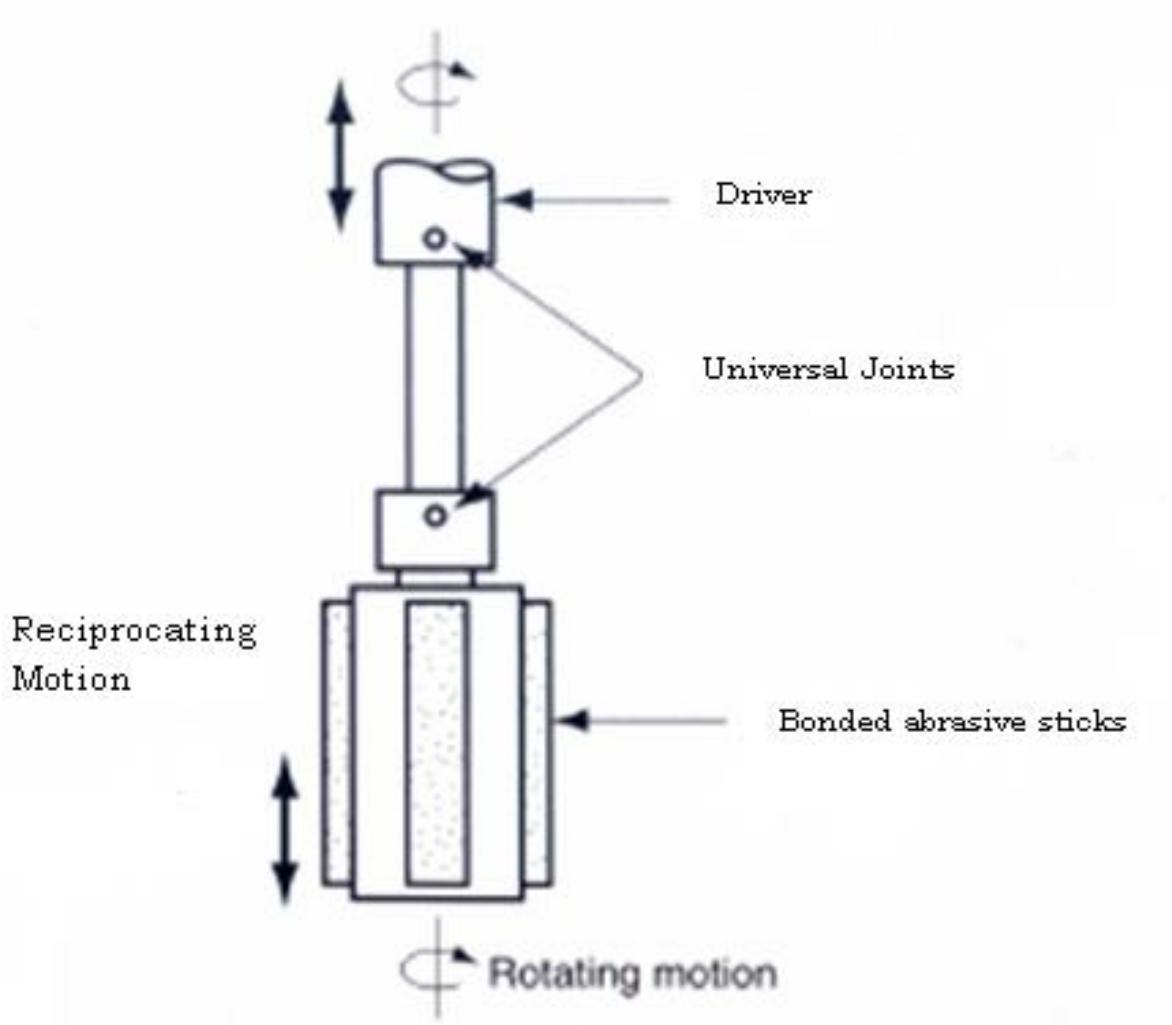



Work
Support rolls
Grinding wheel
Regulating wheel

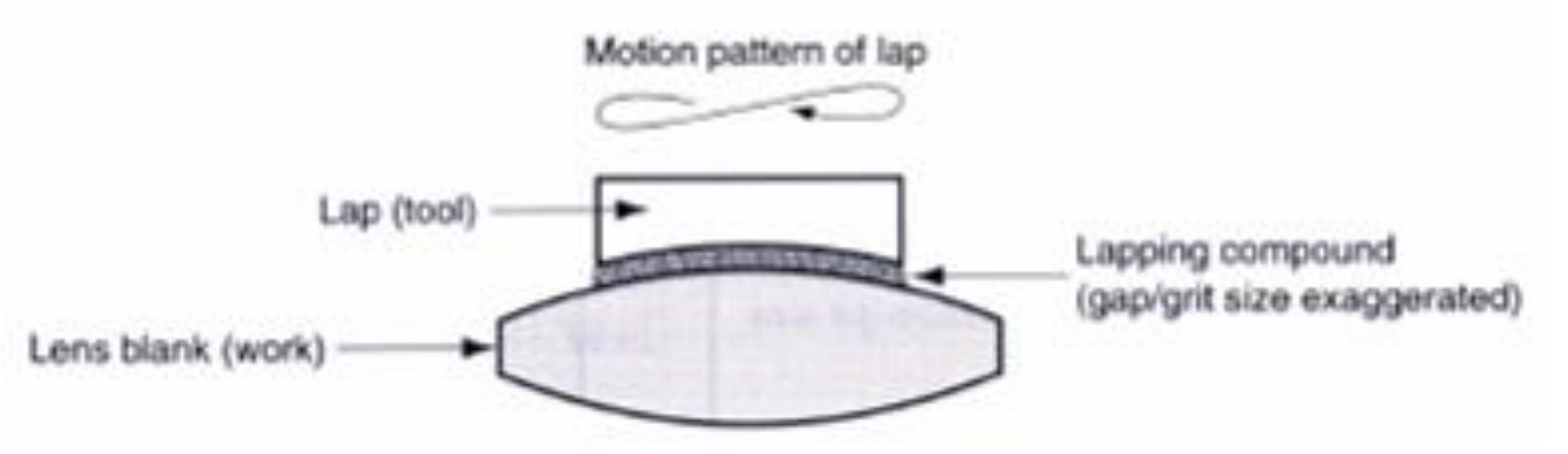
Related Abrasive Processes

- Honing
- Lapping
- Superfinishing
- Polishing
- Buffing

Honing used for round hole



Lapping

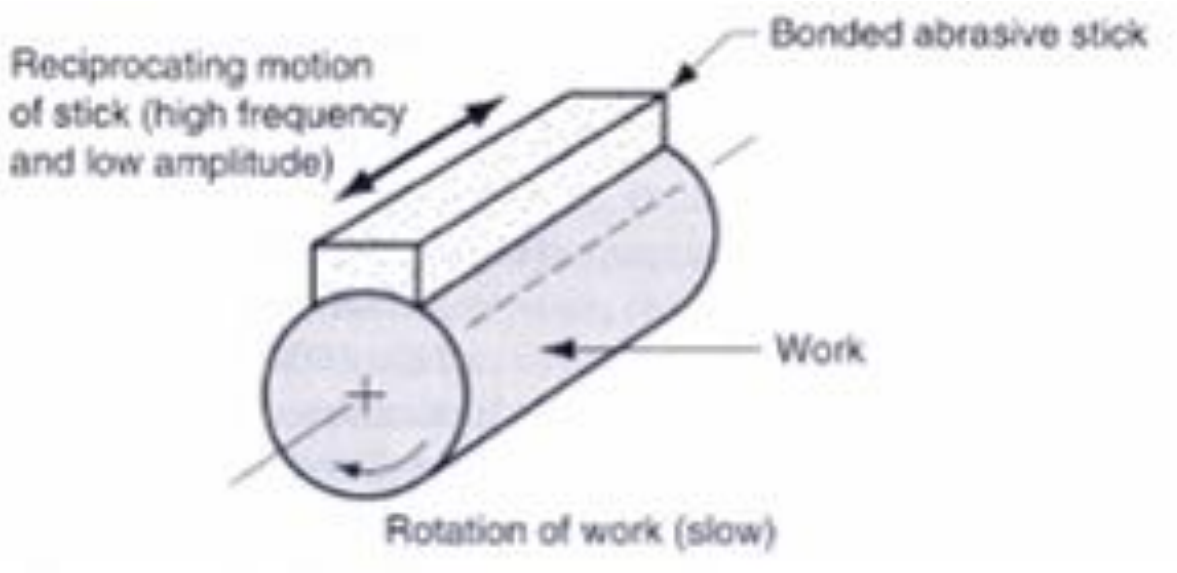


For production of surface of extreme accuracy and smoothness

Fluid suspended abrasive particles between workpiece and lapping tool having the shape of the workpiece

Grit size 300 - 600

Superfinishing



Similar to honing

Shorter stroke ~ 4.5 mm up to 1500 strokes / minute

Lower pressure between tool and workpiece

Lower work speed ~ 0.25 m/s

Smaller grit size ~ up to 1000

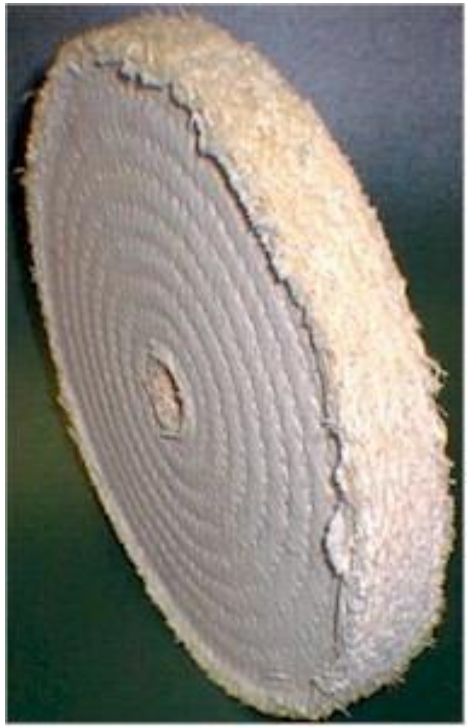
Polishing

- Polishing
  - Removing scratches and burrs by means of abrasive grains attached to a polishing wheel rotating at high speed of around 38 m/s.
  - Abrasive grains are glued to the outside periphery of flexible wheel.
  - Grit size ranges from 20 to 120.

Buffing

Buffing –

- Similar to polishing but used to form high luster surface
- Wheels are softer
- Very fine grit size mixed in buffing compound
- Speed – 40 to 85 m/s
- Perform manually



Surface Roughness Values