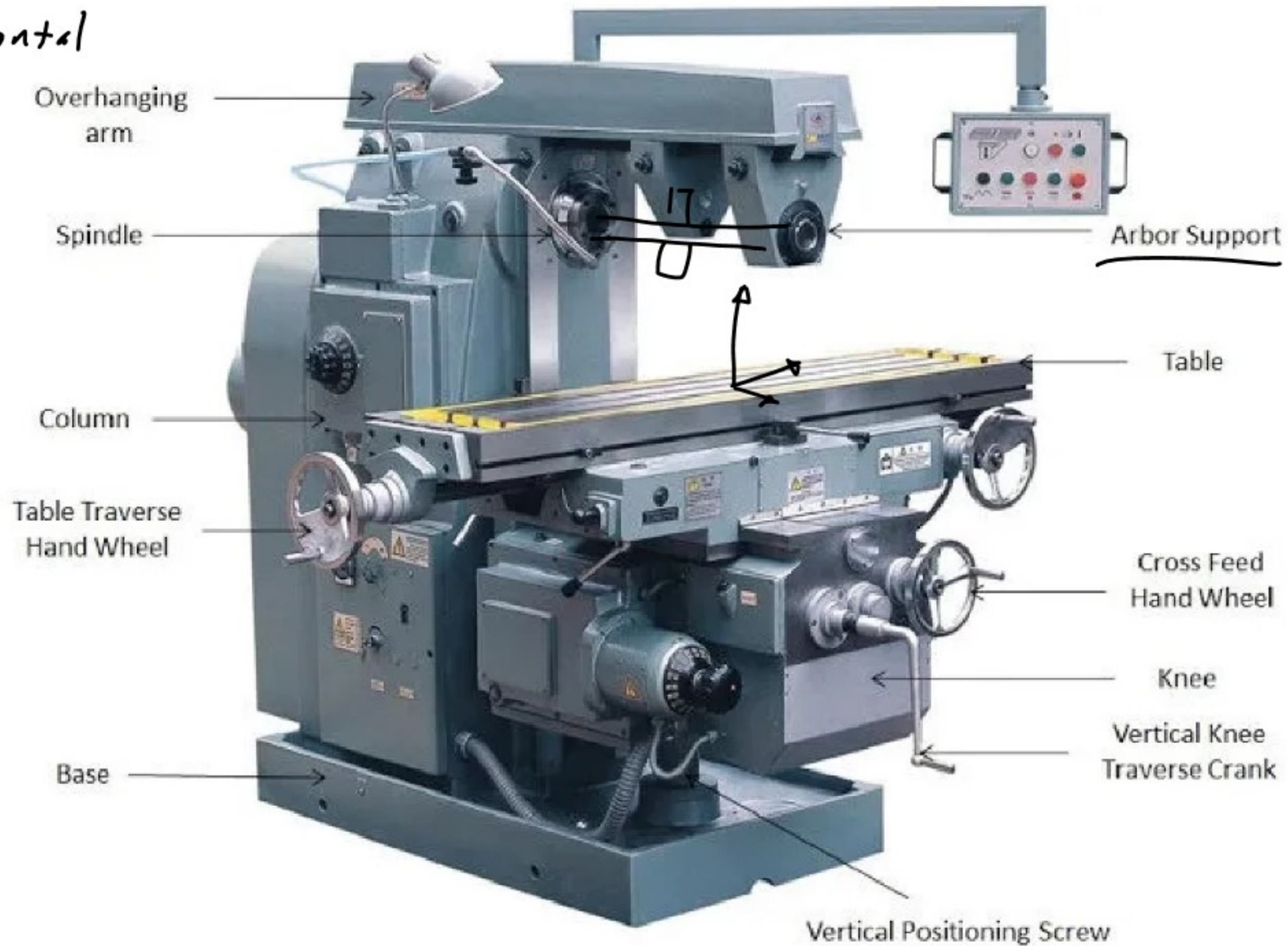


Lathes → Milling Machines

Created 1800

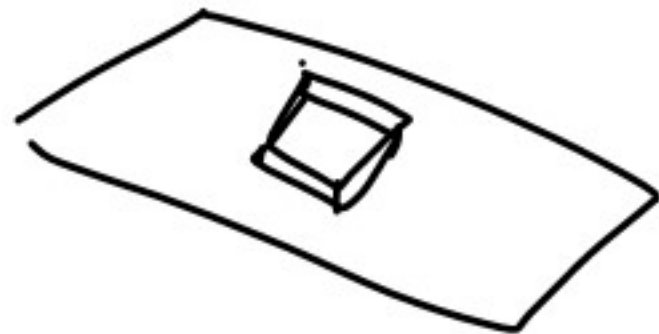
Current form 1850

Horizontal

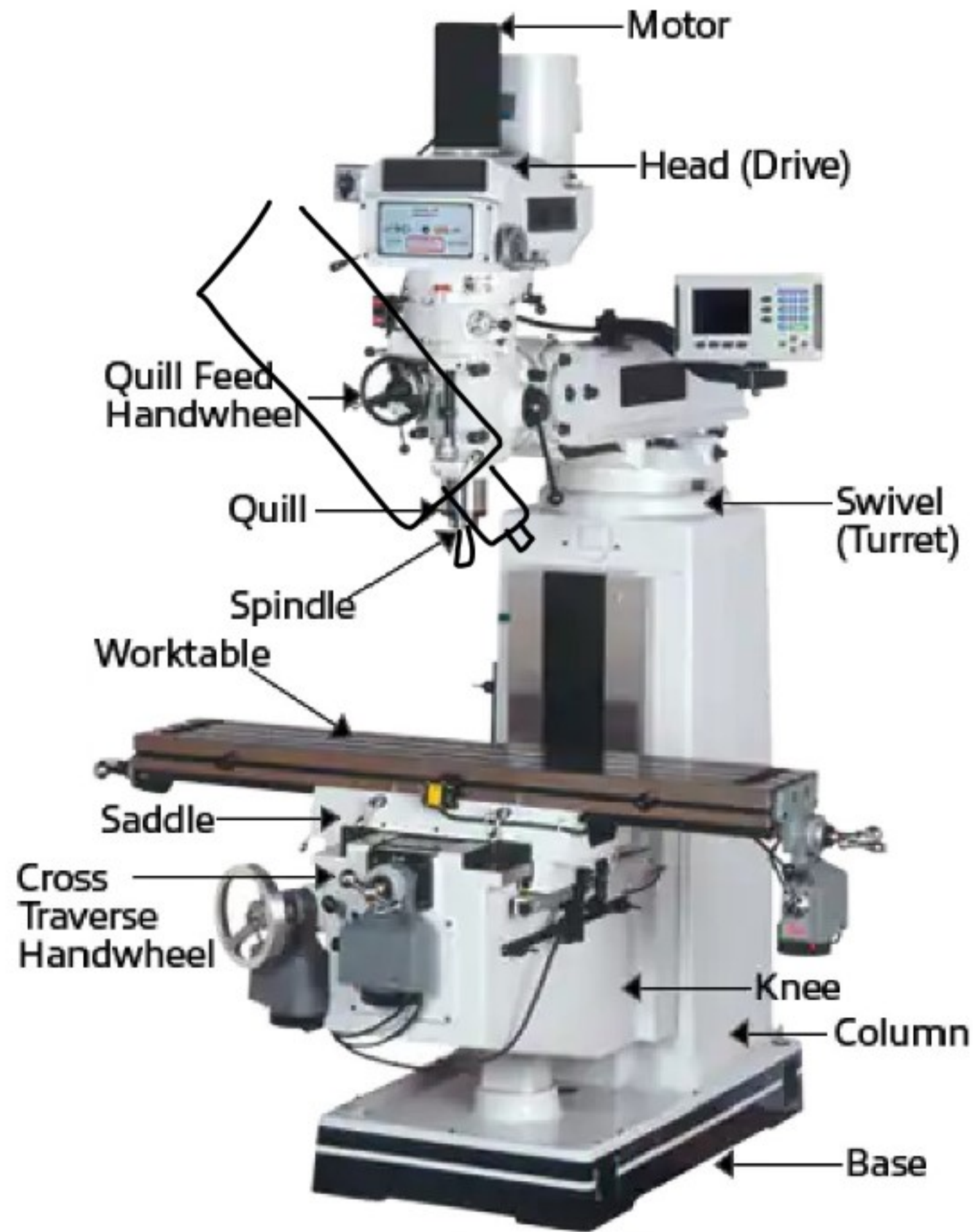


Vertical

1900



5 sides



Endmill

Center Cutting



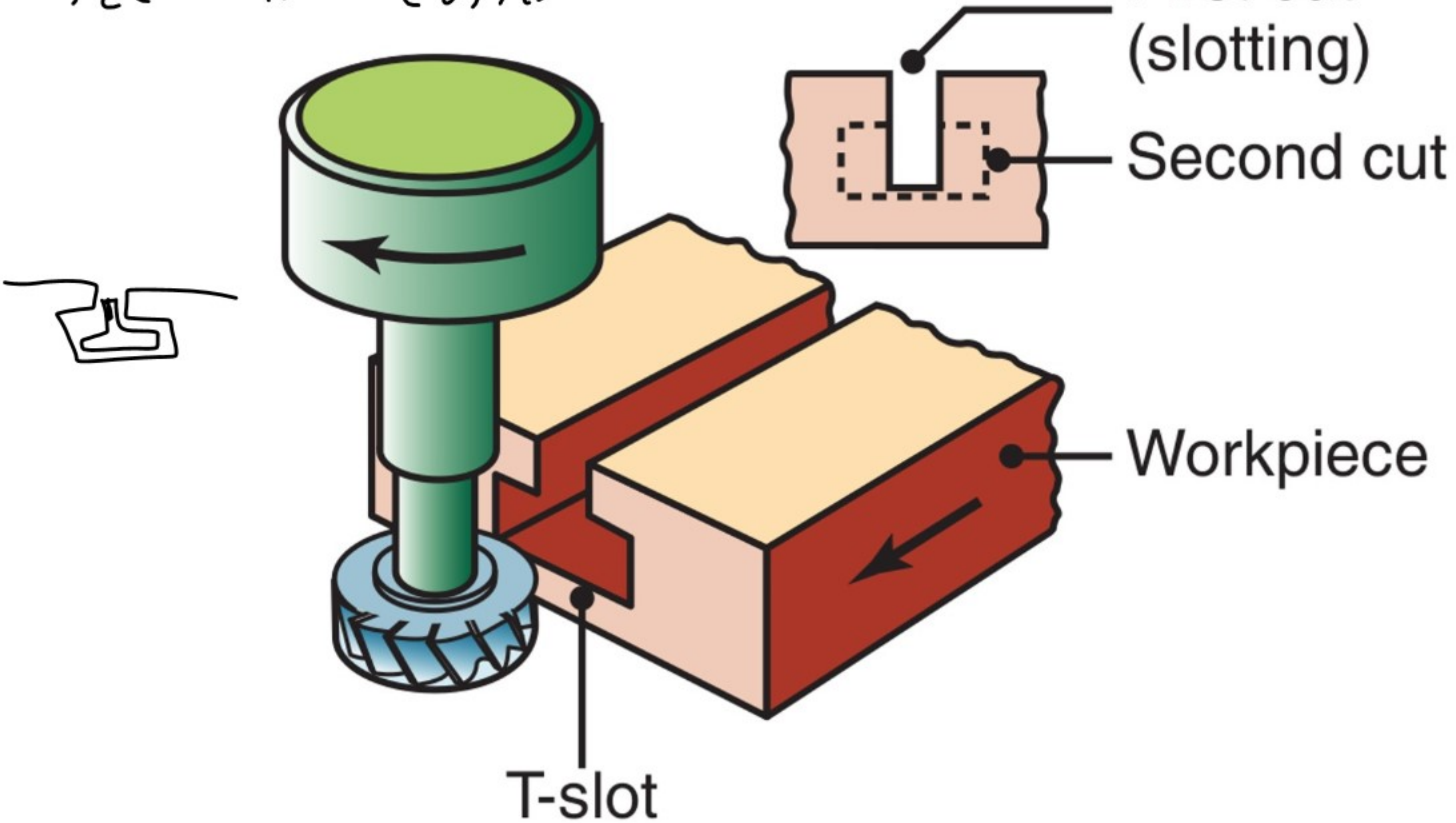
Indexable  
Endmills



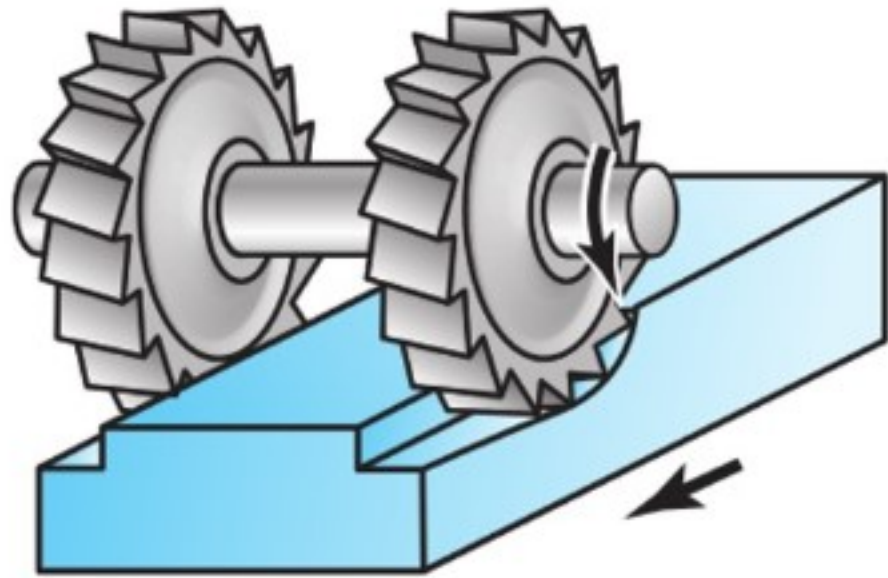
Face Mill



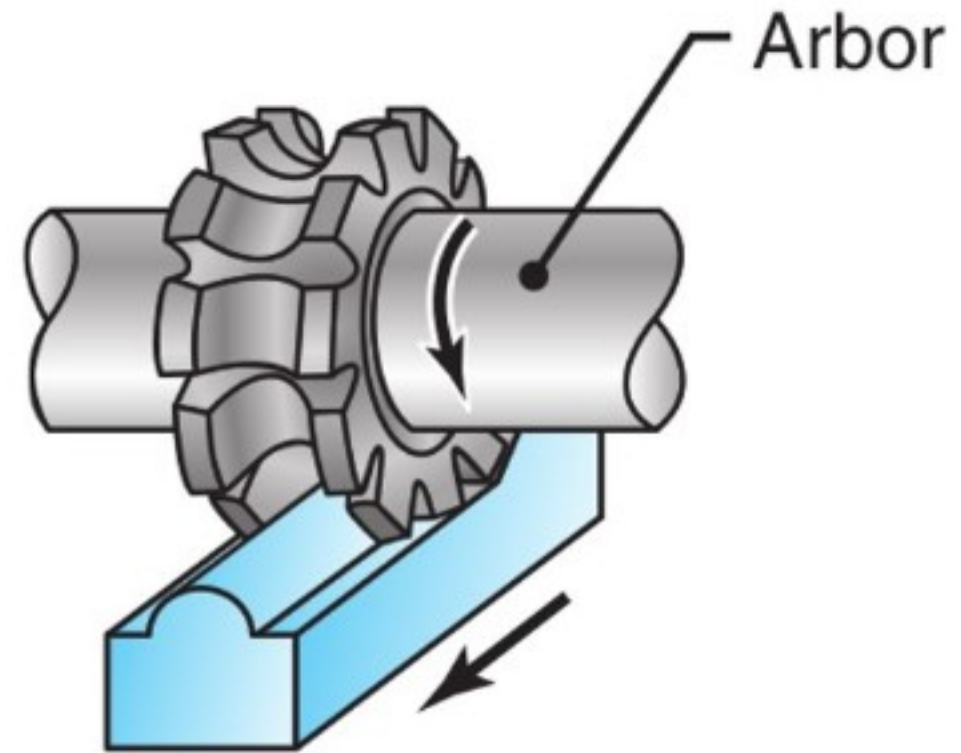
# Tee Slot Cutter



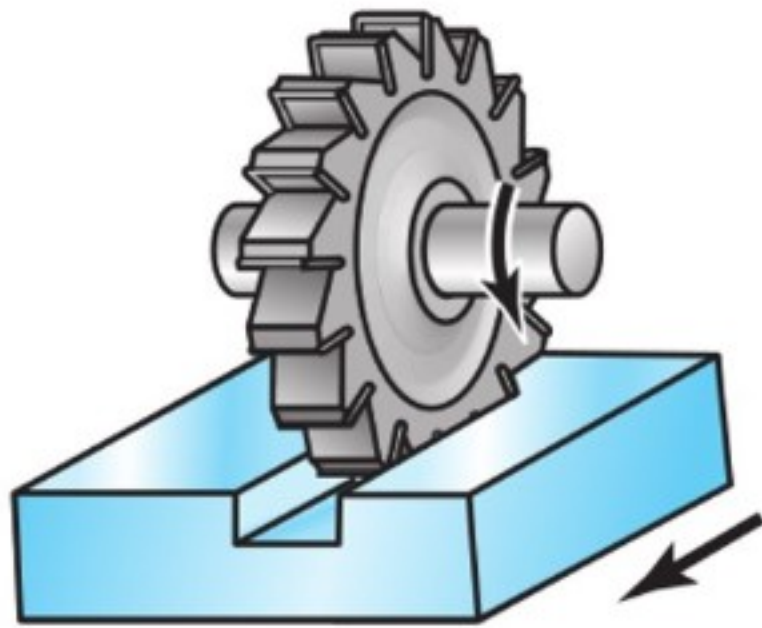
# Horizontal Milling Cutters



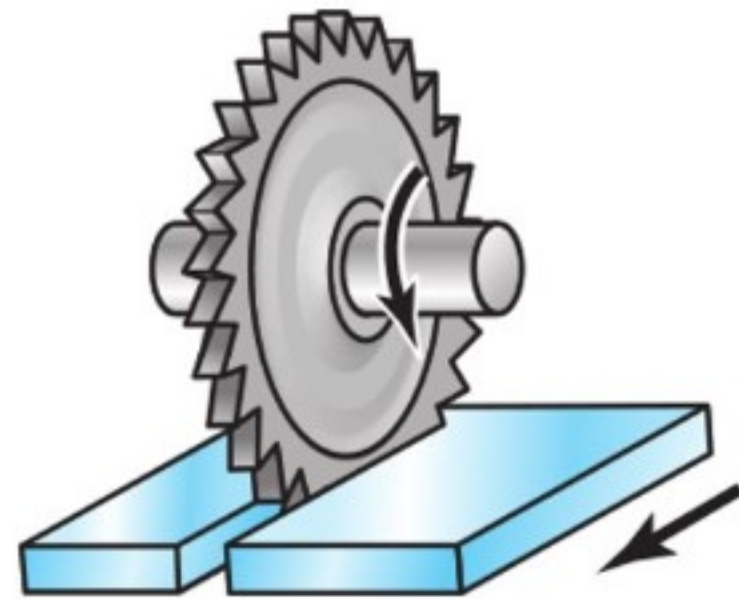
(a) Straddle milling



(b) Form milling



(c) Slotting



(d) Slitting



Gang  
Milling

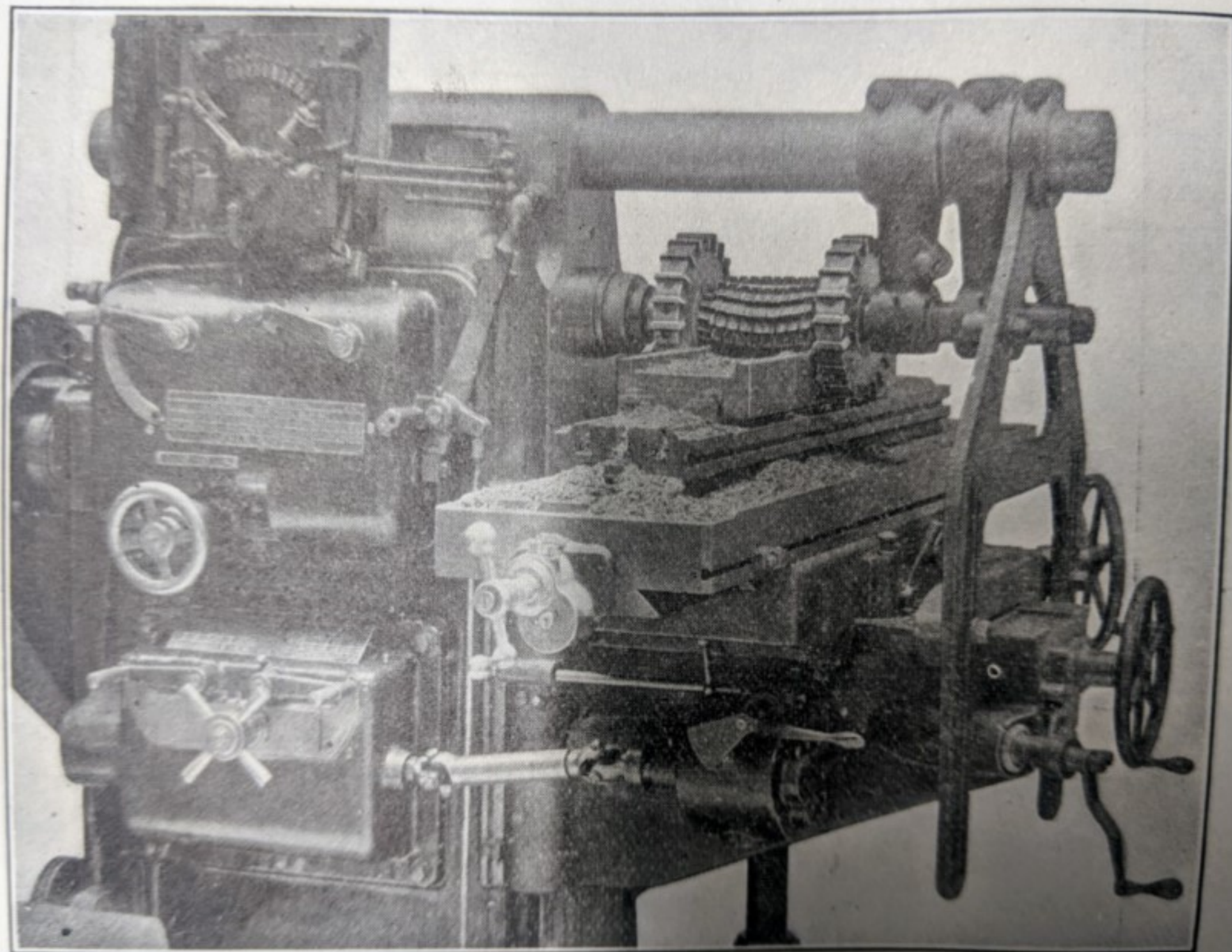
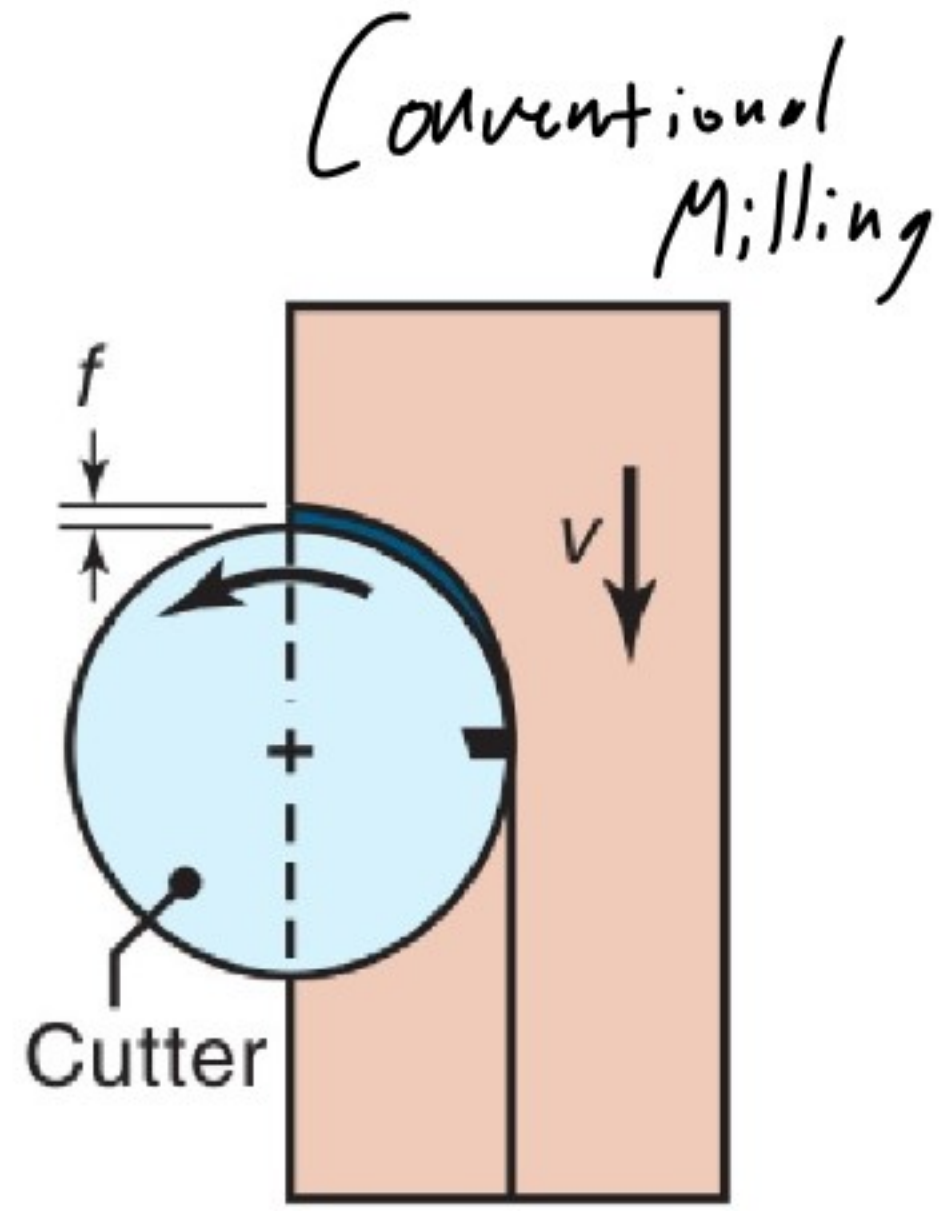
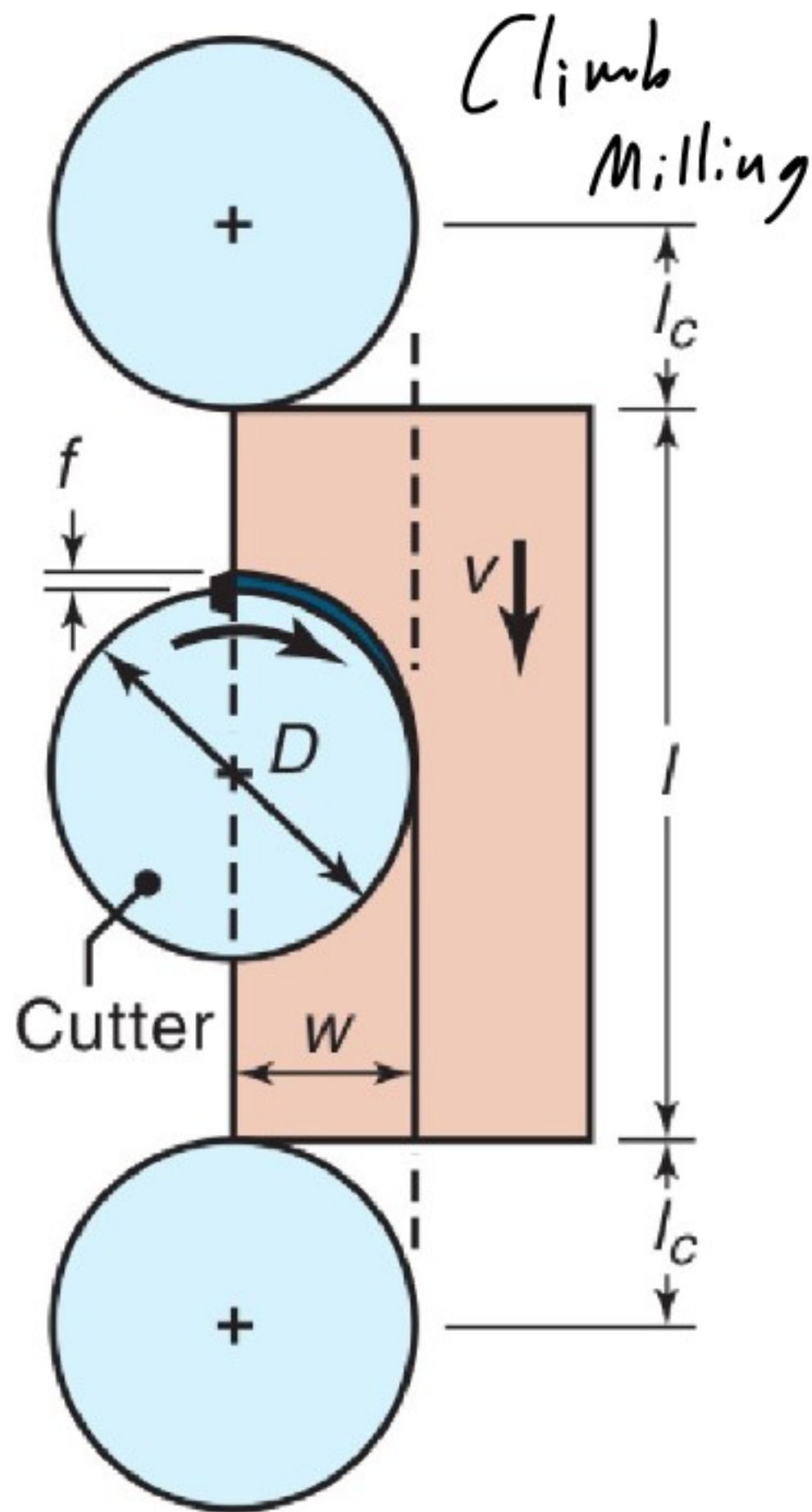
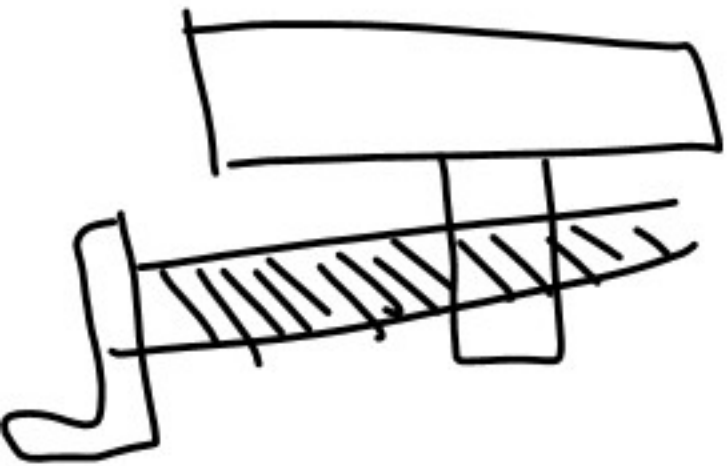
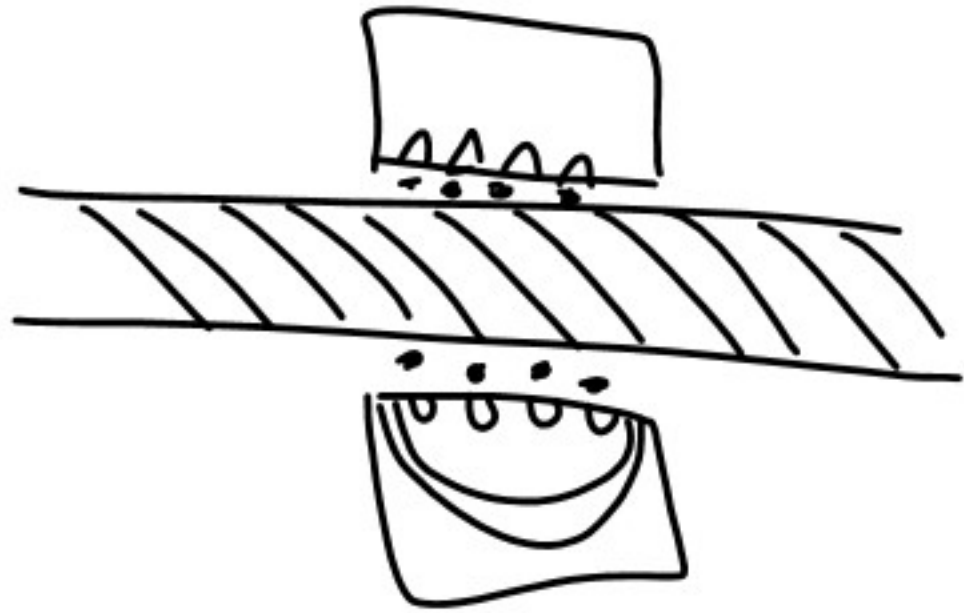


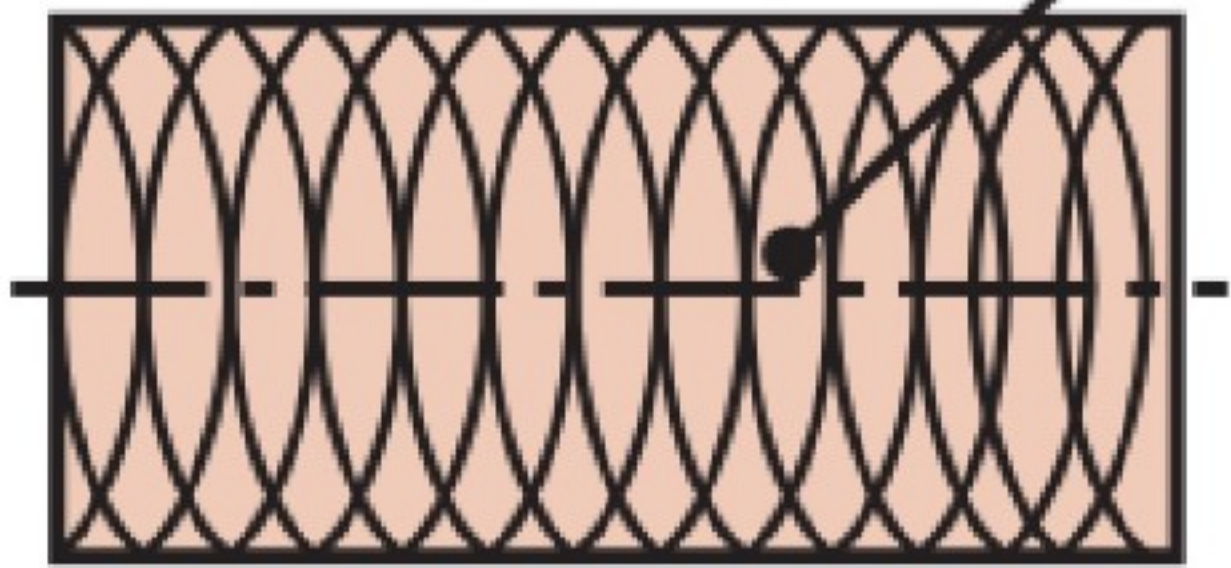
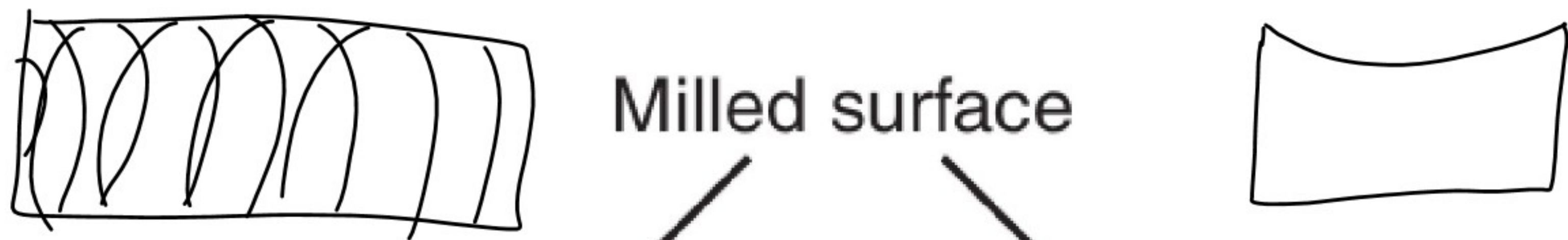
FIG. 233.—Gang milling.

Climb  
and  
Conventional  
Milling

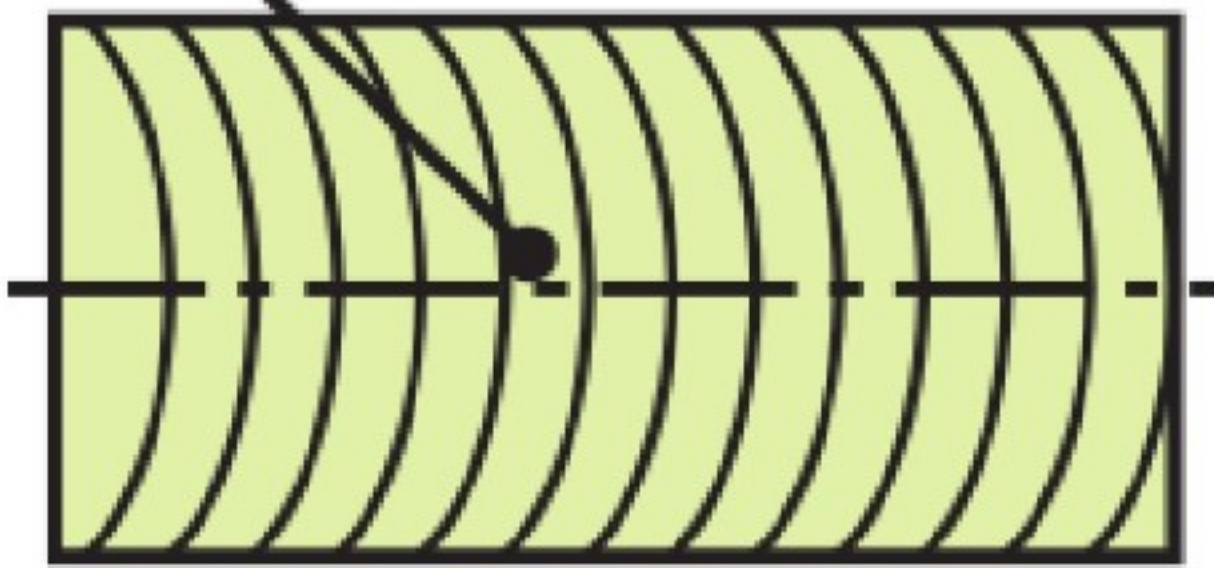


Ball Screw





Back striking



No back striking

Direction of workpiece travel

---

$N$  = Rotational speed of the milling cutter, rpm

$F$  = Feed, mm/tooth

$D$  = Cutter diameter, mm

$n$  = Number of teeth on cutter

$v$  = Linear speed of the workpiece or feed rate, mm/min

$V$  = Surface speed of cutter, m/min

$$= DN$$

$f$  = Feed per tooth, mm/tooth

$$= \underline{v/Nn}$$

$l$  = Length of cut, mm

$t$  = Cutting time, s or min

$$= (l + l_c) / v, \text{ where } l_c = \text{extent of the cutter's first contact with the workpiece}$$

MRR = mm<sup>3</sup>/min

$$= wdv, \text{ where } w \text{ is the width of cut}$$

Torque = N-m

$$= F_c D / 2$$

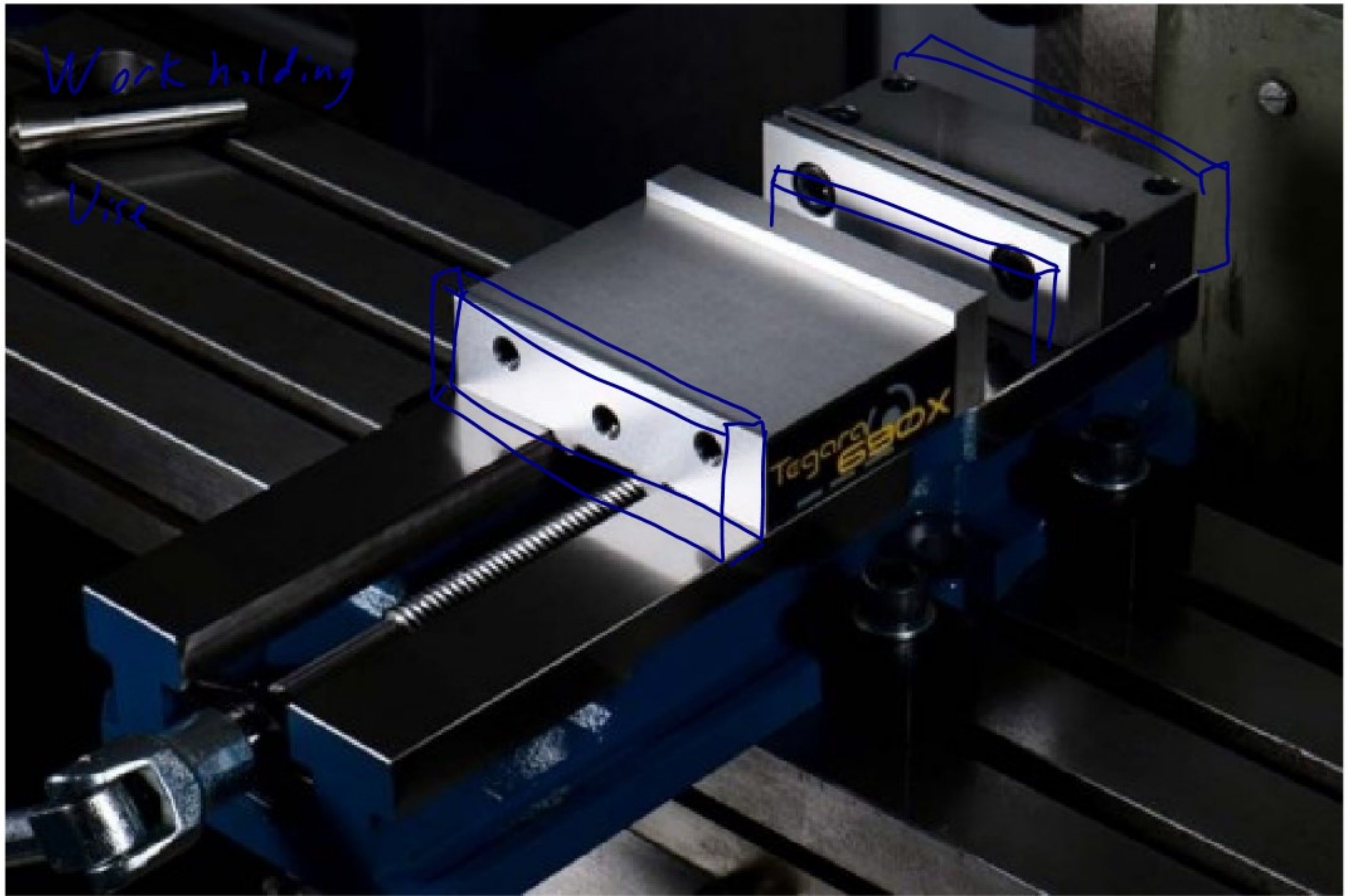
Power = kW

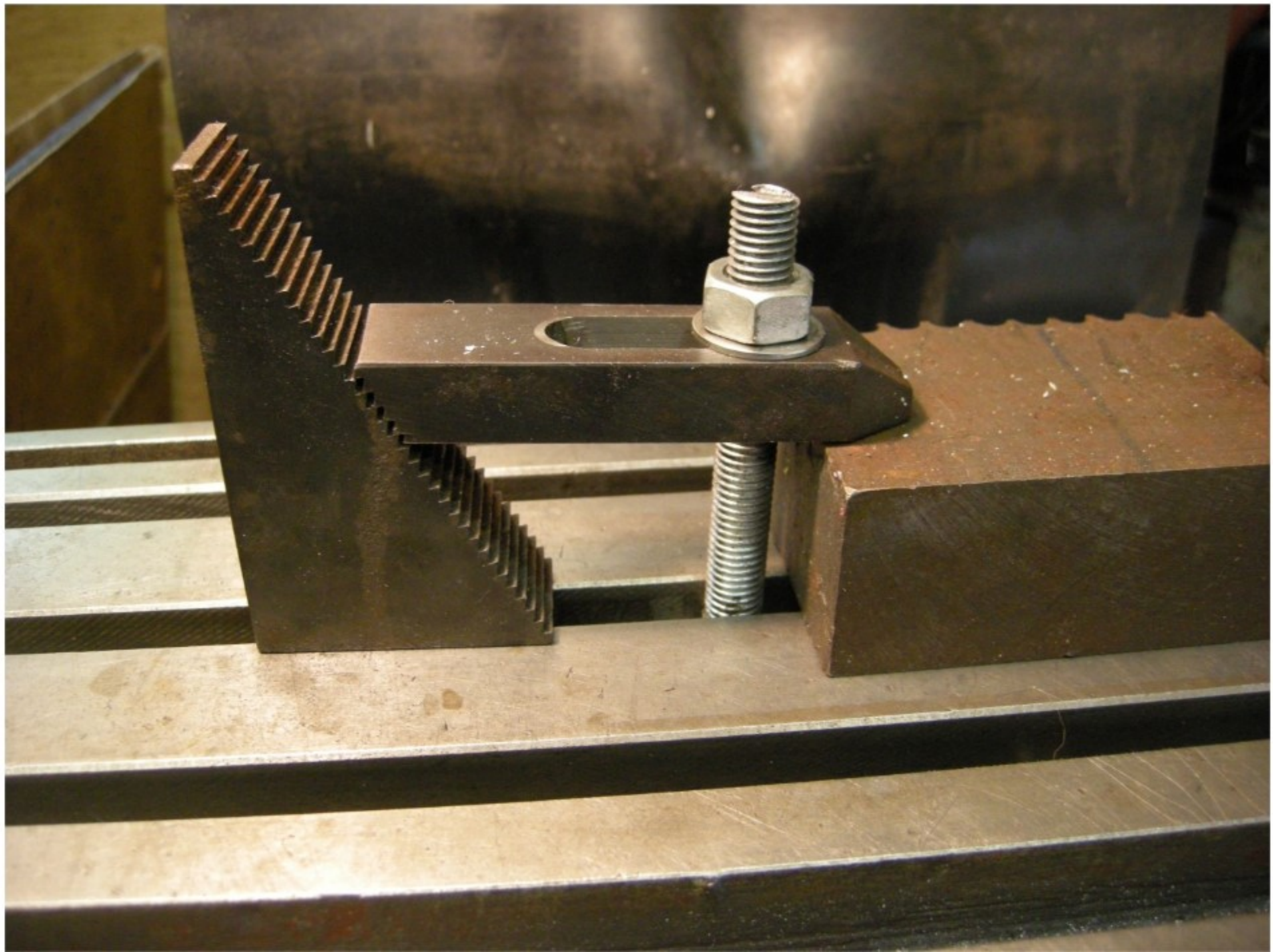
$$= (\text{Torque})(\omega), \text{ where } \omega = 2\pi N \text{ radians/min}$$

---

Work holding

Vise





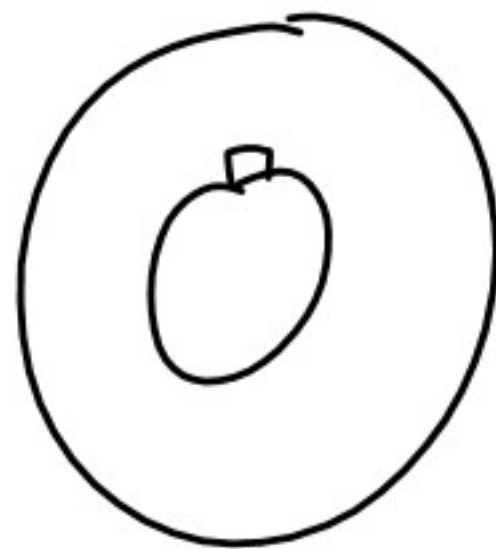
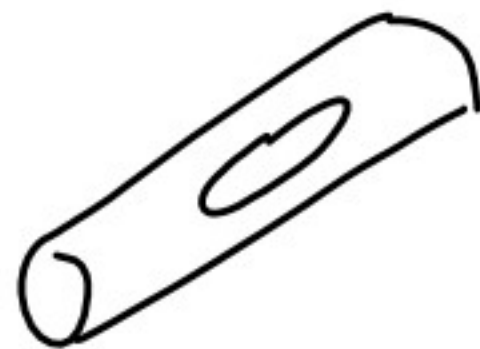
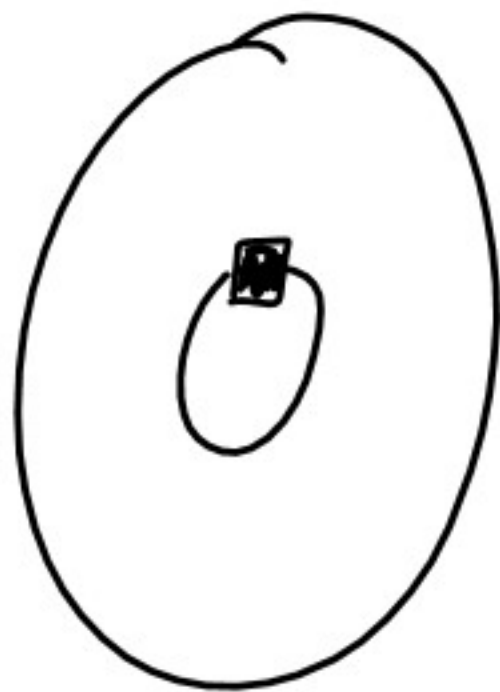
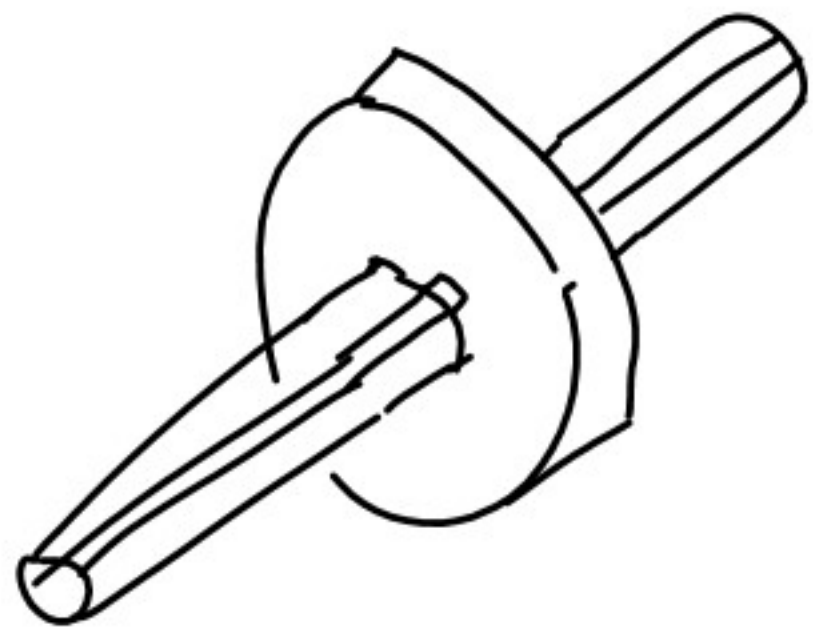
Custom Fixturing

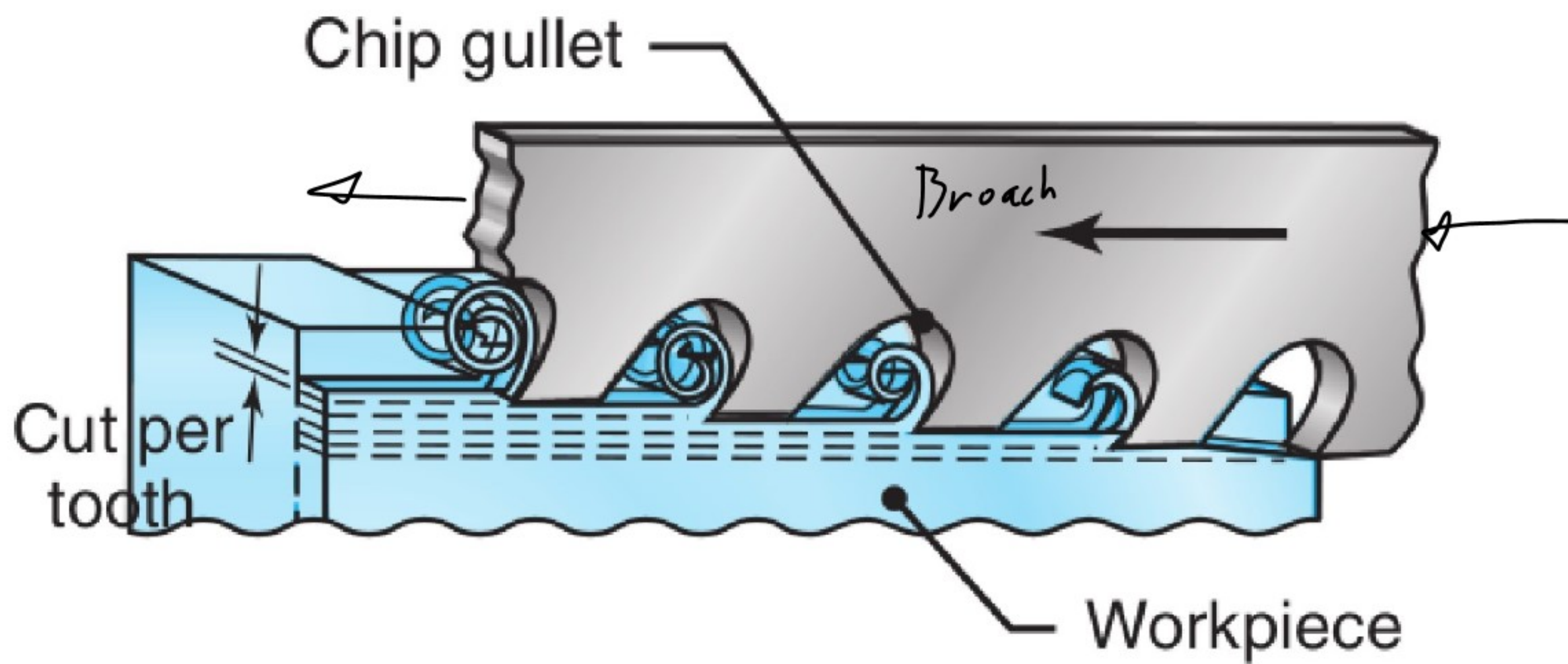


Broaching

Keyways







# Gears

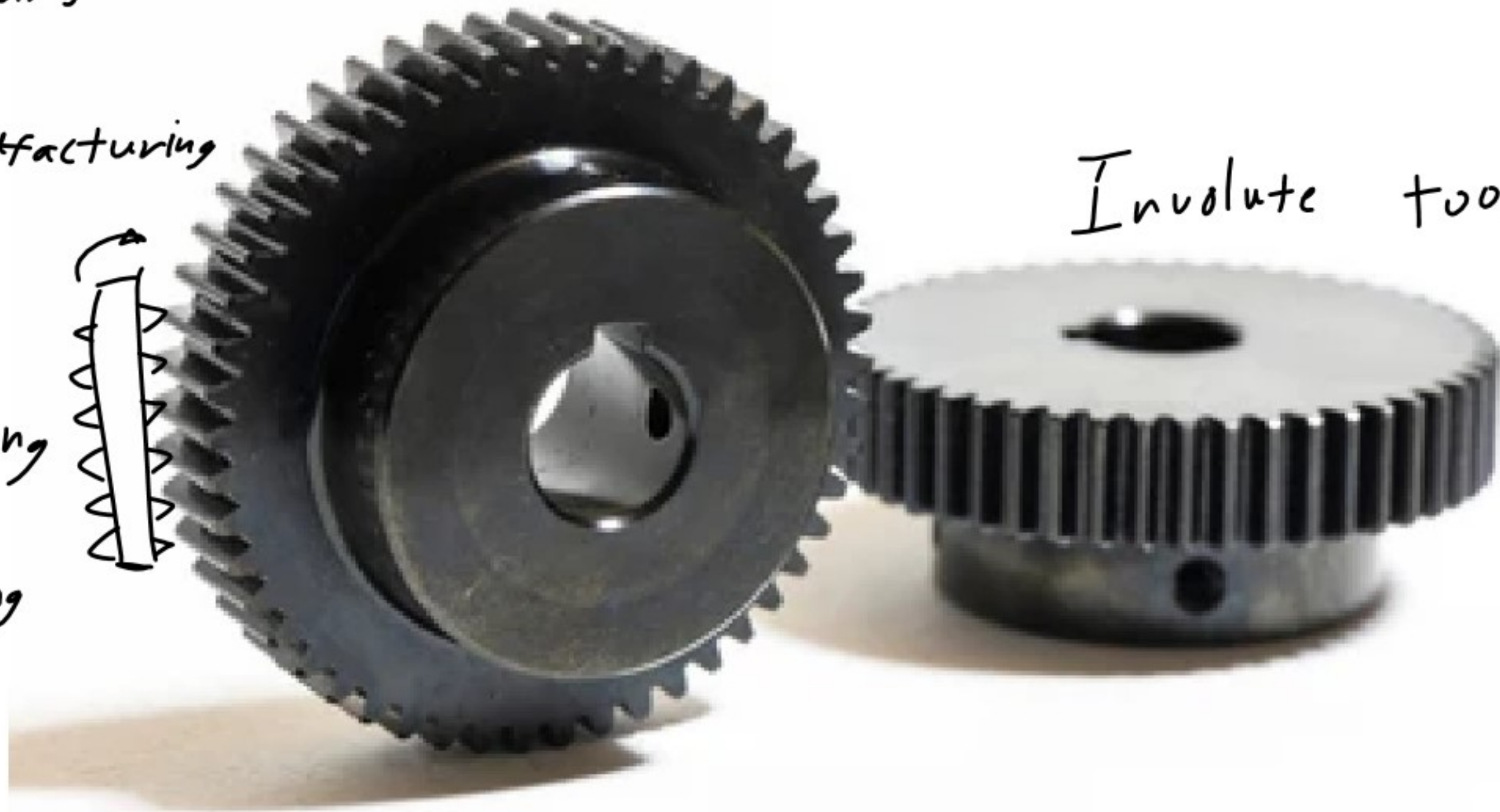
Straight tooth

Manufacturing

Involute tooth

Shaping

Hobbing



# Helical Gears

Hobbing  
Shaping



Bevel gears

Shaping



Spiral  
Bevel  
Gears



- ▶ <https://www.youtube.com/watch?v=RDGBhGxlsJk>
- ▶ <https://www.youtube.com/watch?v=2mWDUFftUcs>
- ▶ <https://www.youtube.com/watch?v=ssU6yPIfrLE>
- ▶ <https://www.youtube.com/watch?v=H-UaDNxRLTw>
- ▶ <https://www.youtube.com/watch?v=JwAzY3DYpWA>
- ▶ <https://www.youtube.com/watch?v=BLZ2k09vRD4>