

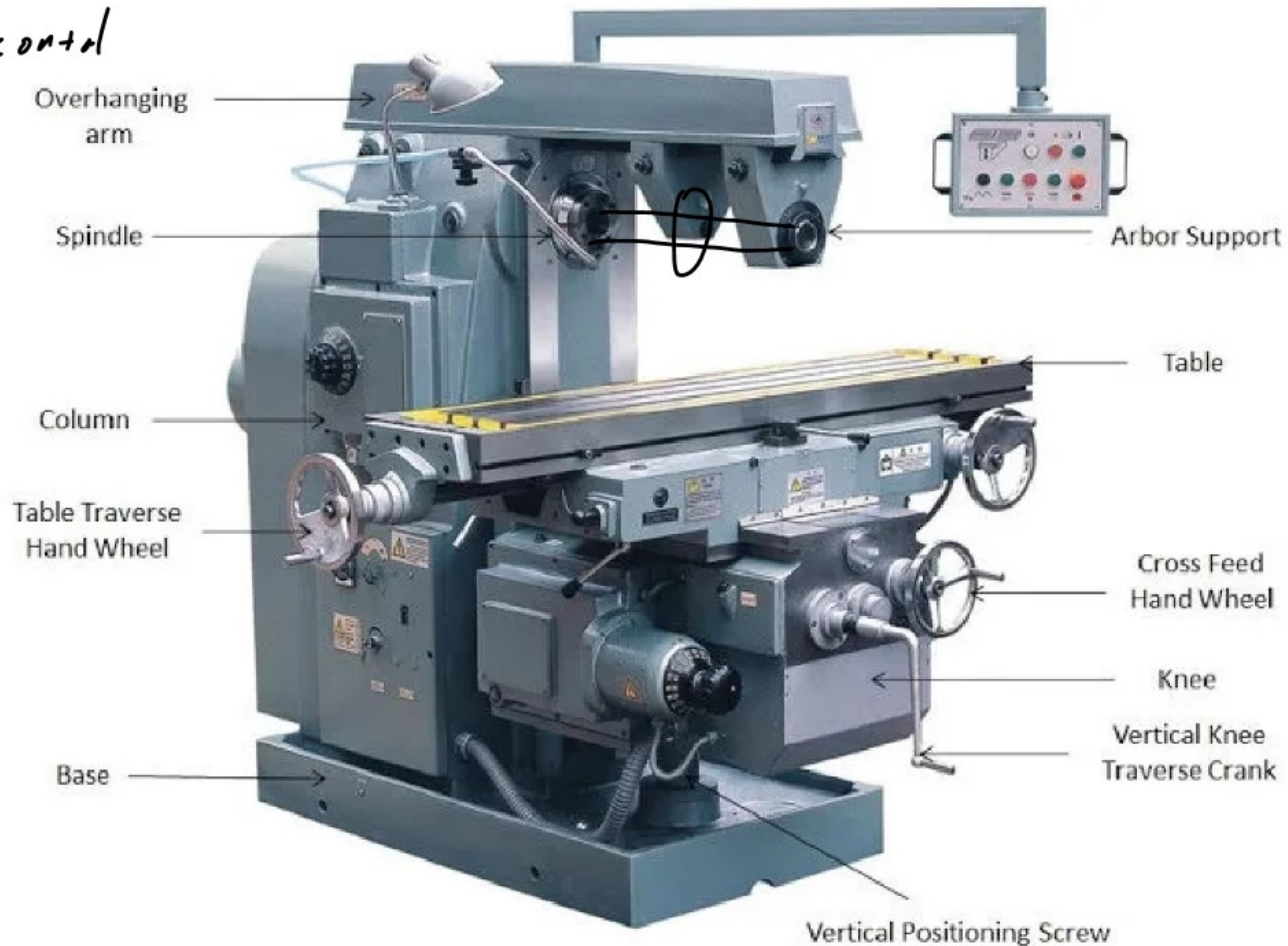
Lathes

Milling Machine

First Invented around 1800

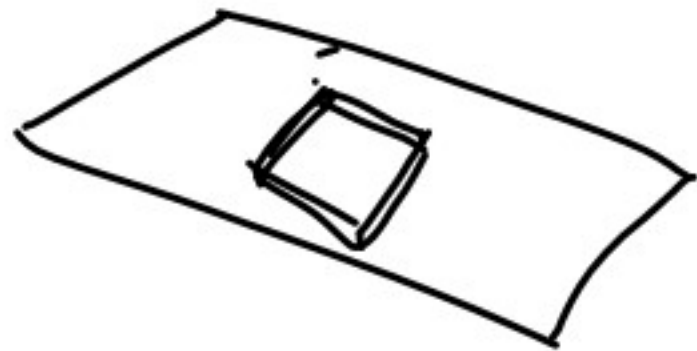
Current form 1850

Horizontal

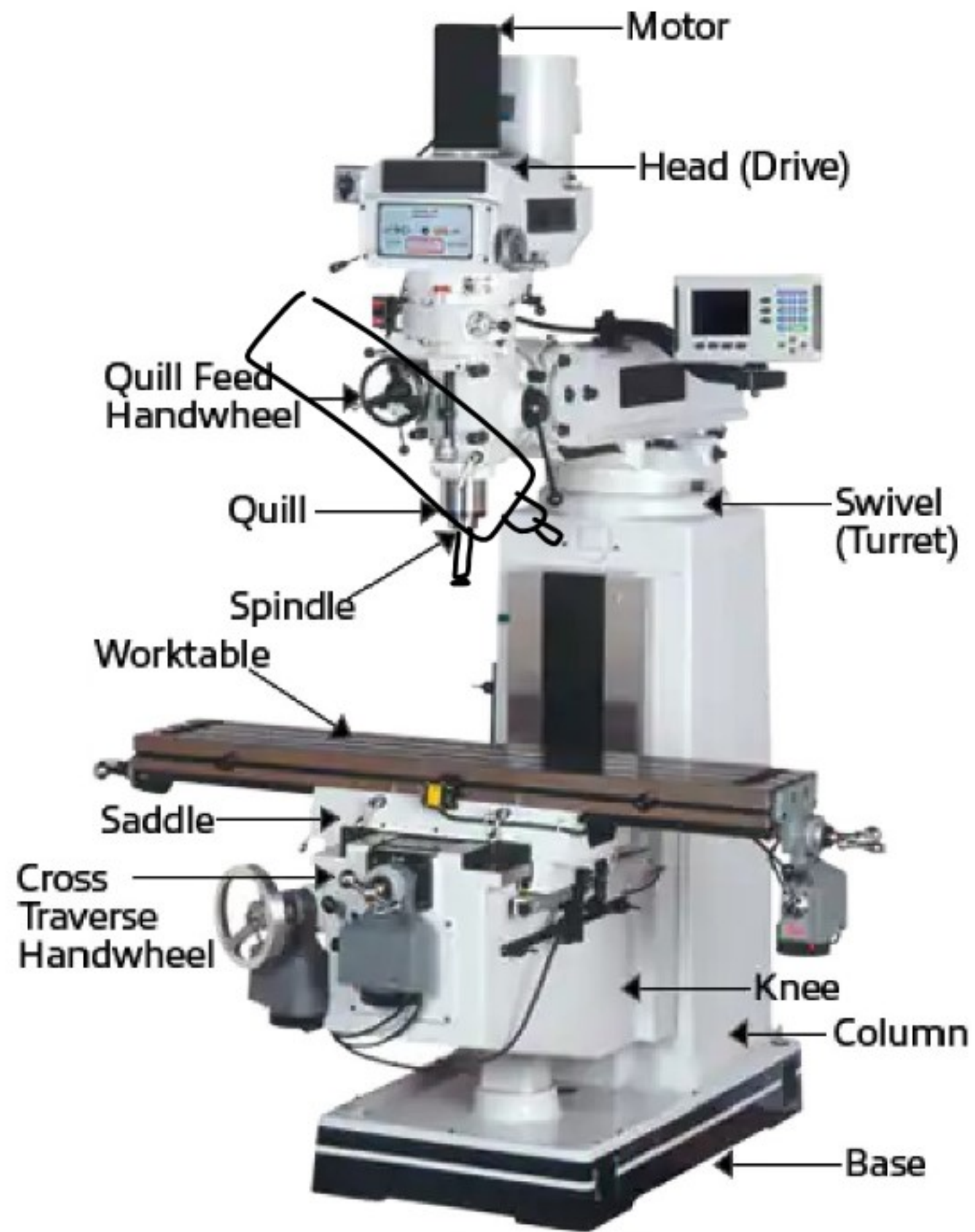


Vertical

1900



5 sides



Endmill

Center Cutting

High Speed Steel
Solid Carbide



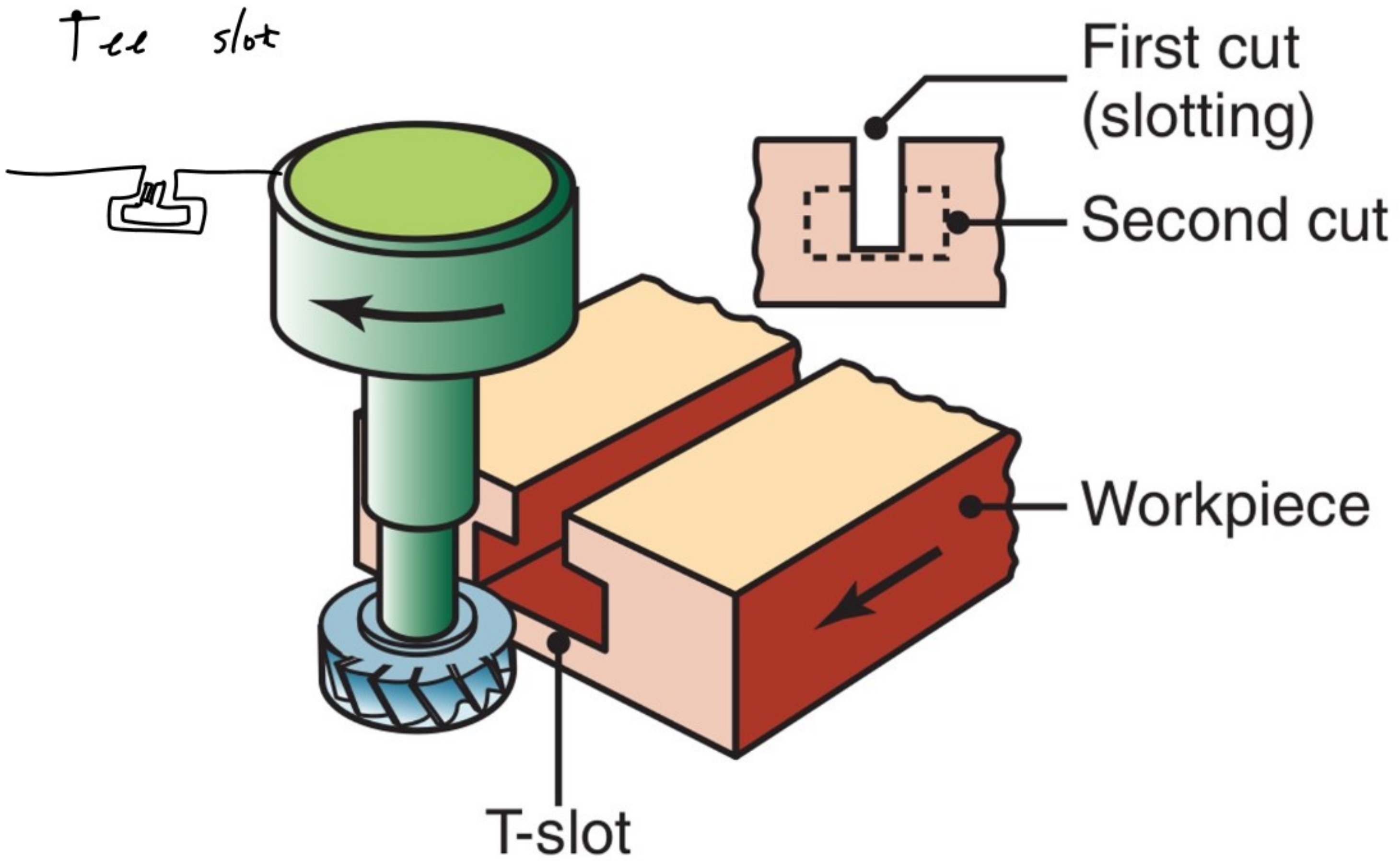
Indexable
Endmills



Face Mills

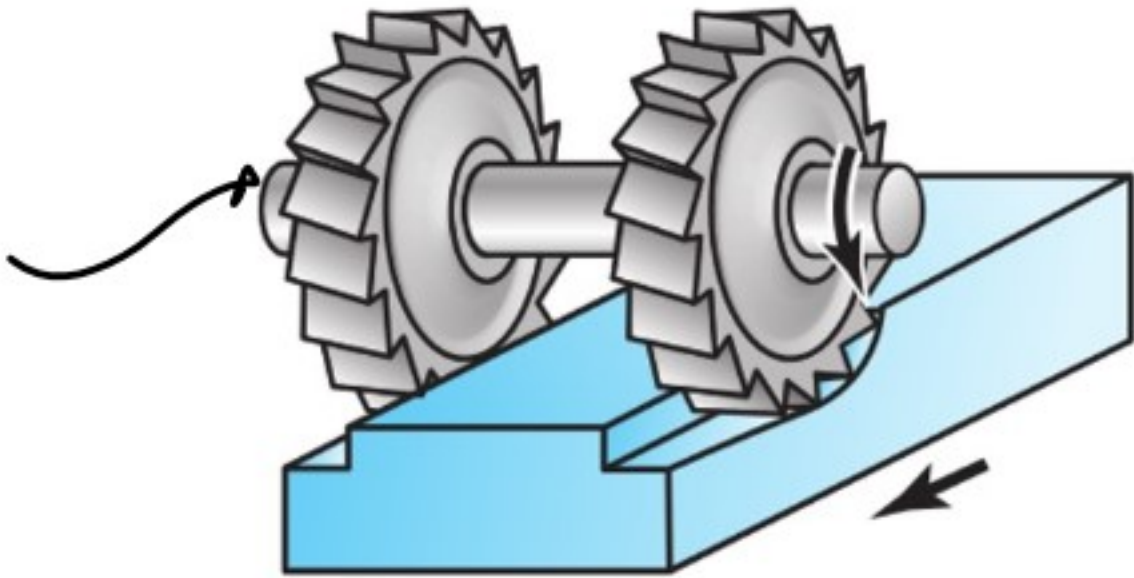
Flycutting



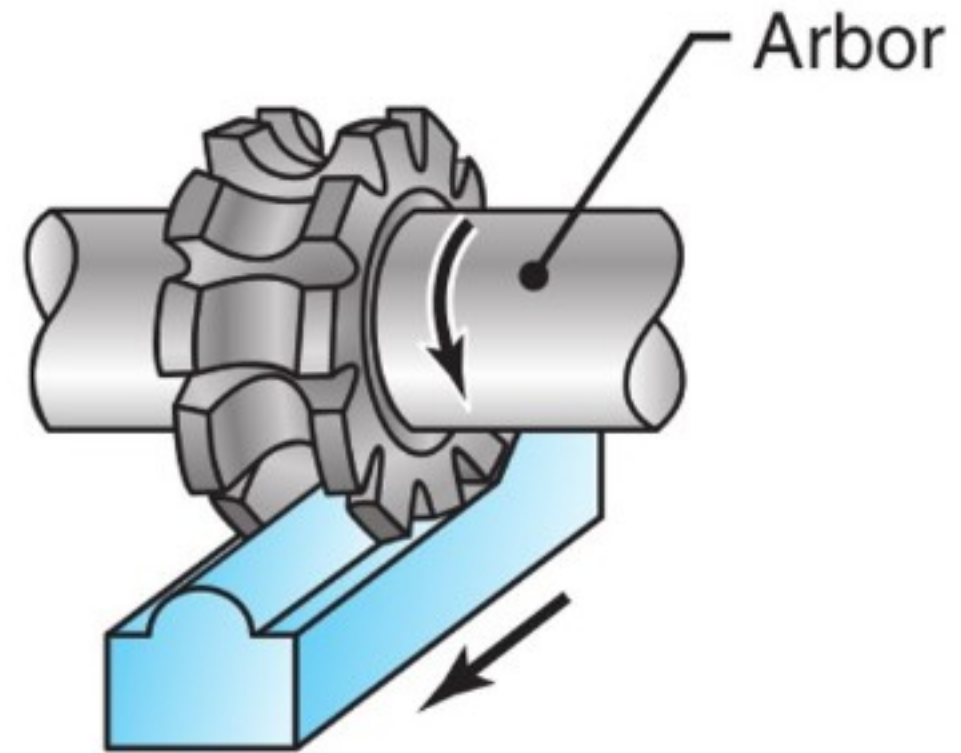


Horizontal Milling Cutters

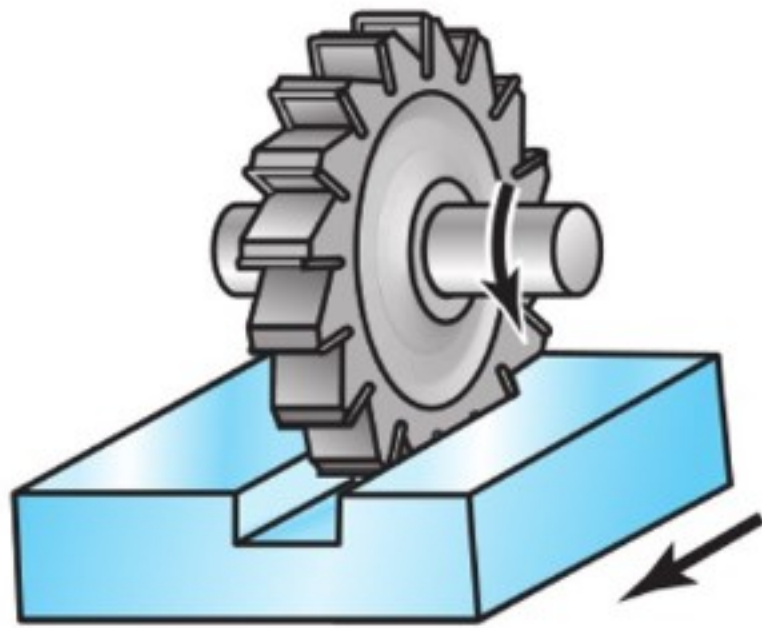
Arbor



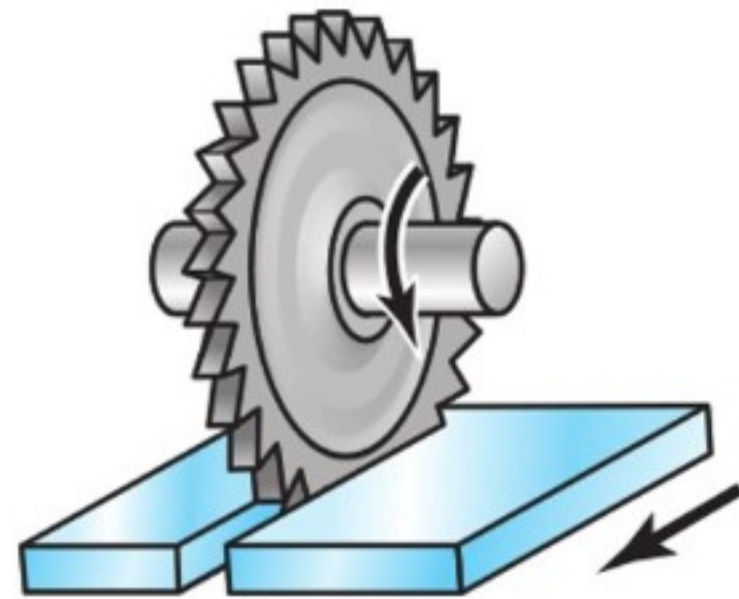
(a) Straddle milling



(b) Form milling



(c) Slotting



(d) Slitting

Gang
Milling

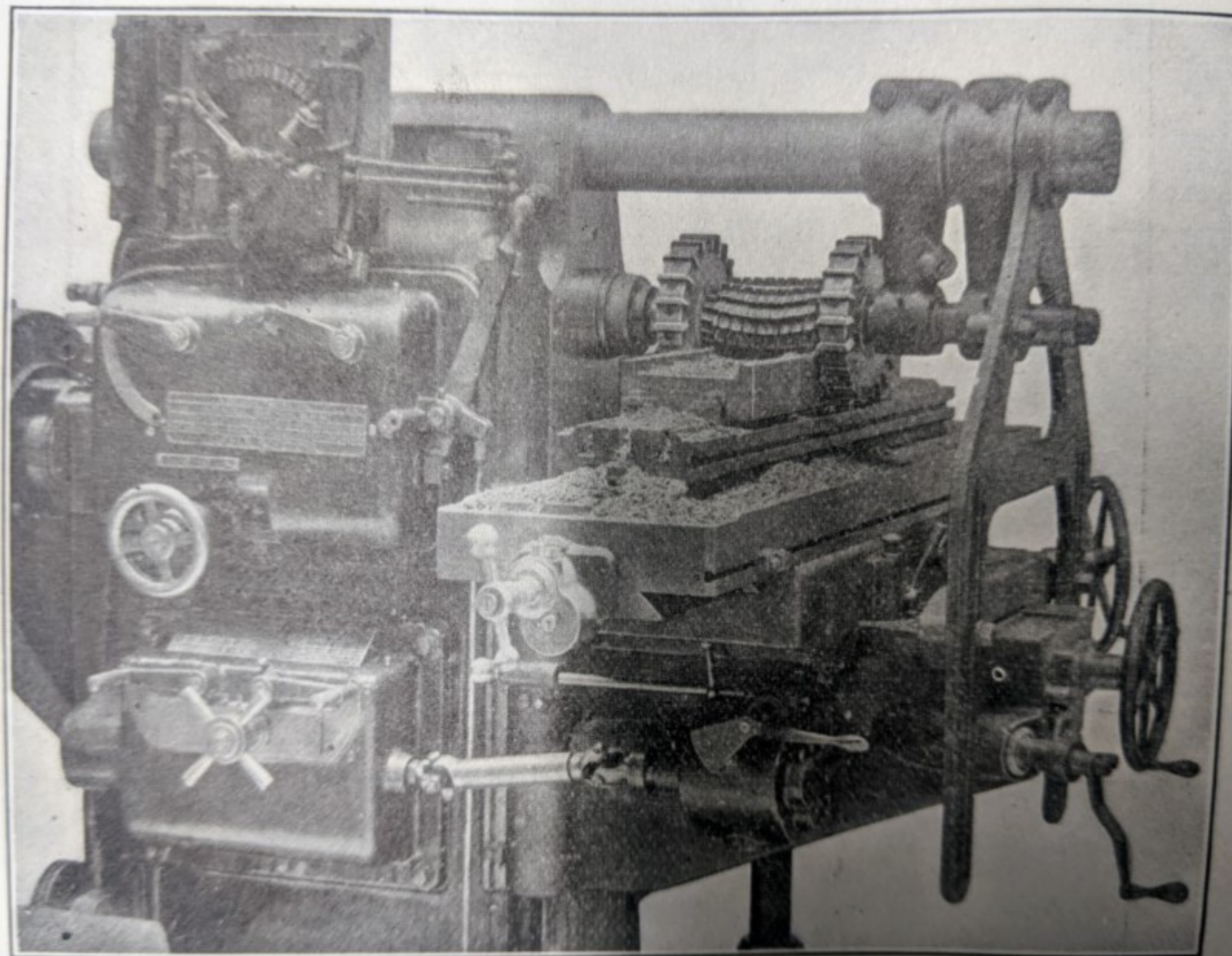
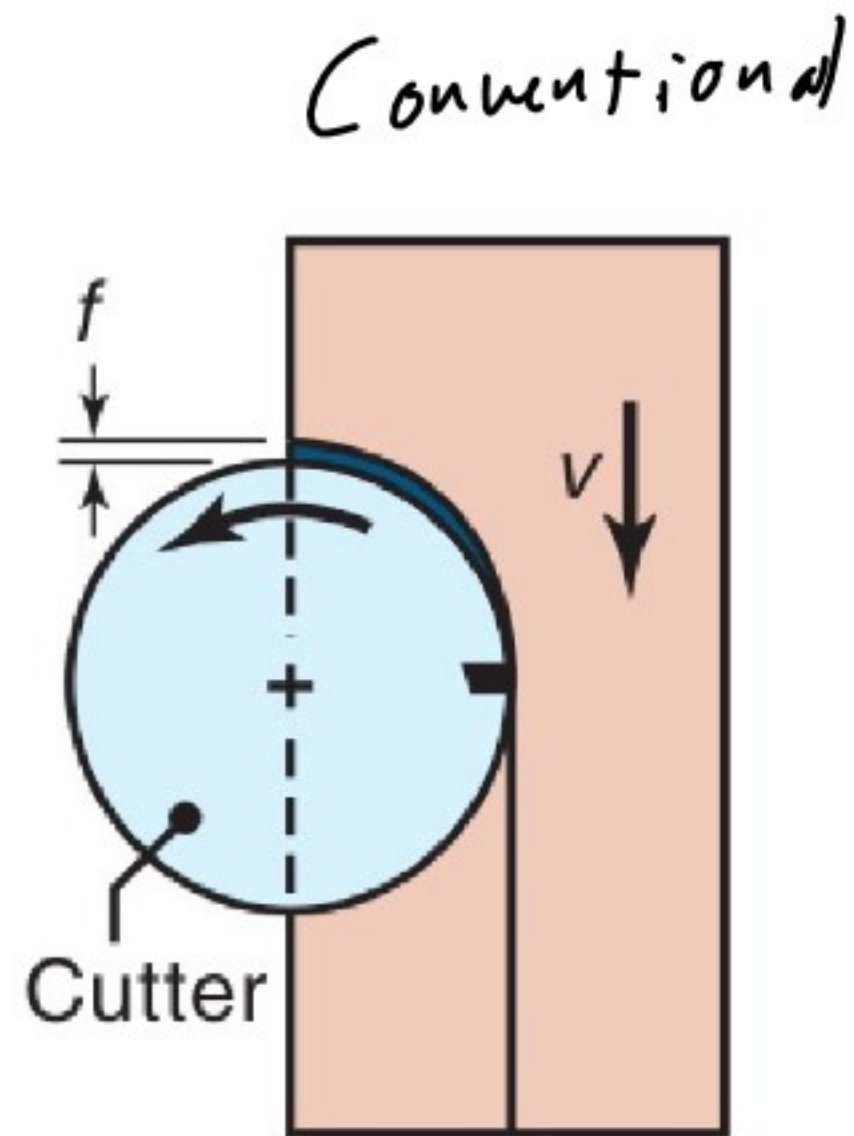
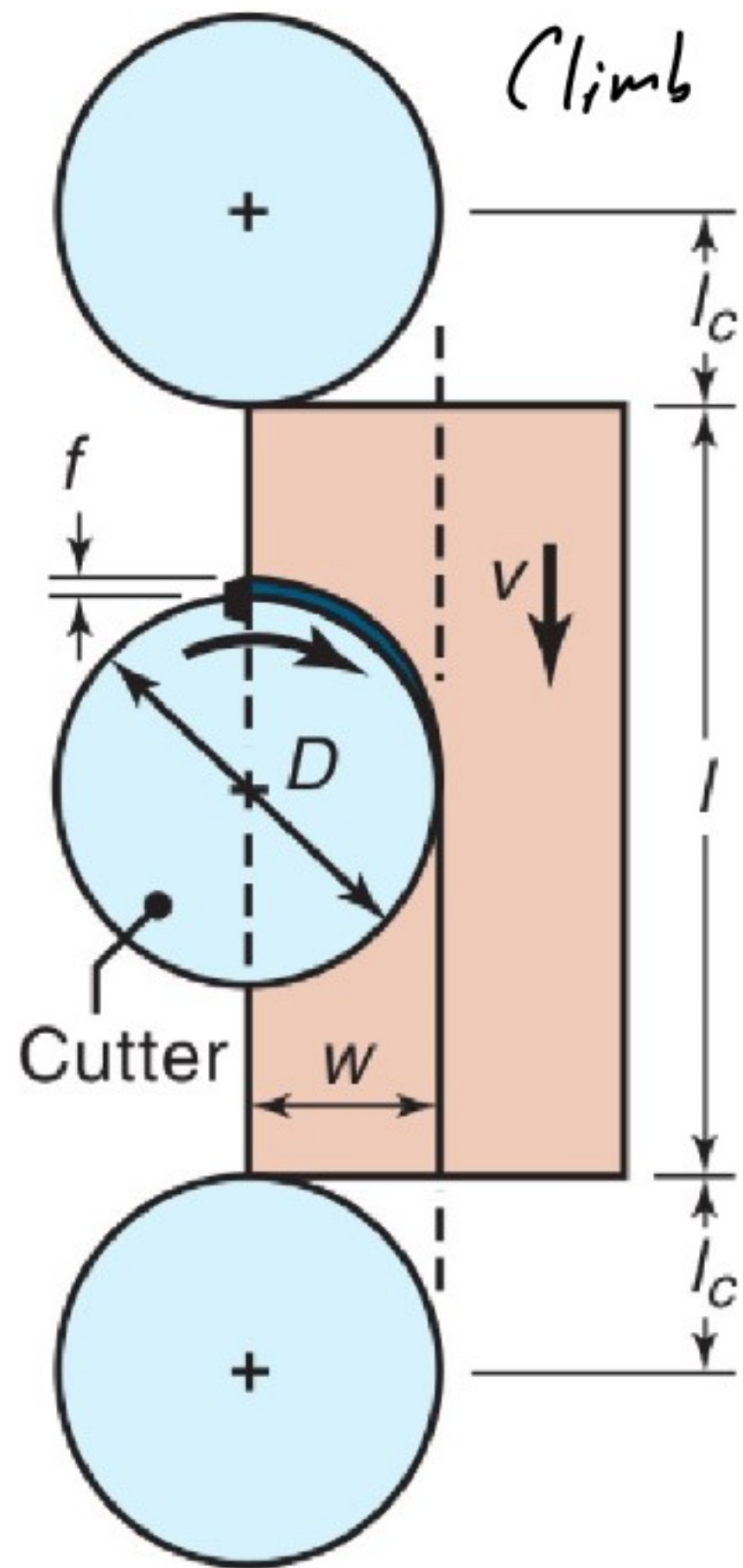
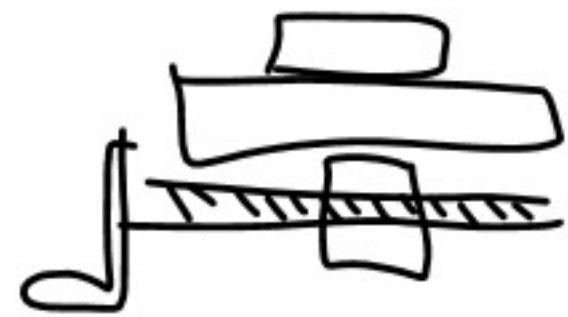
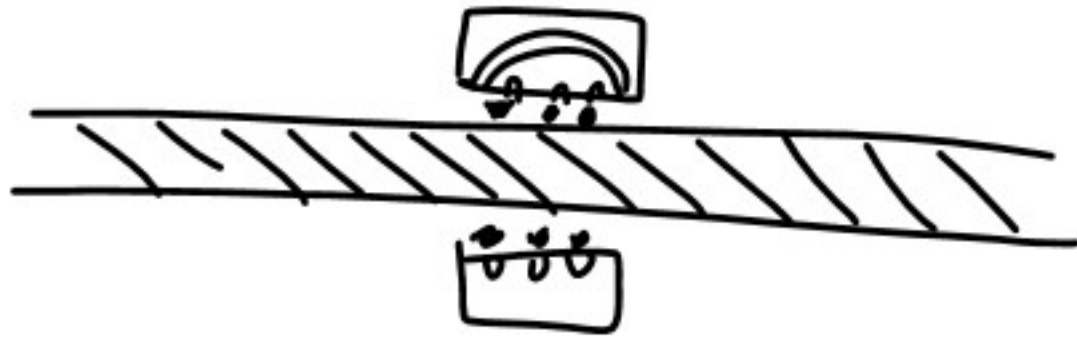


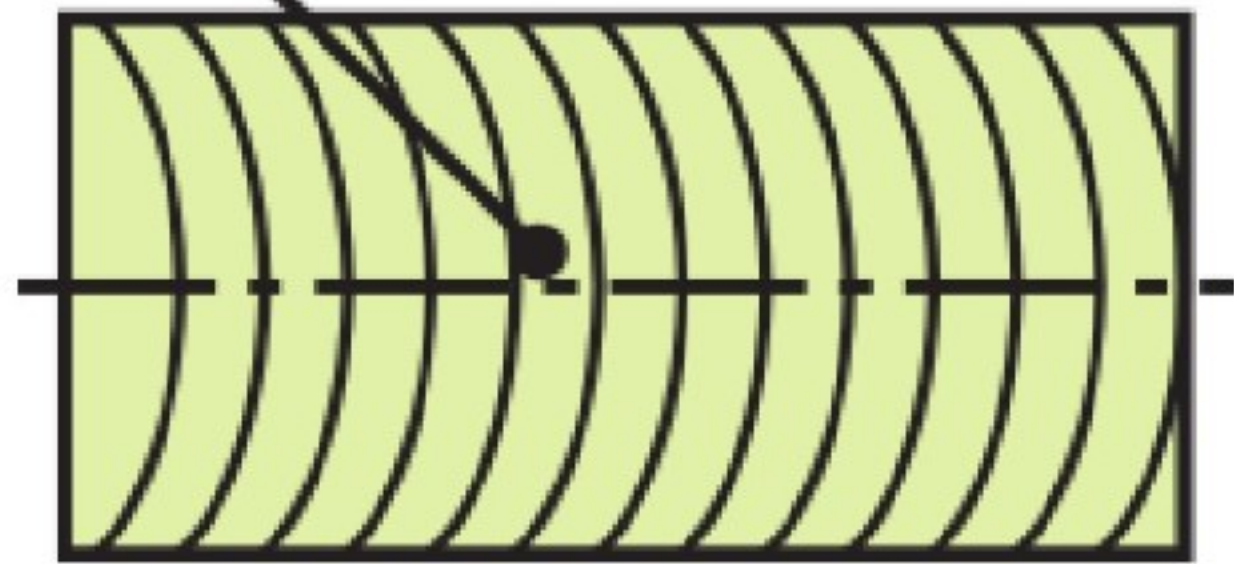
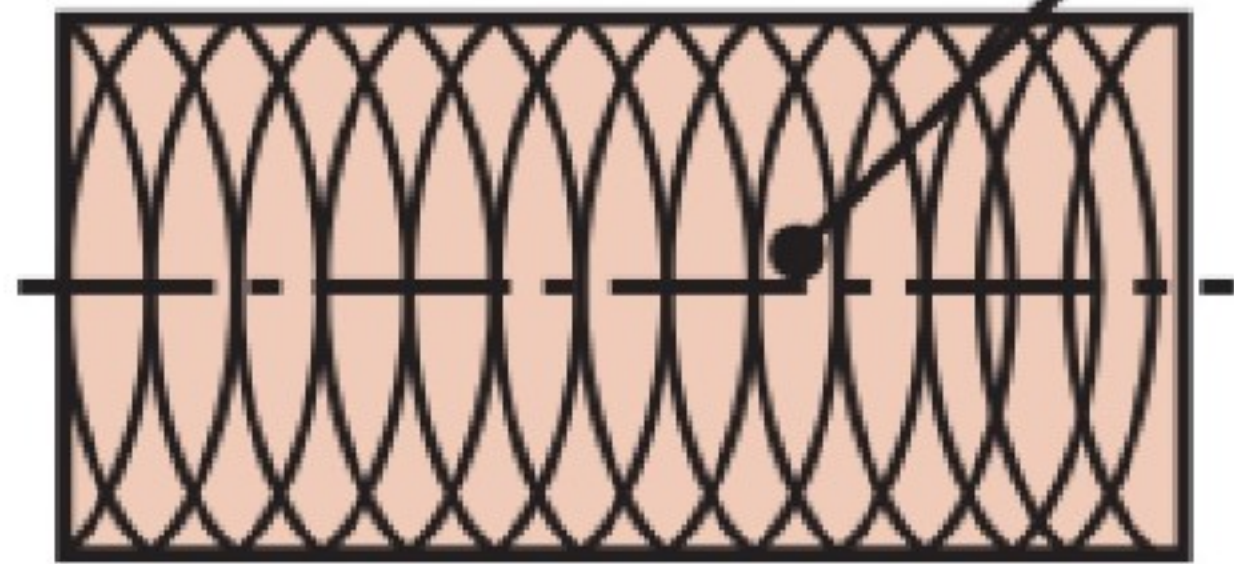
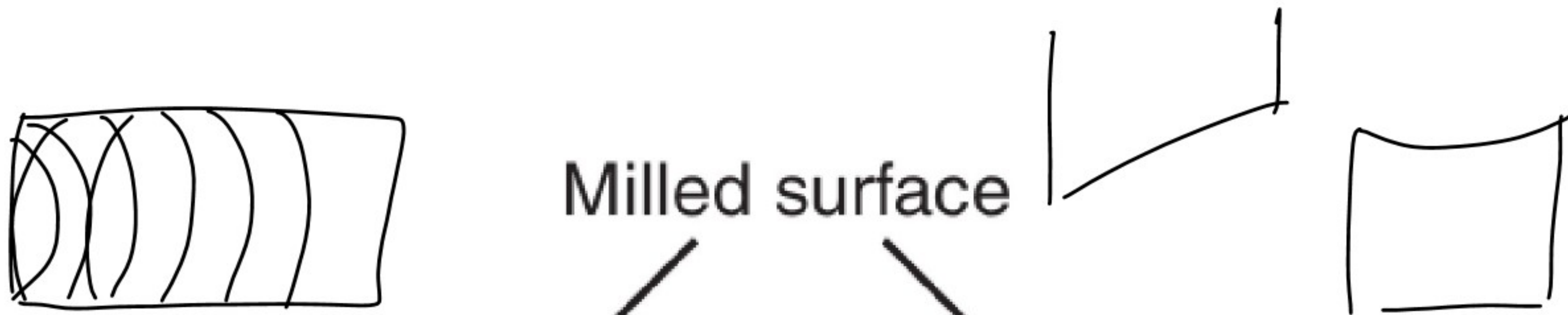
FIG. 233.—Gang milling.

Climb
and
Conventional
Cutting



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 = mm³/min

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

Torque = N-m

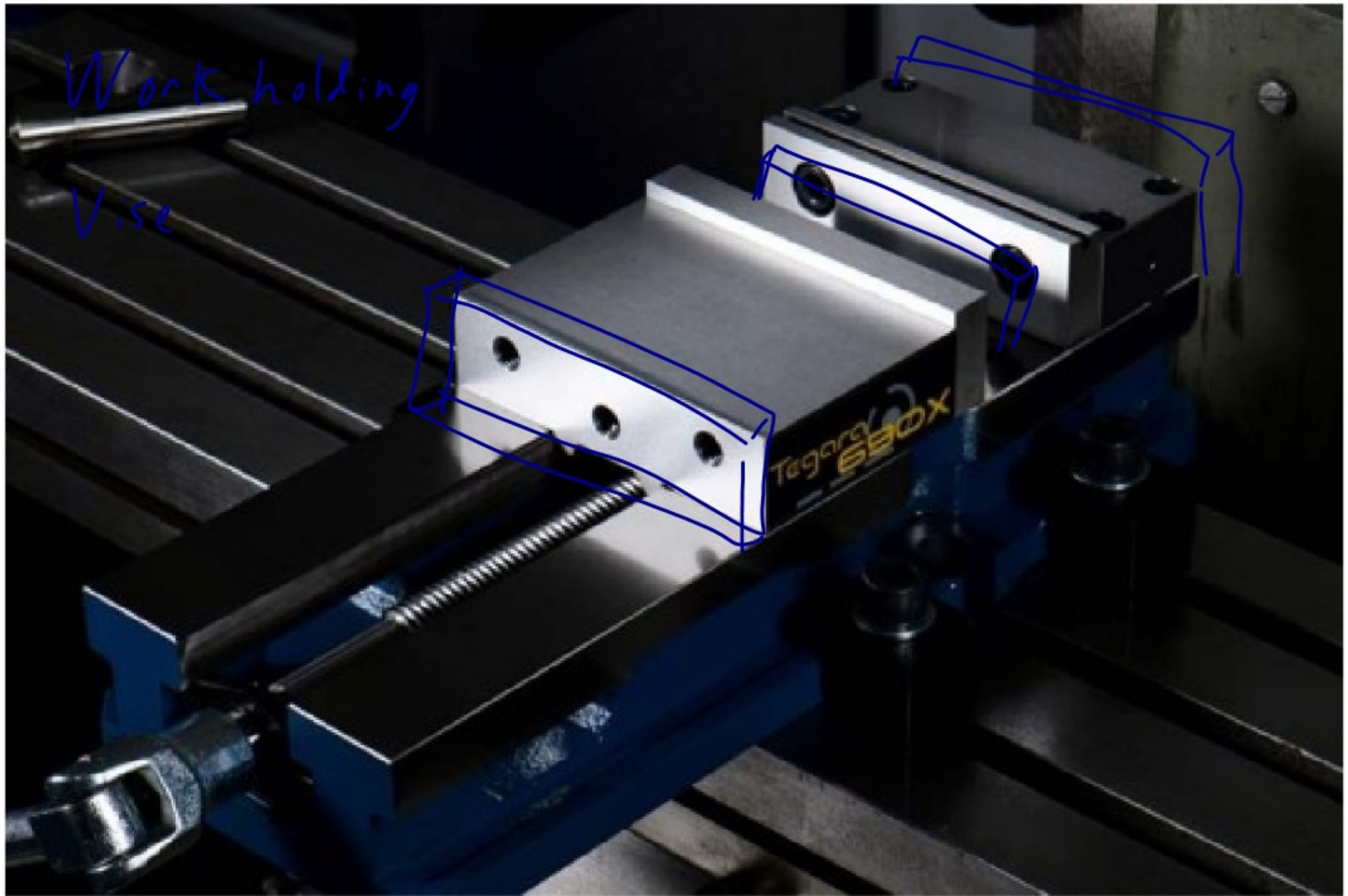
$$= F_c D / 2$$

Power = kW

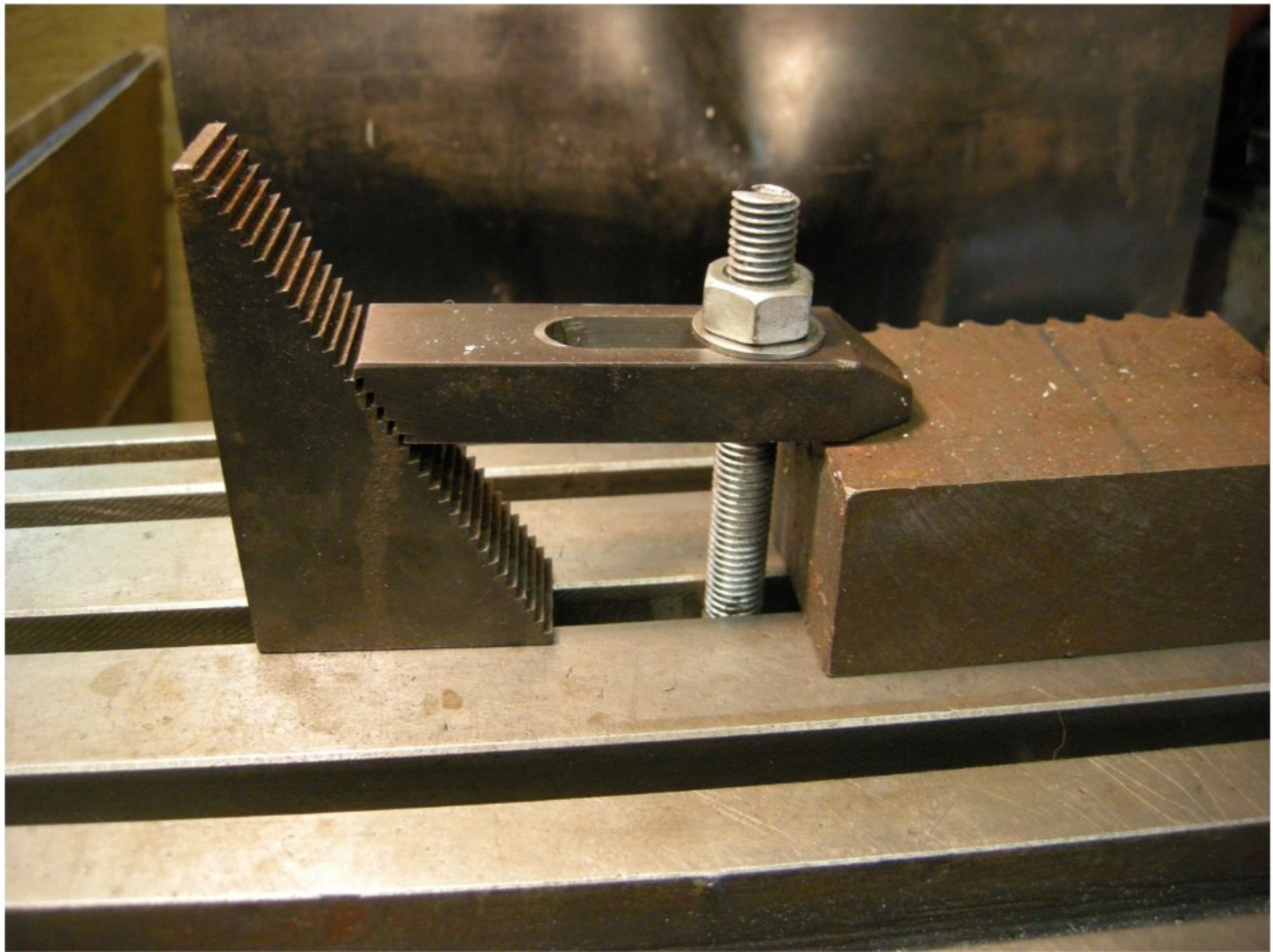
$$= (\text{Torque})(\omega), \text{ where } \omega = 2\pi N \text{ radians/min}$$

Work holding

Vise



Clamps



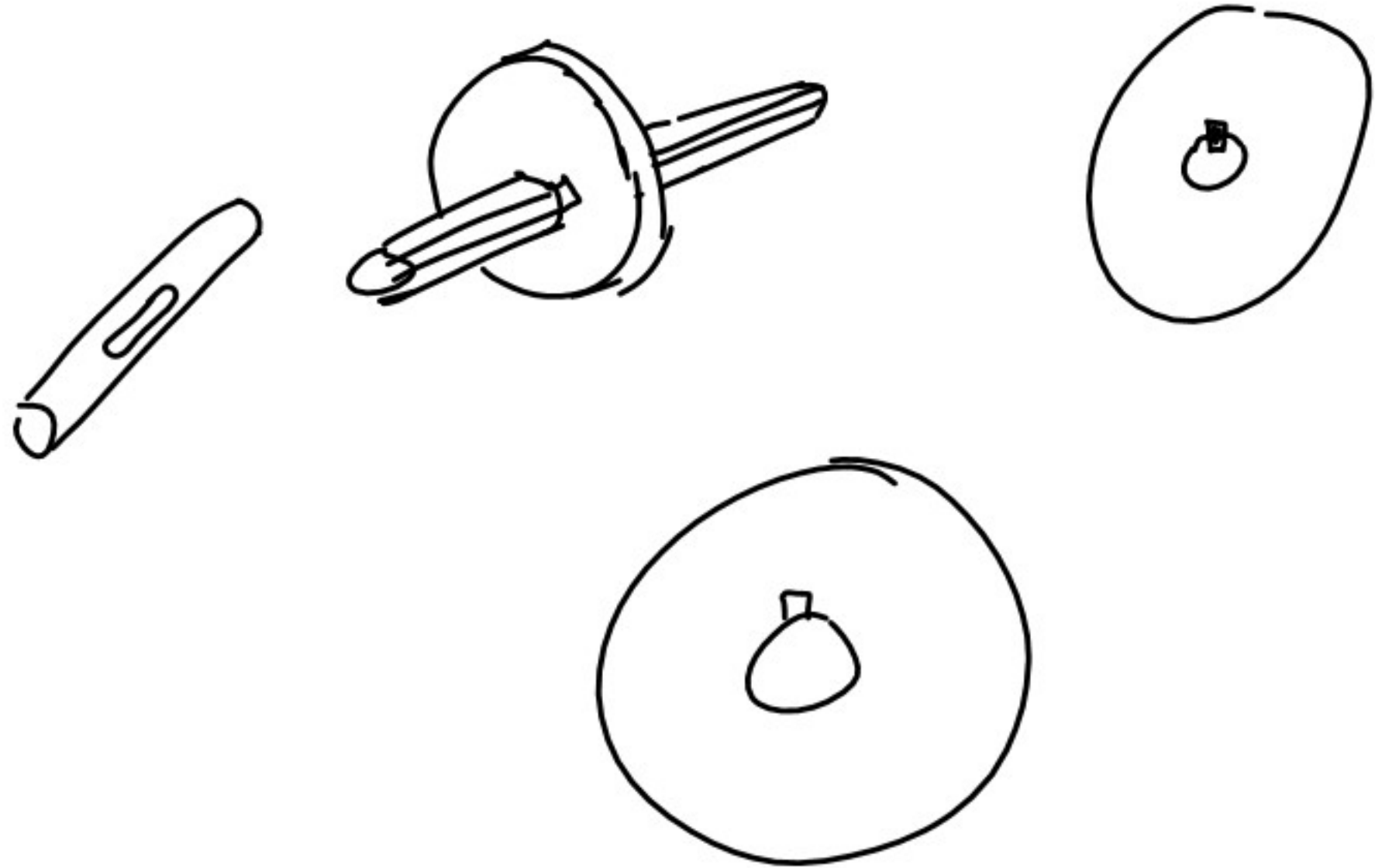
Fixturing

Custom Workholding Solution

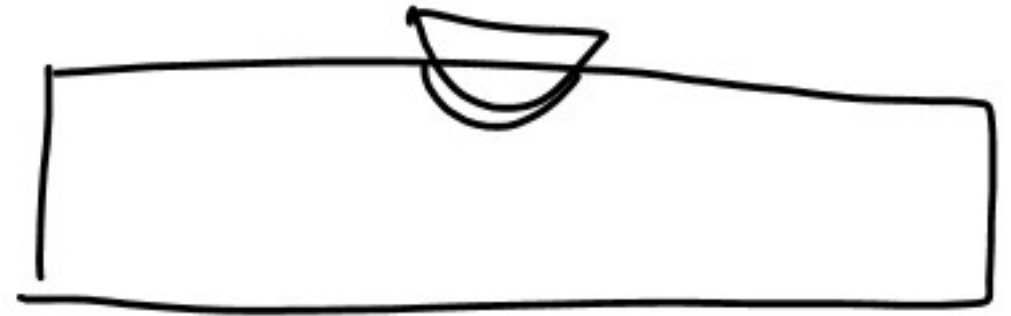
Broaching

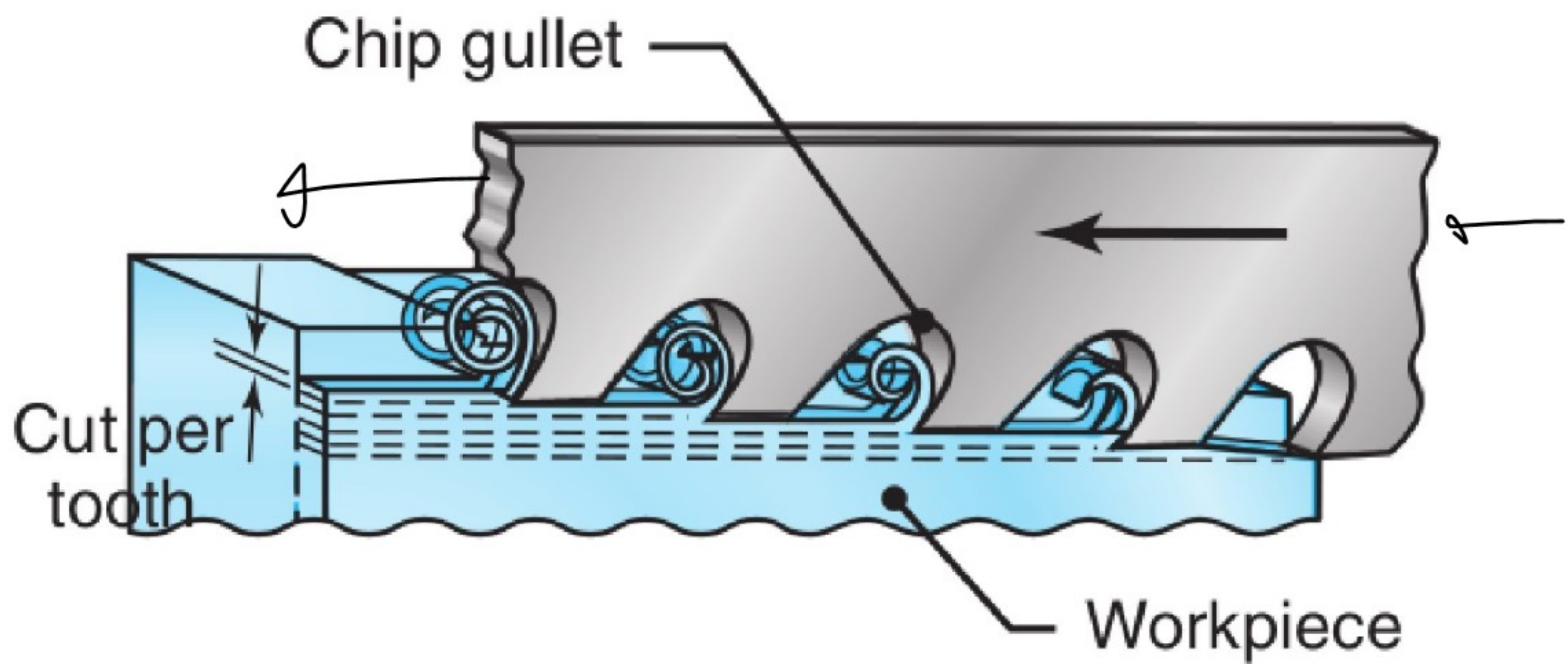
Keyways





Woodnut key





Gears

Manufacturing

Hobbing

Shaping



Straight Tooth

Involute



Helical



Hobbing
Shaping



Bevel Gears



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>