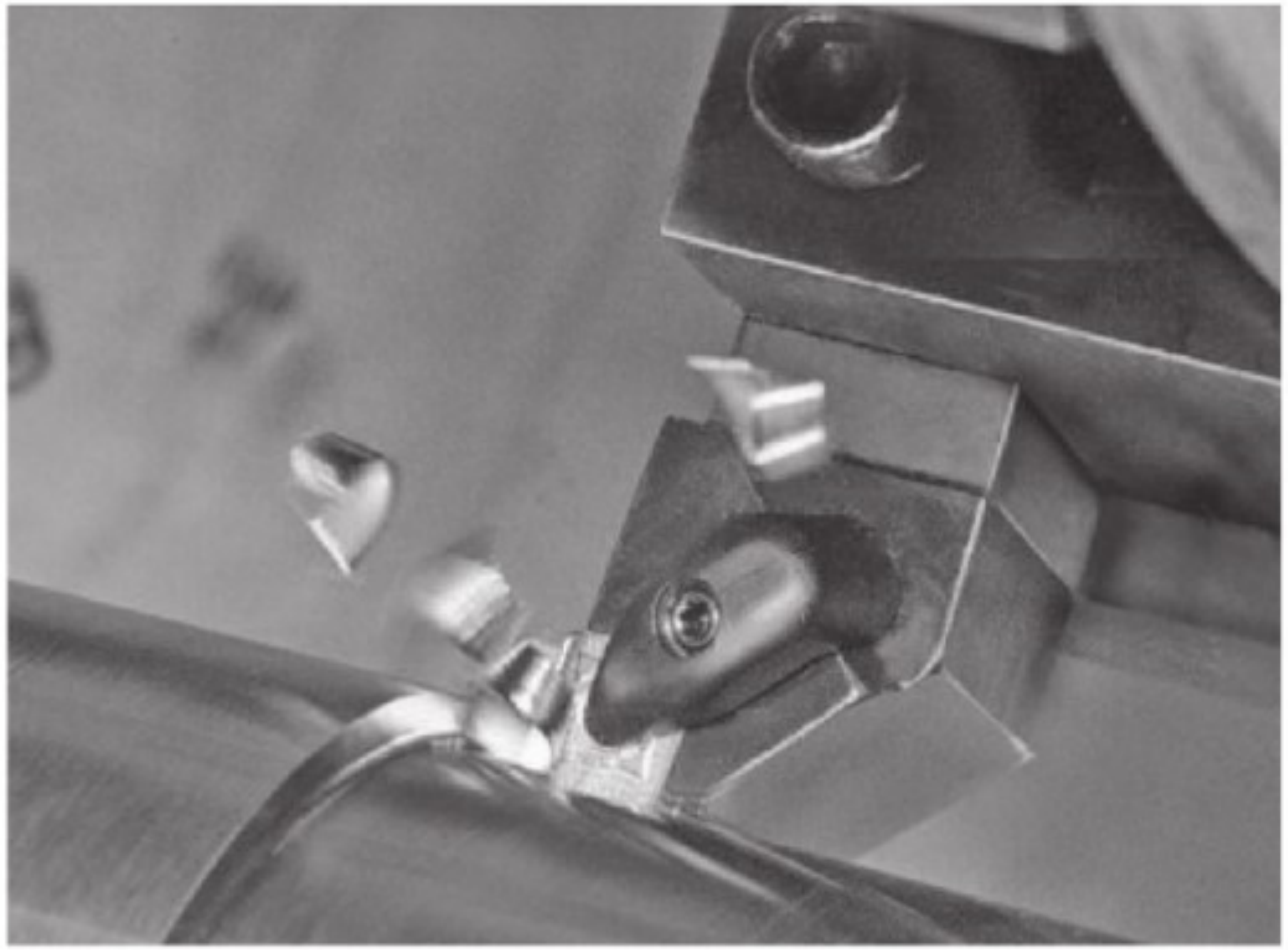
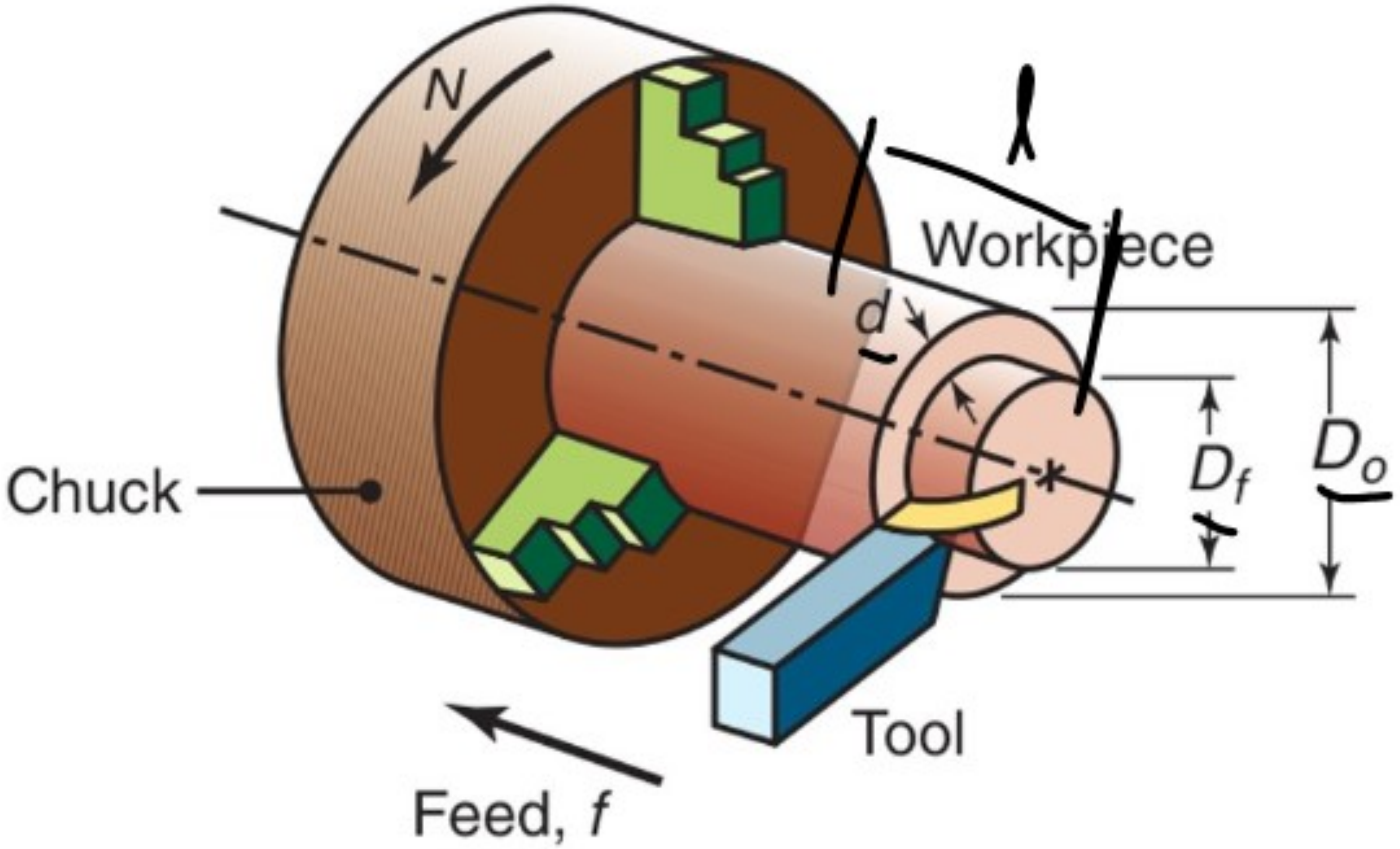



N
Workpiece
d
Chuck
D_f
D_o
Tool
Feed, f

$$MRR = \pi D_{avg} \, d f / N$$

$$\frac{\text{Volume}}{\text{time}}$$

$$D_{avg} = \frac{D_o + D_f}{2}$$

$$MRR = d f V$$

$$t = \frac{l}{f N}$$

D_o original Diameter

D_f final Diameter

d depth of cut

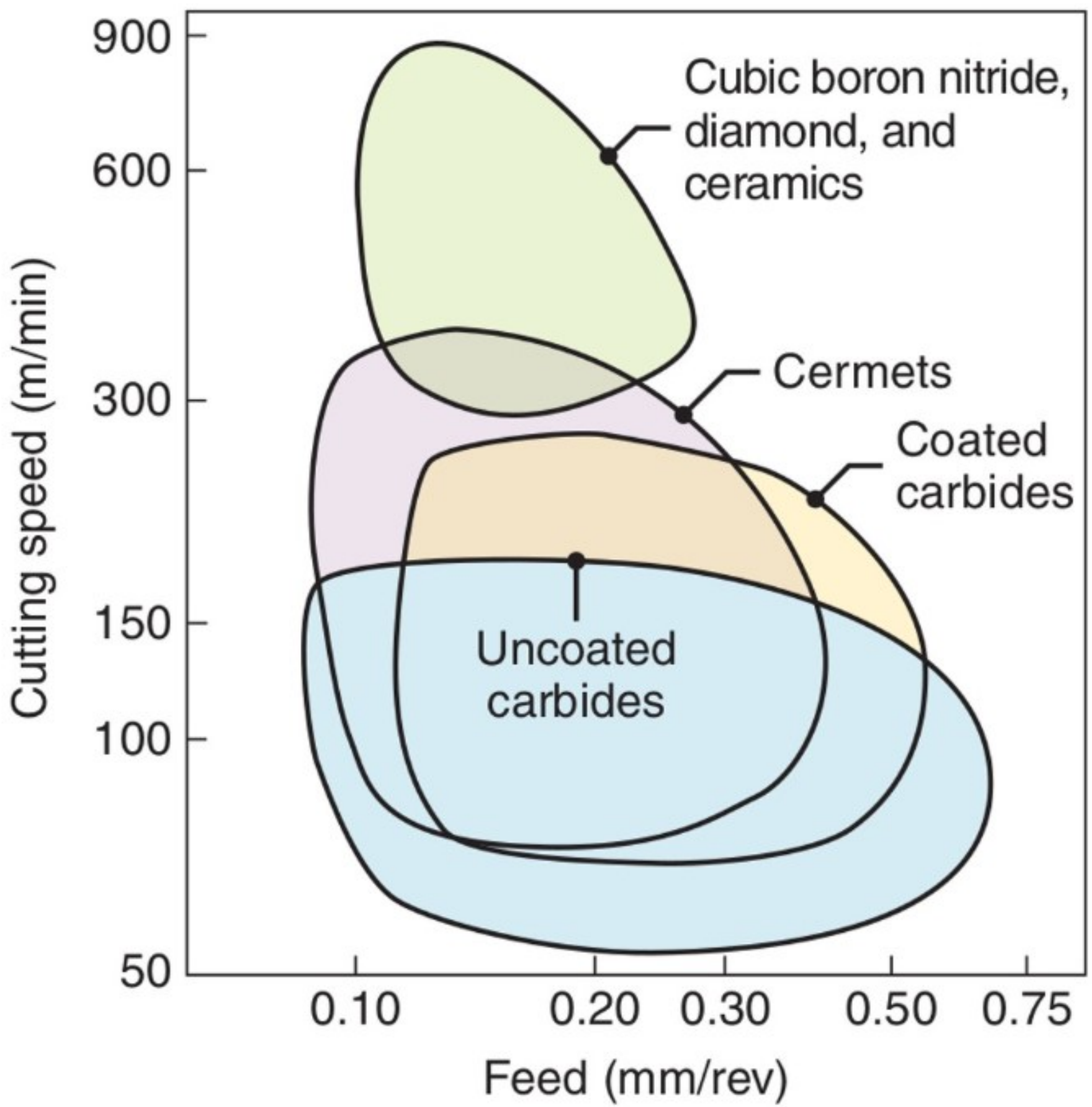
f feed distance

N rotational speed

t cutting time

l cut length

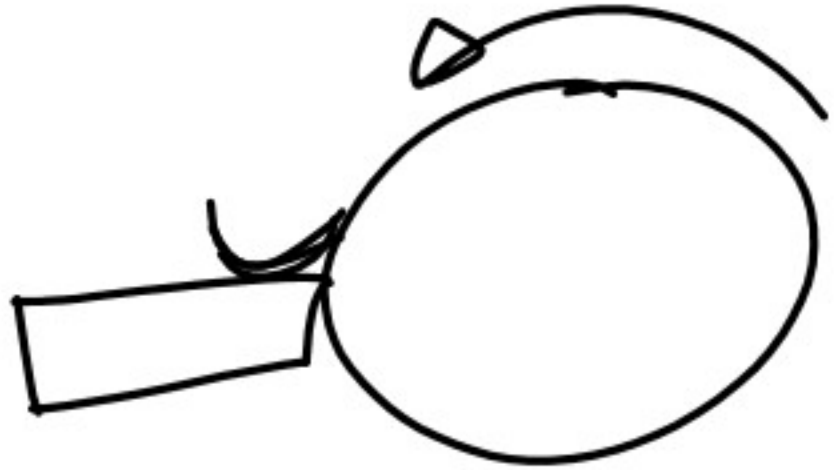
$$
\begin{aligned}
N &= \text{Rotational speed of the workpiece, rpm} \\
f &= \text{Feed, mm/rev} \\
v &= \text{Feed rate, or linear speed of the tool along workpiece length, mm/min} \\
&= fN \\
V &= \text{Surface speed of workpiece, m/min} \\
&= \pi D_o N \text{(for maximum speed)} \\
&= \pi D_{\text{avg}} N \text{(for average speed)} \\
l &= \text{Length of cut, mm} \\
D_o &= \text{Original diameter of workpiece, mm} \\
D_f &= \text{Final diameter of workpiece, mm} \\
D_{\text{avg}} &= \text{Average diameter of workpiece, mm} \\
&= (D_o + D_f)/2 \\
d &= \text{Depth of cut, mm} \\
&= (D_o - D_f)/2 \\
t &= \text{Cutting time, s} \\
&= l/fN \\
\text{MRR} &= \text{mm}^3/\text{min} \\
&= \pi D_{\text{avg}} d f N \\
\text{Torque} &= \text{N-m} \\
&= F_c D_{\text{avg}}/2 \\
\text{Power} &= \text{kW} \\
&= (\text{Torque})(\omega), \text{ where } \omega = 2\pi N \text{ rad/min}
\end{aligned}
$$

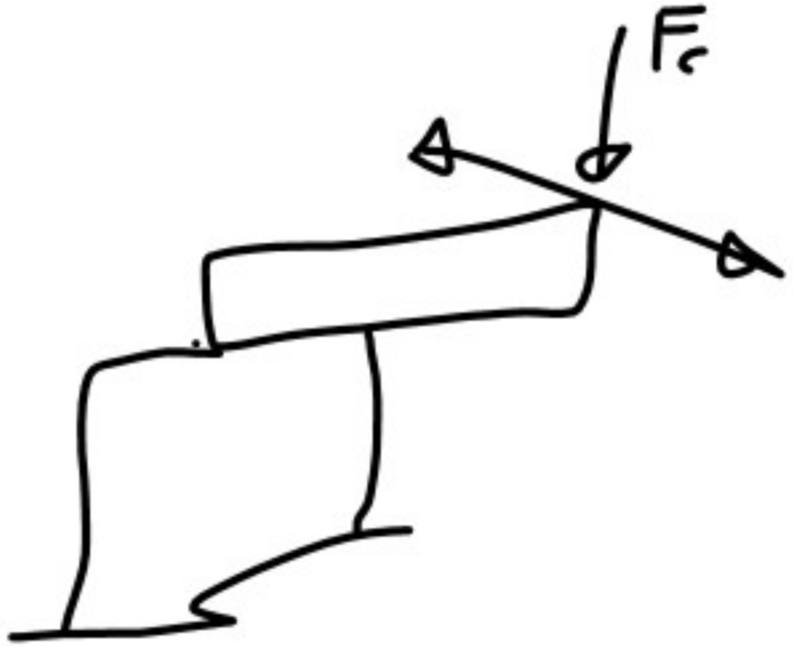


Cubic boron nitride, diamond, and ceramics
Cermets
Coated carbides
Uncoated carbides
900
600
300
150
100
50
Cutting speed (m/min)
0.10
0.20
0.30
0.50
0.75
Feed (mm/rev)

		General-purpose starting conditions			Range for roughing and finishing		
Workpiece material	Cutting tool	Depth of cut, mm	Feed, mm/rev	Cutting speed,	Depth of cut,	Feed, mm/rev	Cutting speed, m/min
Low-C and free machining steels	Uncoated carbide	1.5–6.3	0.35	90	0.5–7.6	0.15–1.1	60–135
	Ceramic-coated carbide	″	″	245–275	″	″	180–495
	Triple-coated carbide	″	″	185–200	″	″	90–245
	TiN-coated carbide	″	″	105–150	″	″	60–230
	Al_2O_3 ceramic	″	0.25	395–440	″	″	365–550
	Cermet	″	0.30	215–290	″	″	180–455
Medium and high-C steels	Uncoated carbide	1.2–4.0	0.30	75	2.5–7.6	0.15–0.75	135–225
	Ceramic-coated carbide	″	″	185–230	″	″	120–410
	Triple-coated carbide	″	″	120–150	″	″	75–215
	TiN-coated carbide	″	″	90–200	″	″	45–215
	Al_2O_3 ceramic	″	0.25	335	″	″	245–455
	Cermet	″	0.25	170–245	″	″	105–305
Cast iron, gray	Uncoated carbide	1.25–6.3	0.32	90	0.4–12.7	0.1–0.75	75–185
	Ceramic-coated carbide	″	″	200	″	″	120–365
	TiN-coated carbide	″	″	90–135	″	″	60–215
	Al_2O_3 ceramic	″	0.25	455–490	″	″	365–855
	SiN ceramic	″	0.32	730	″	″	200–990
	Polycrystalline cBN	″	″	1000	″	″	200–1160

Chatter





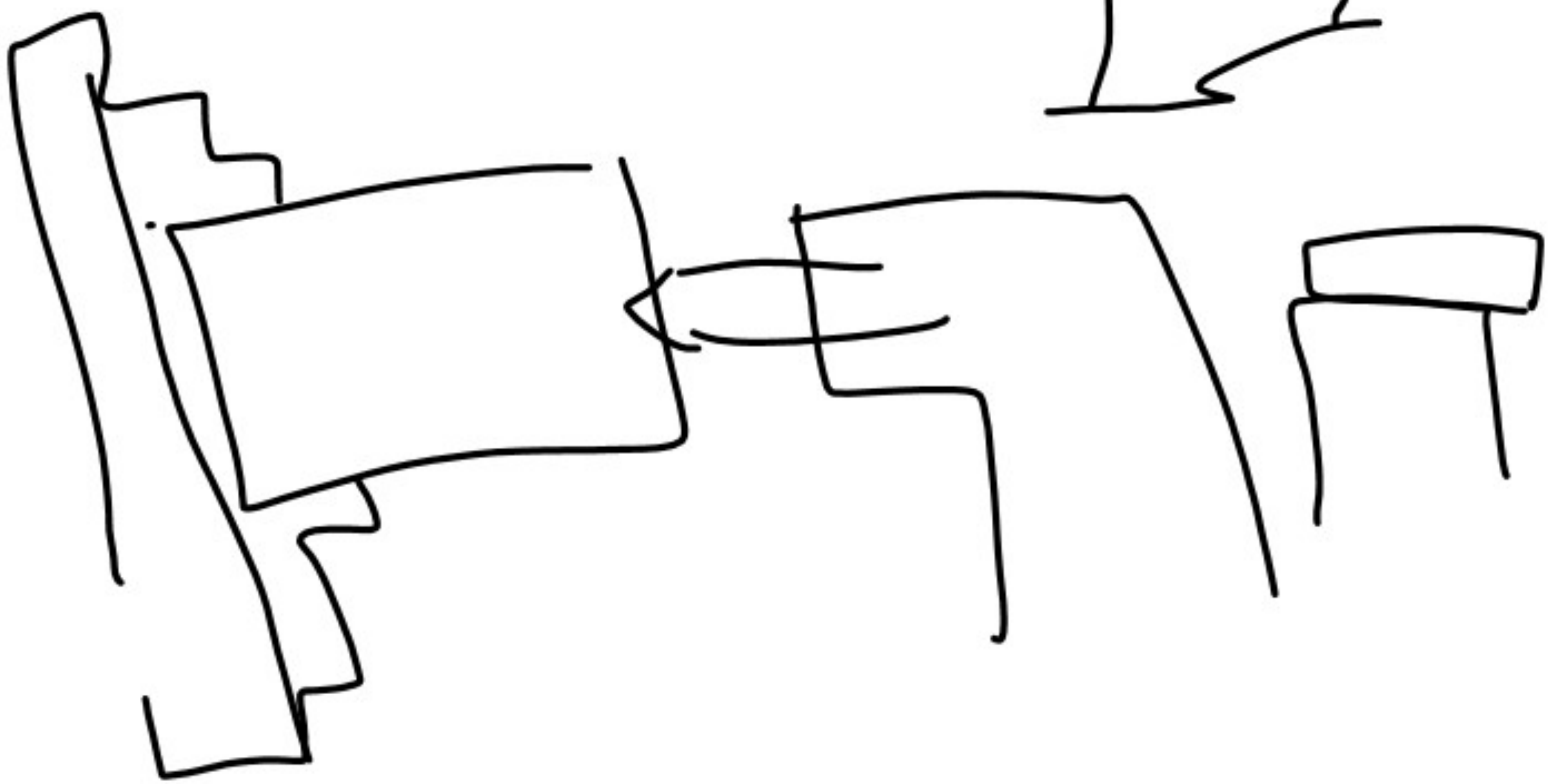
Increase stiffness

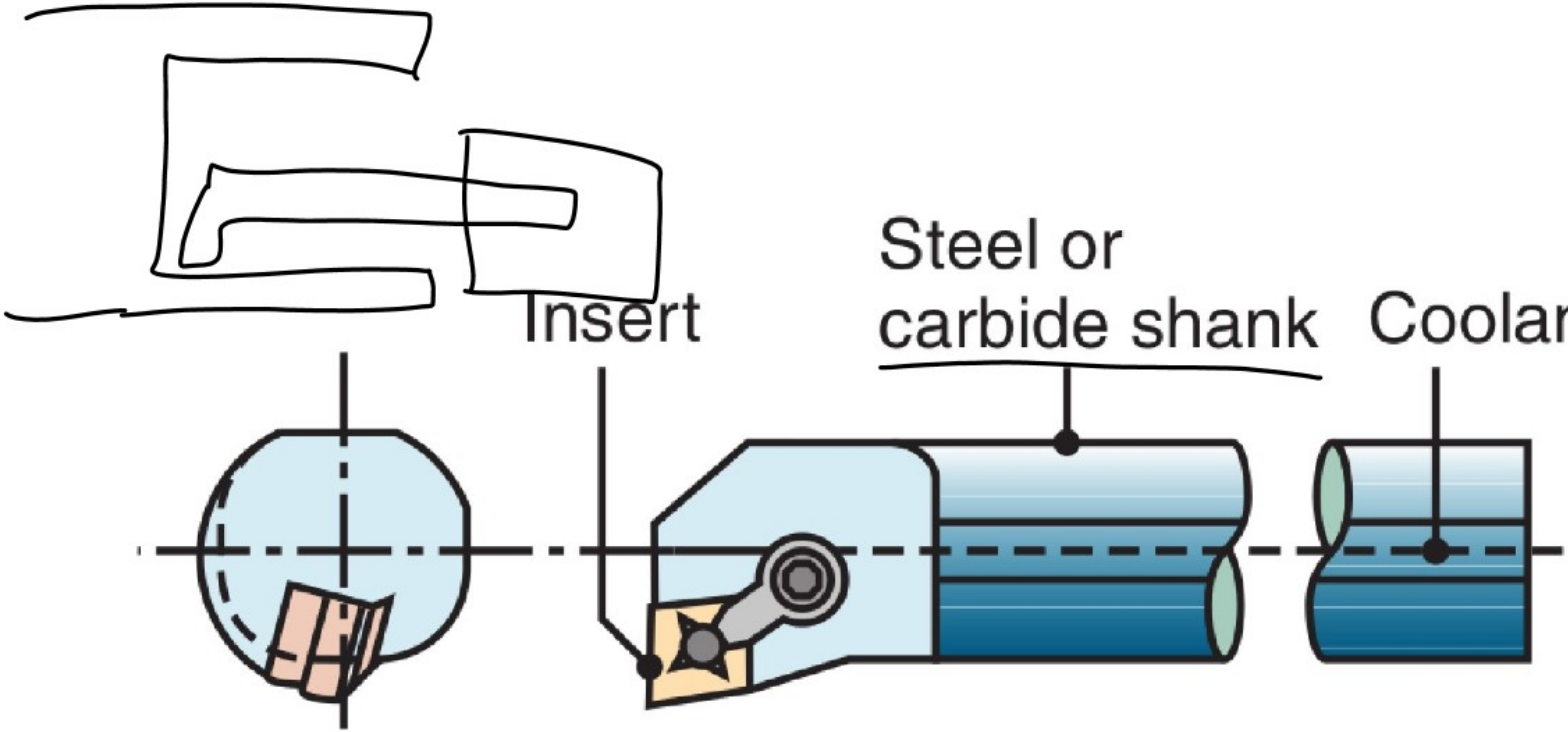
Changing frequency

Deeper cut

Increase Feed

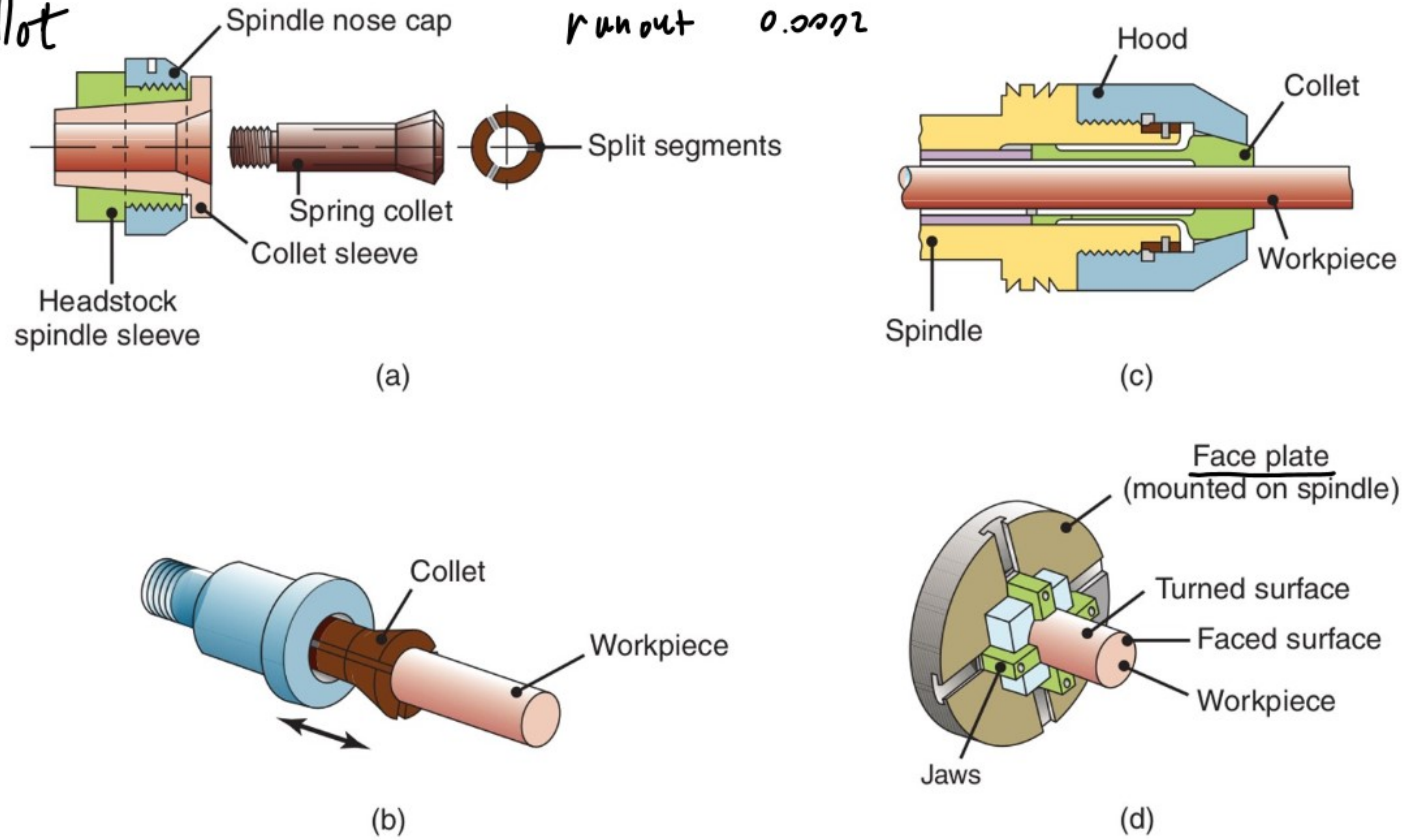
Damping



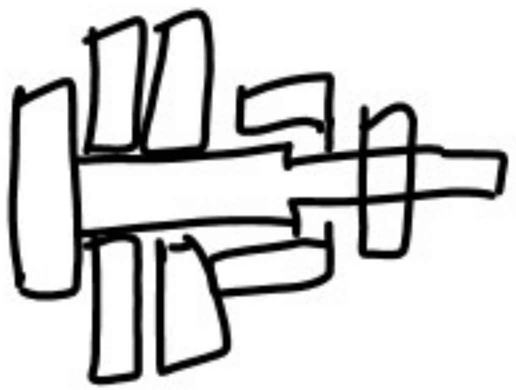

Insert
Steel or
carbide shank
Coolant

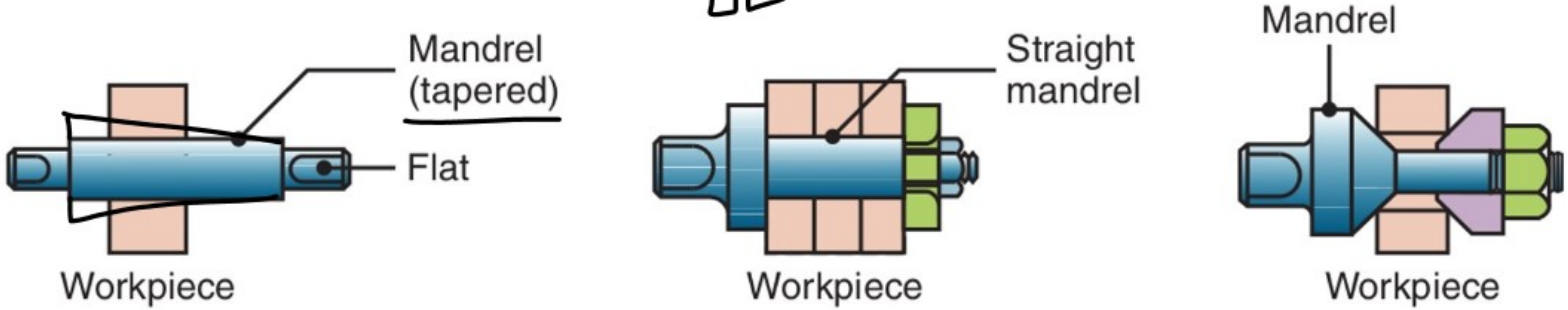
Collet

runout 0.0002



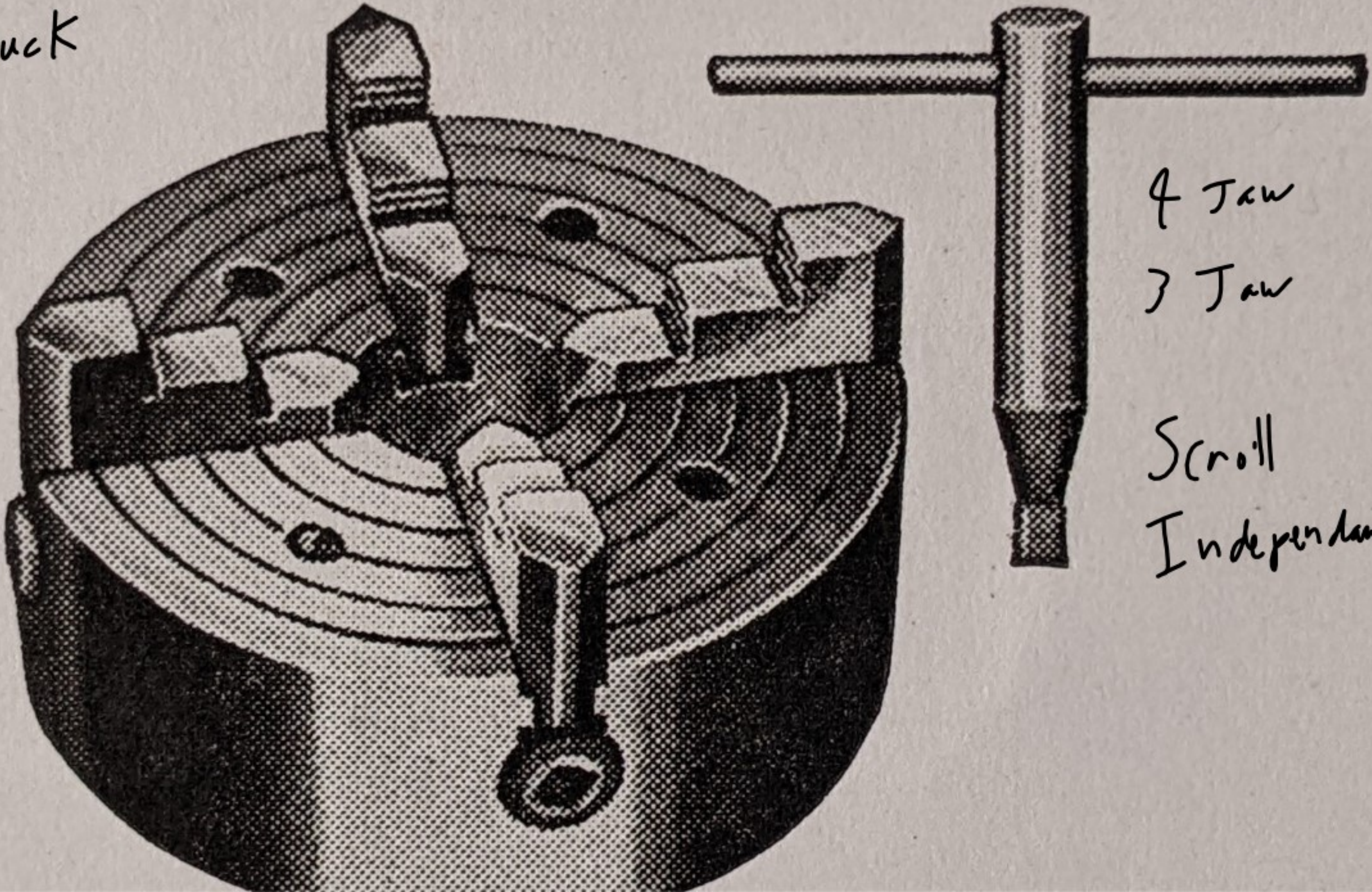
Mandrel





(a) Solid mandrel (b) Gang mandrel (c) Cone mandrel

Chuck

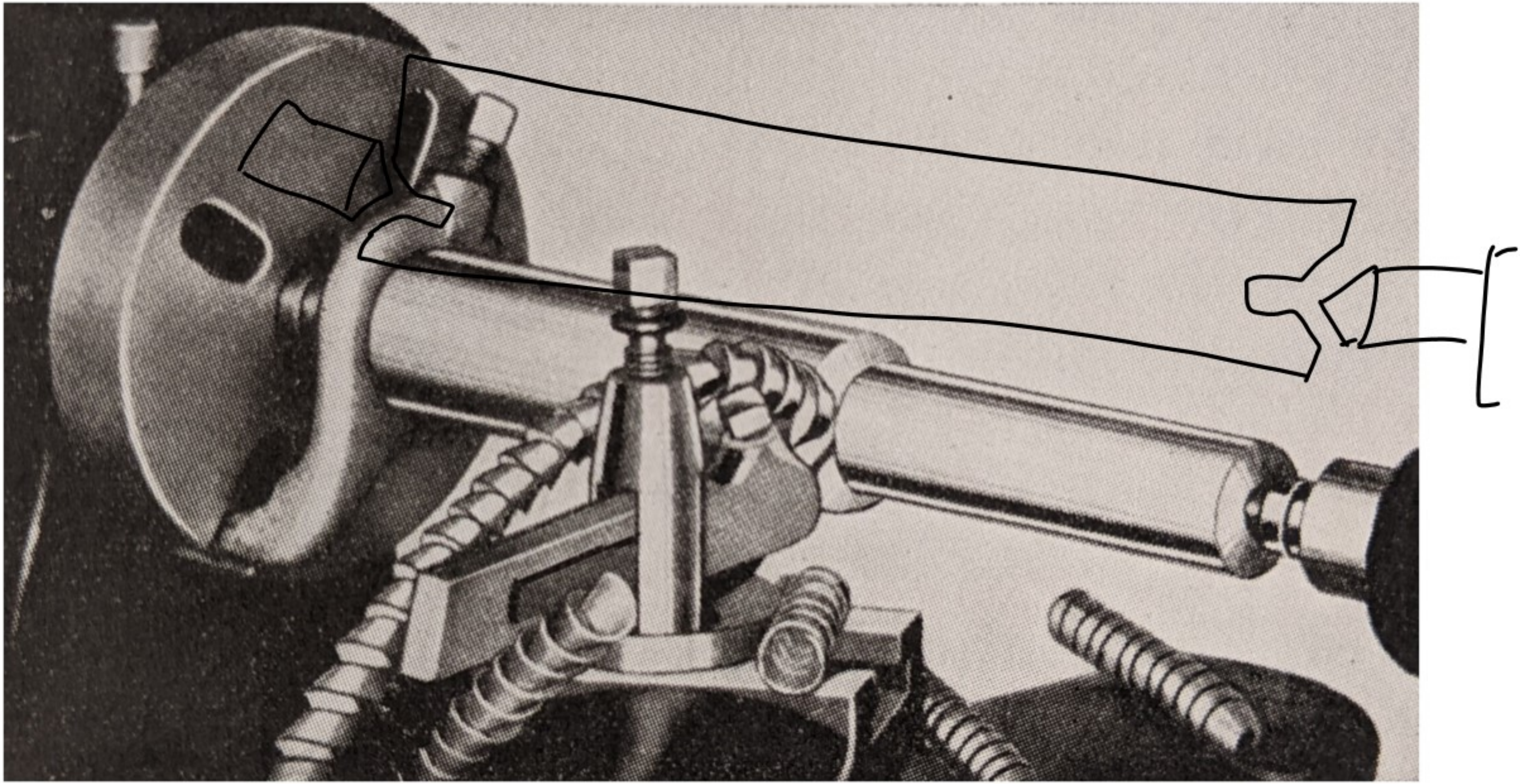


4 Jaw

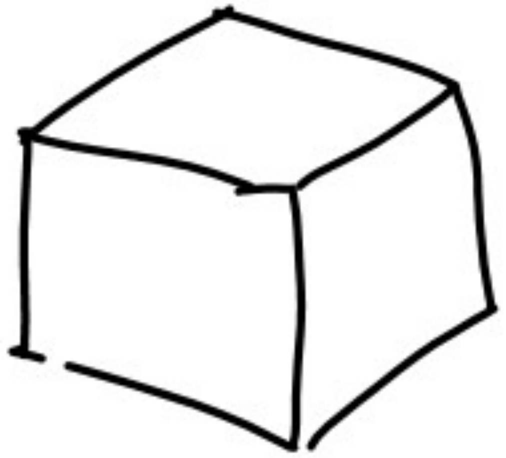
3 Jaw

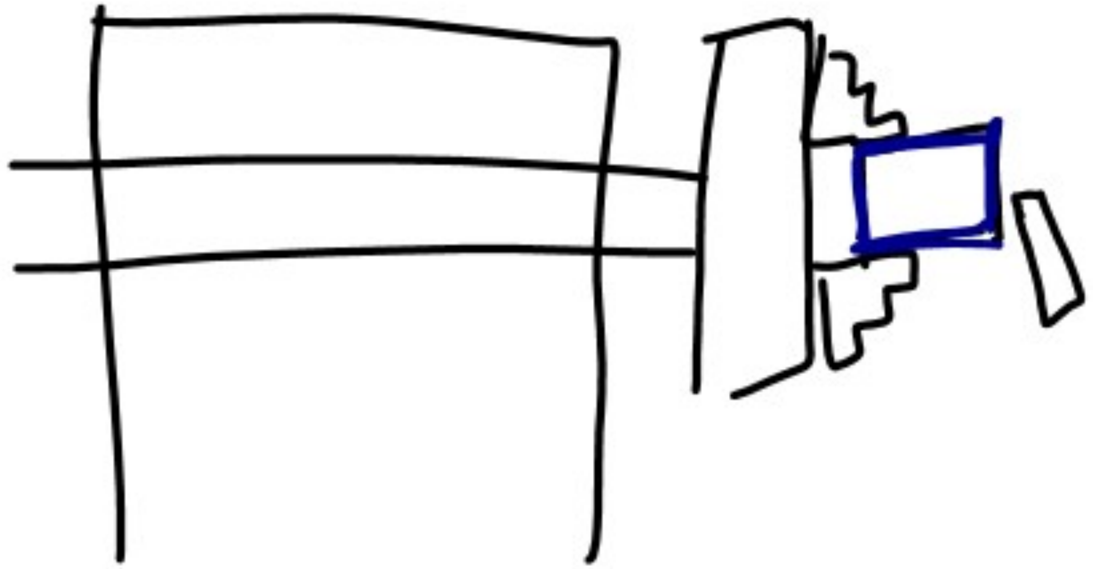
Scroll

Independant



Making Cubes on a lathe



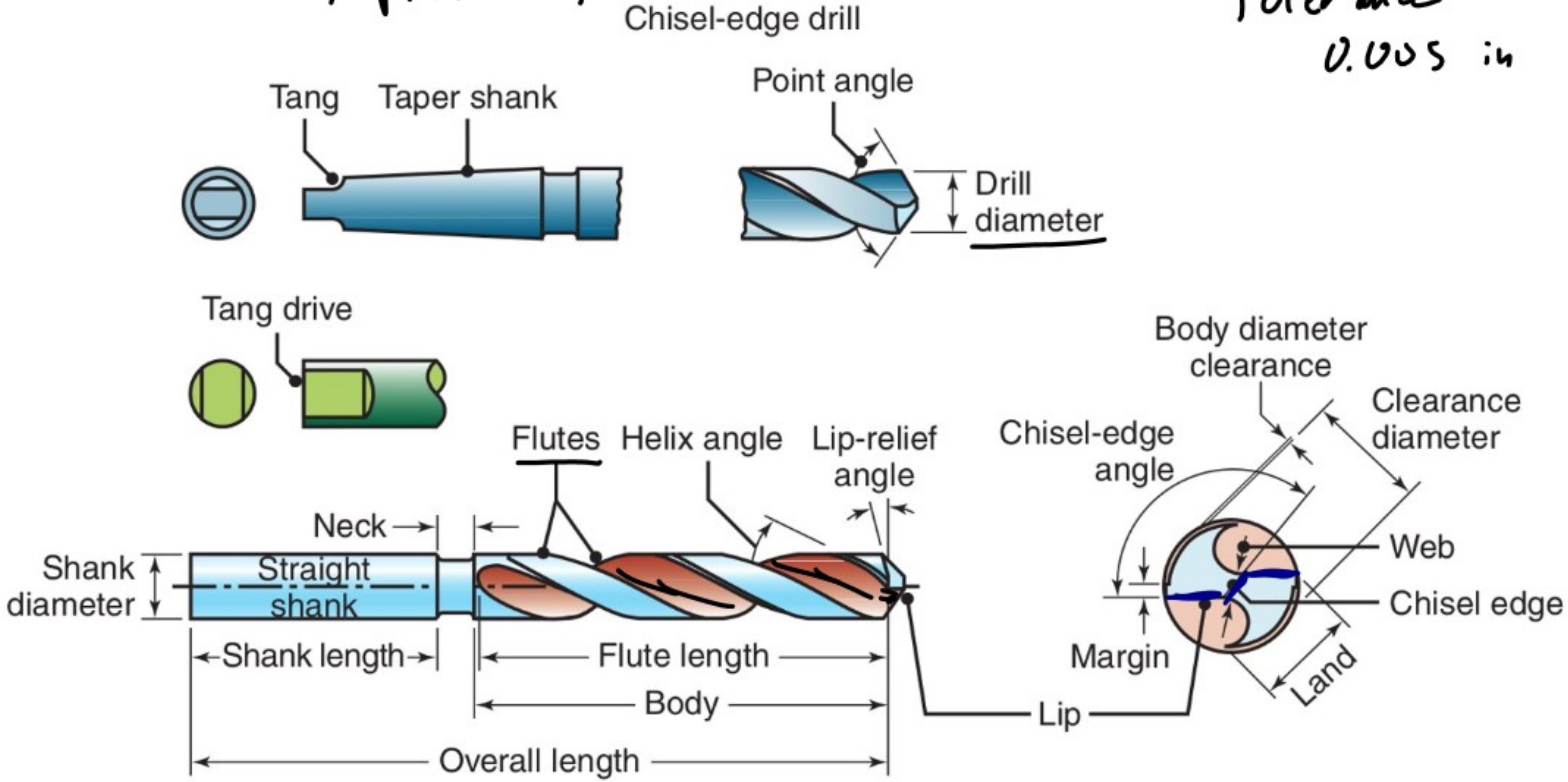


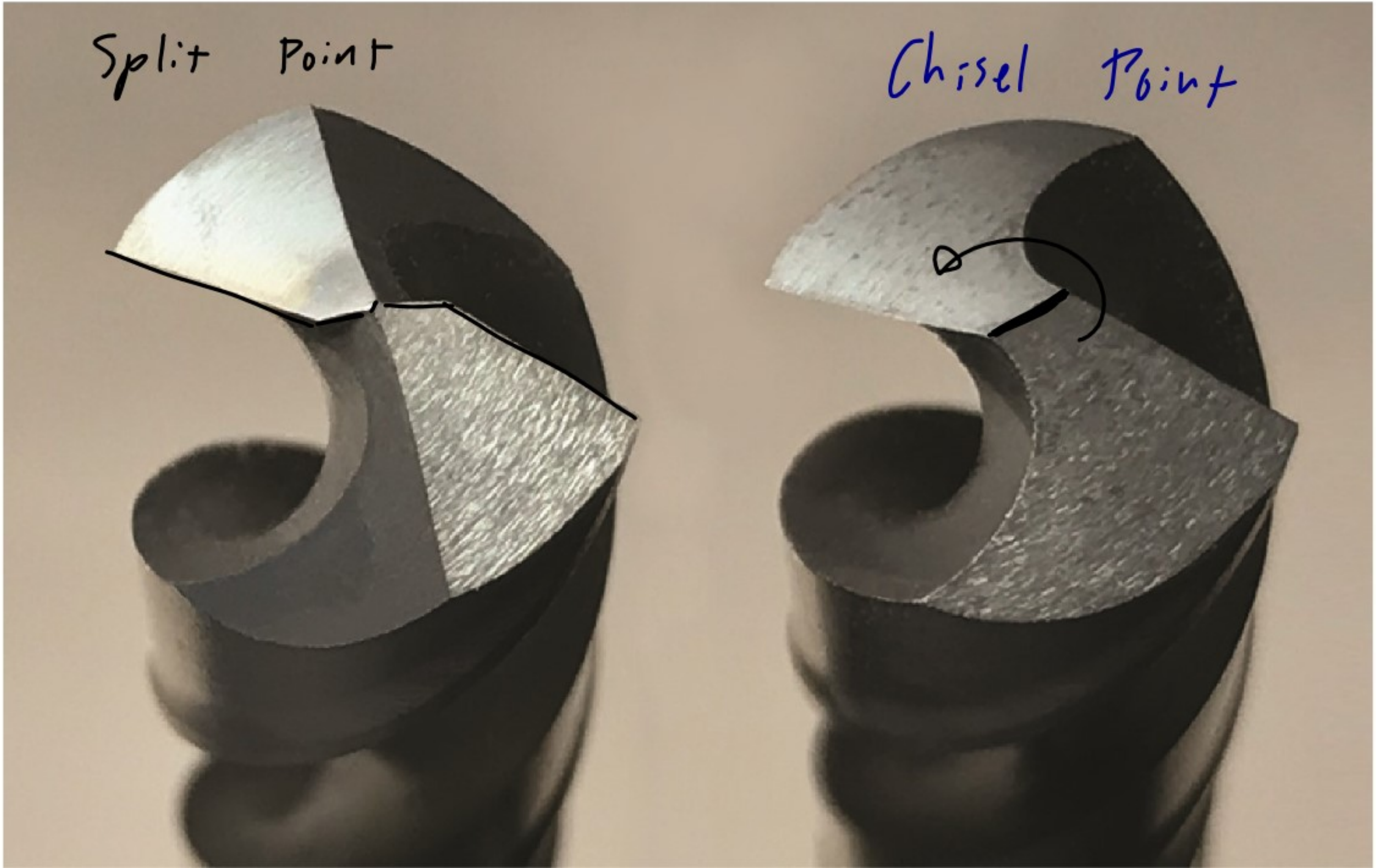
Drills

Make Round Holes

tolerance

0.005 in

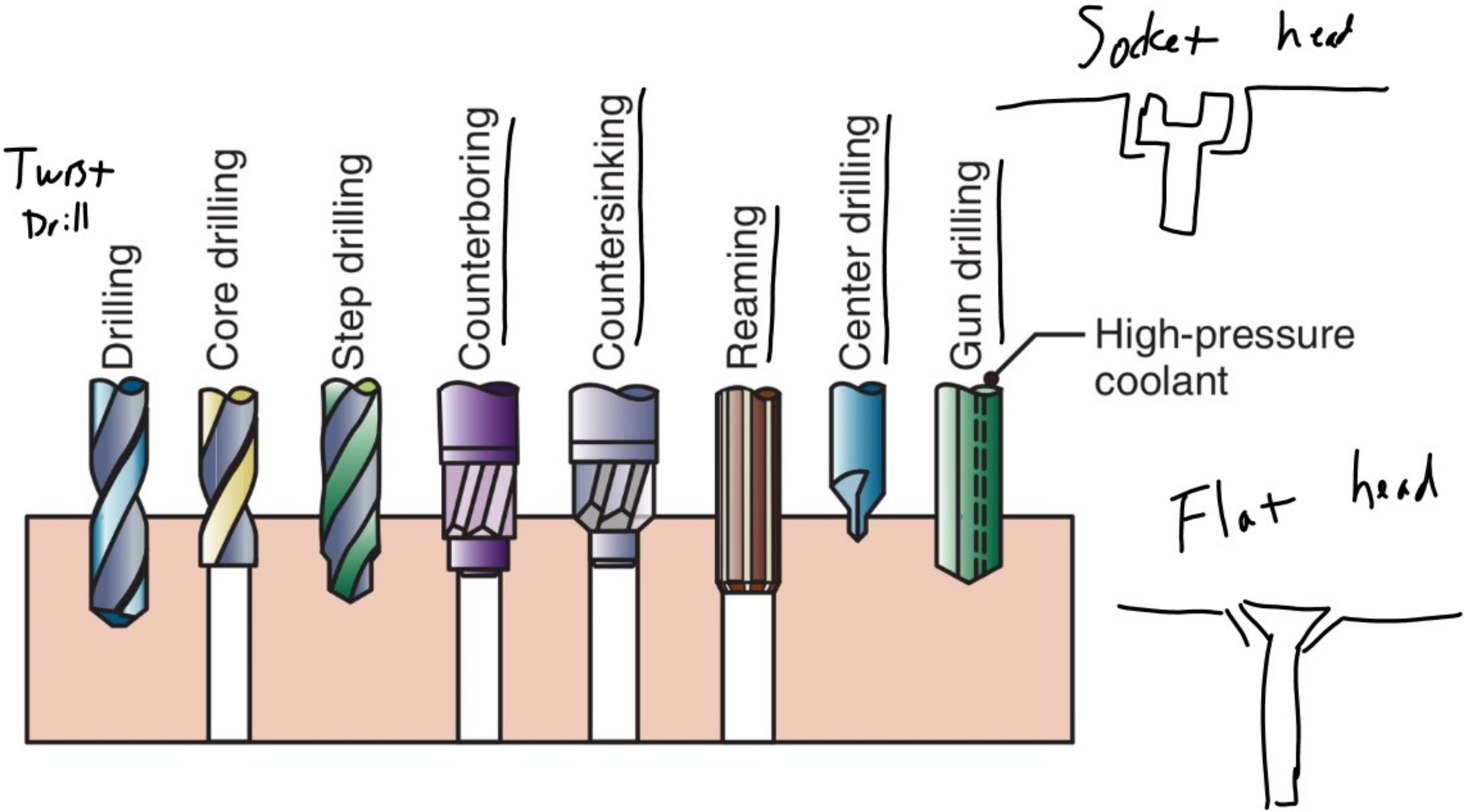



Split Point
Chisel Point

$$MRR = \frac{\pi D^2}{4} f N$$

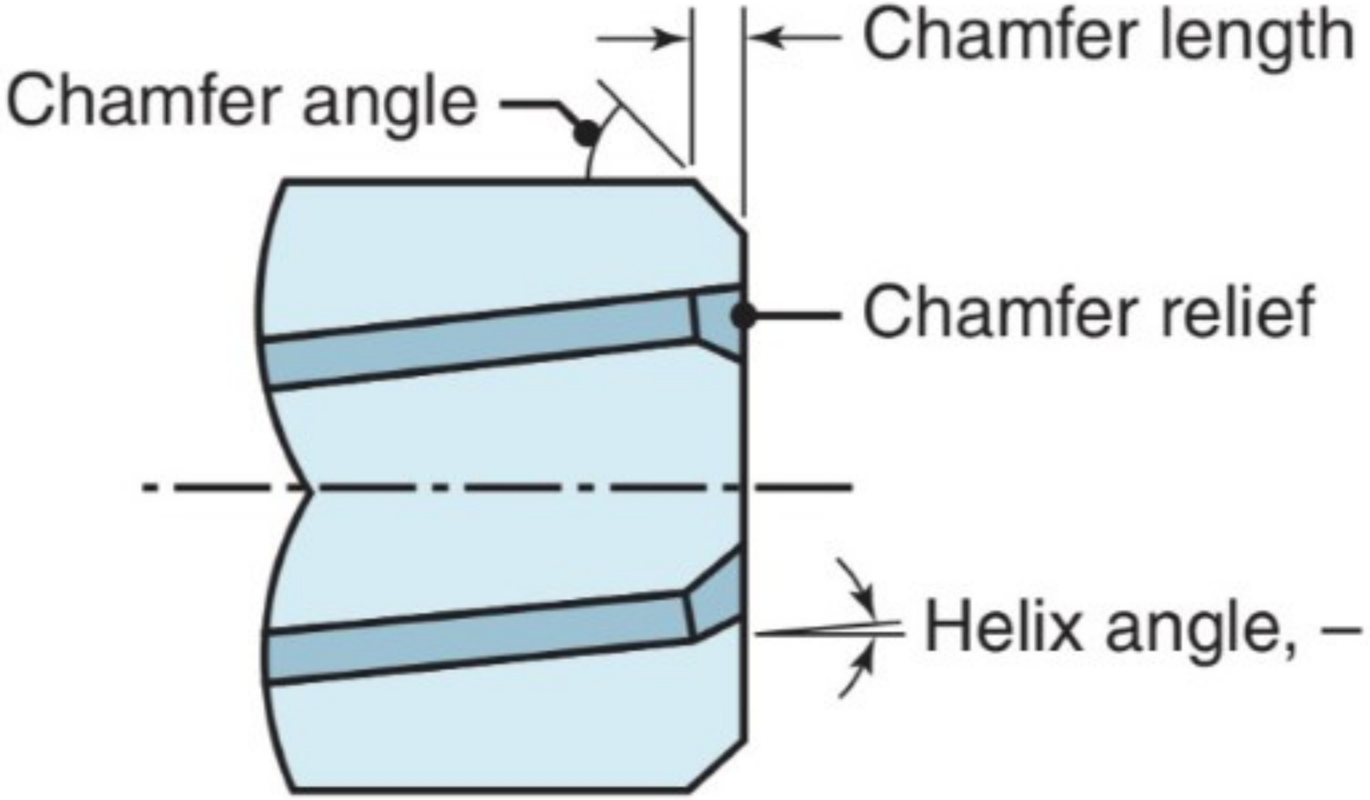
D drill diameter

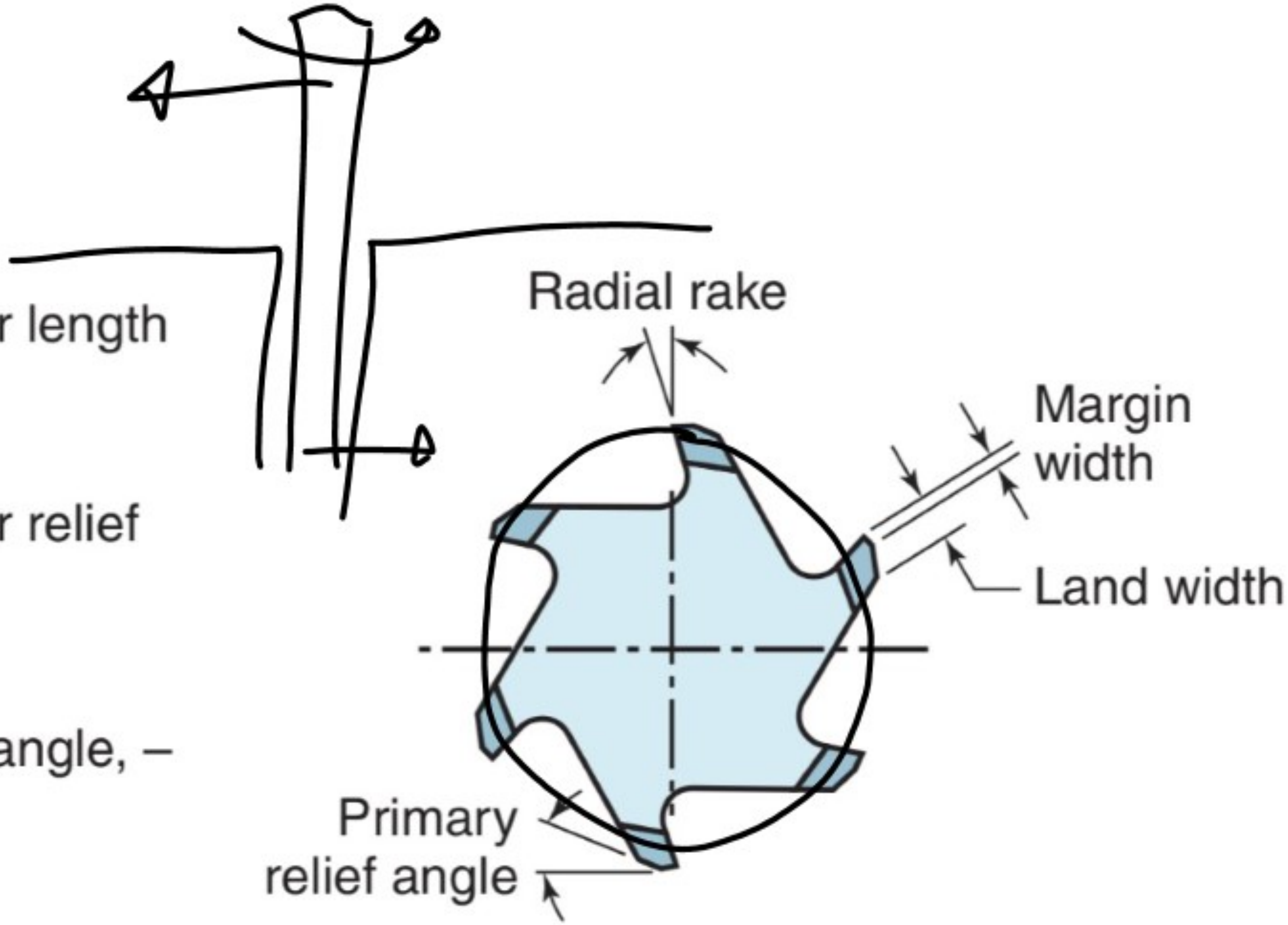
Torque and power from specific energy


Twist Drill
Drilling
Core drilling
Step drilling
Counterboring
Countersinking
Reaming
Center drilling
Gun drilling
High-pressure coolant
Socket head
Flat head

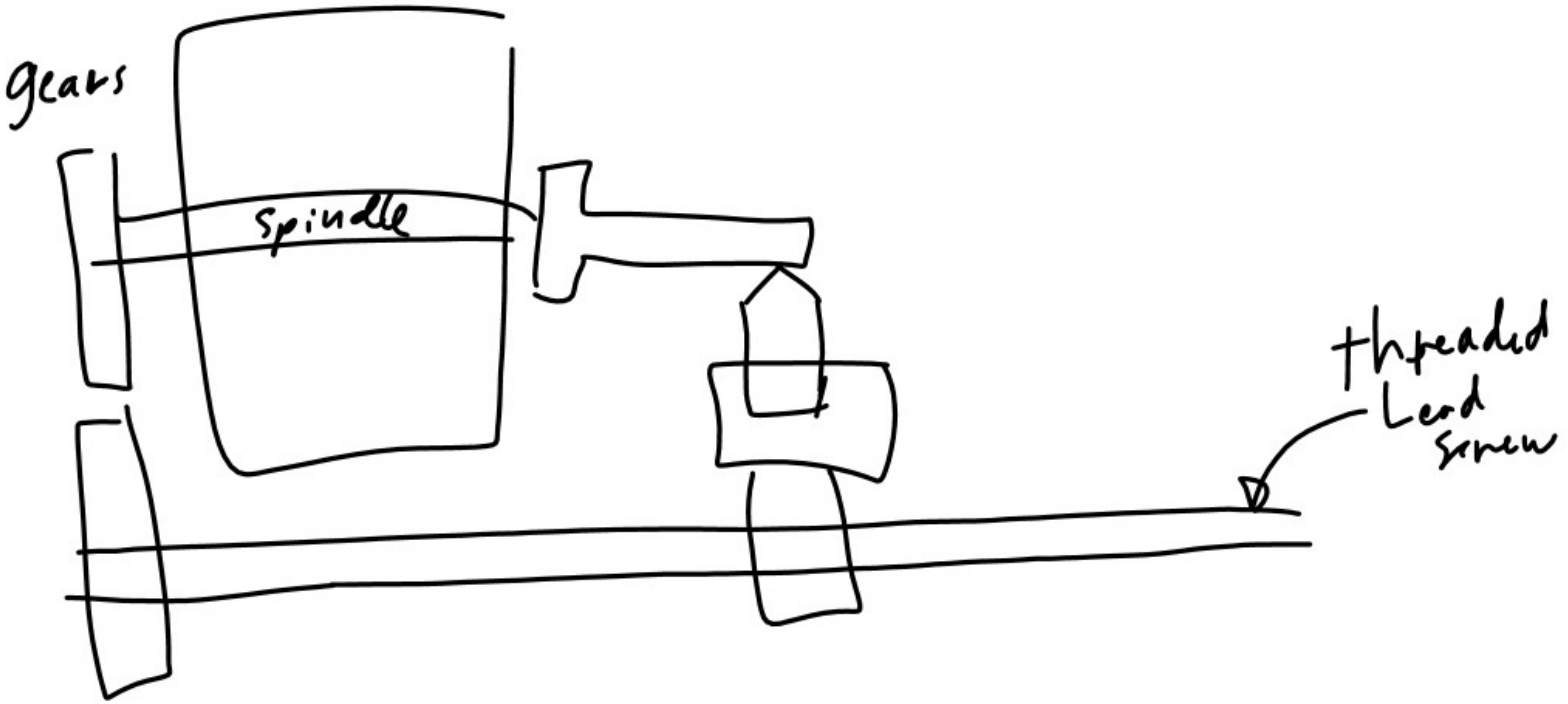
tolerances

0.0005 in

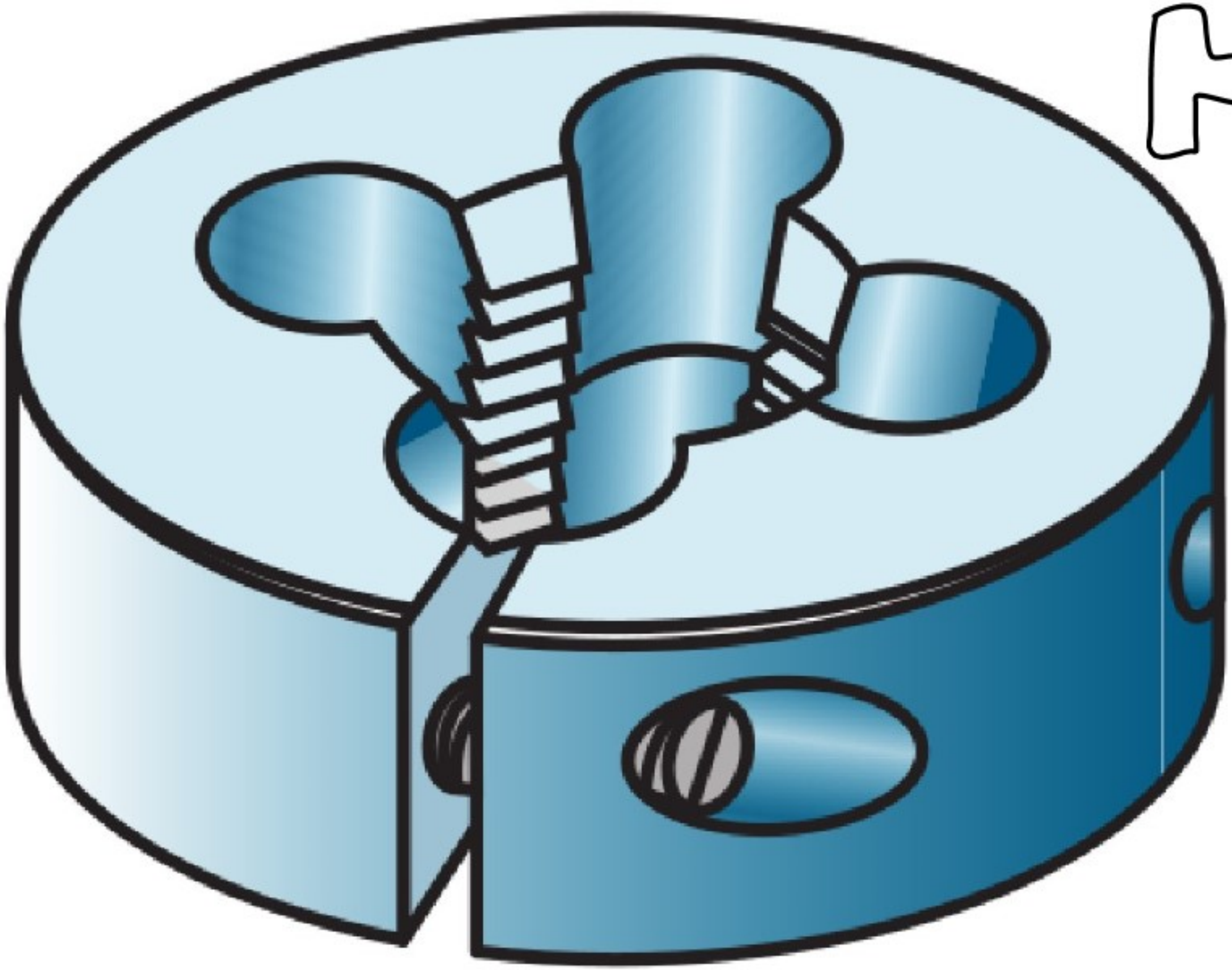


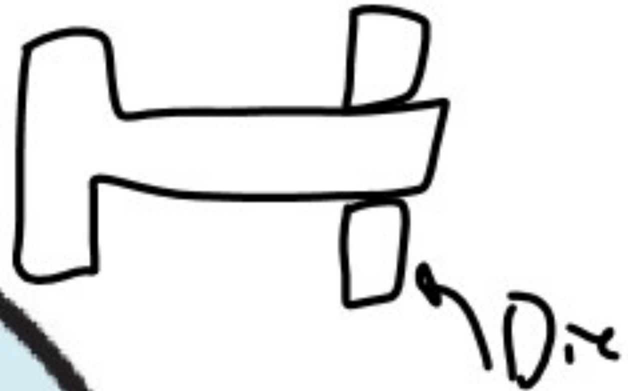


Threading

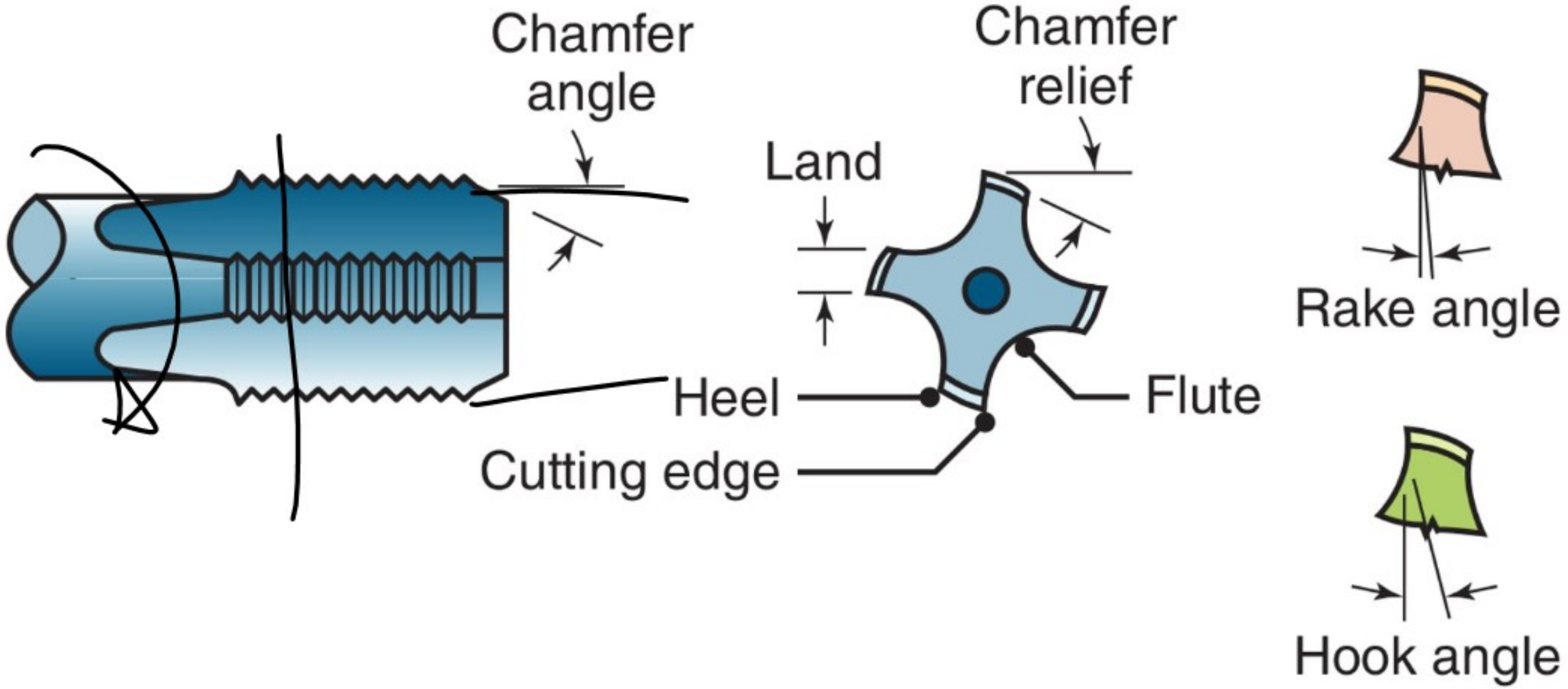


Die





Tap



Chamfer angle
Chamfer relief
Land
Heel
Flute
Cutting edge
Rake angle
Hook angle