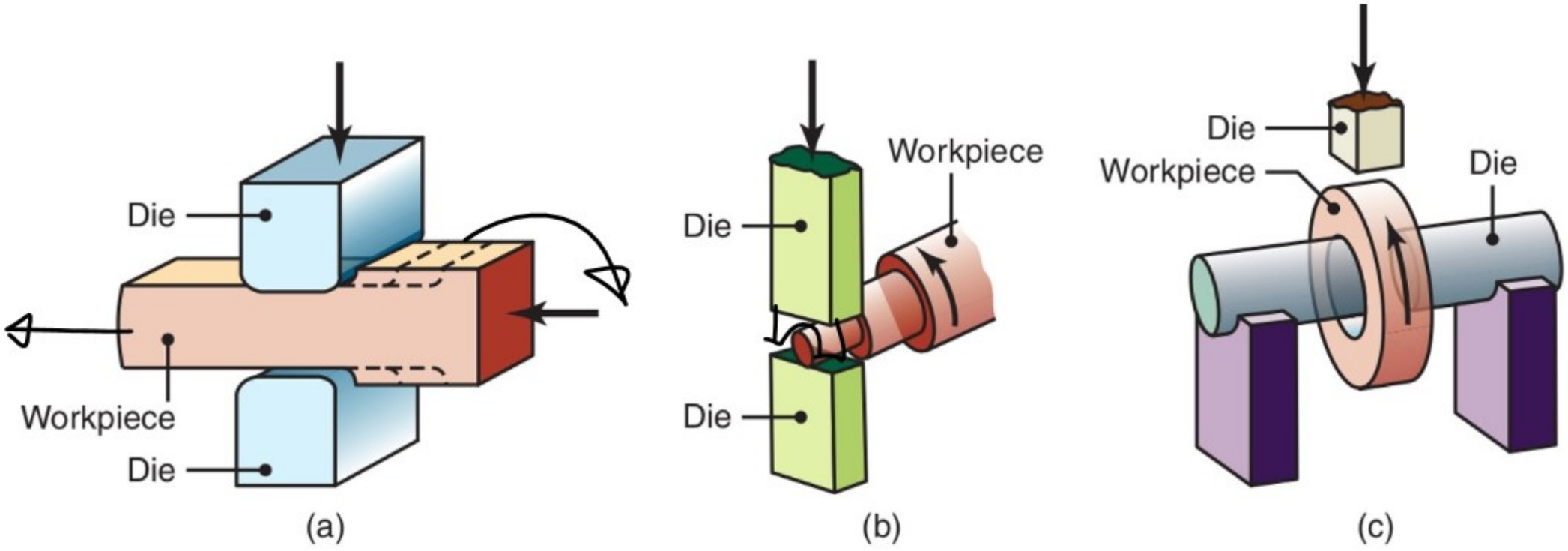
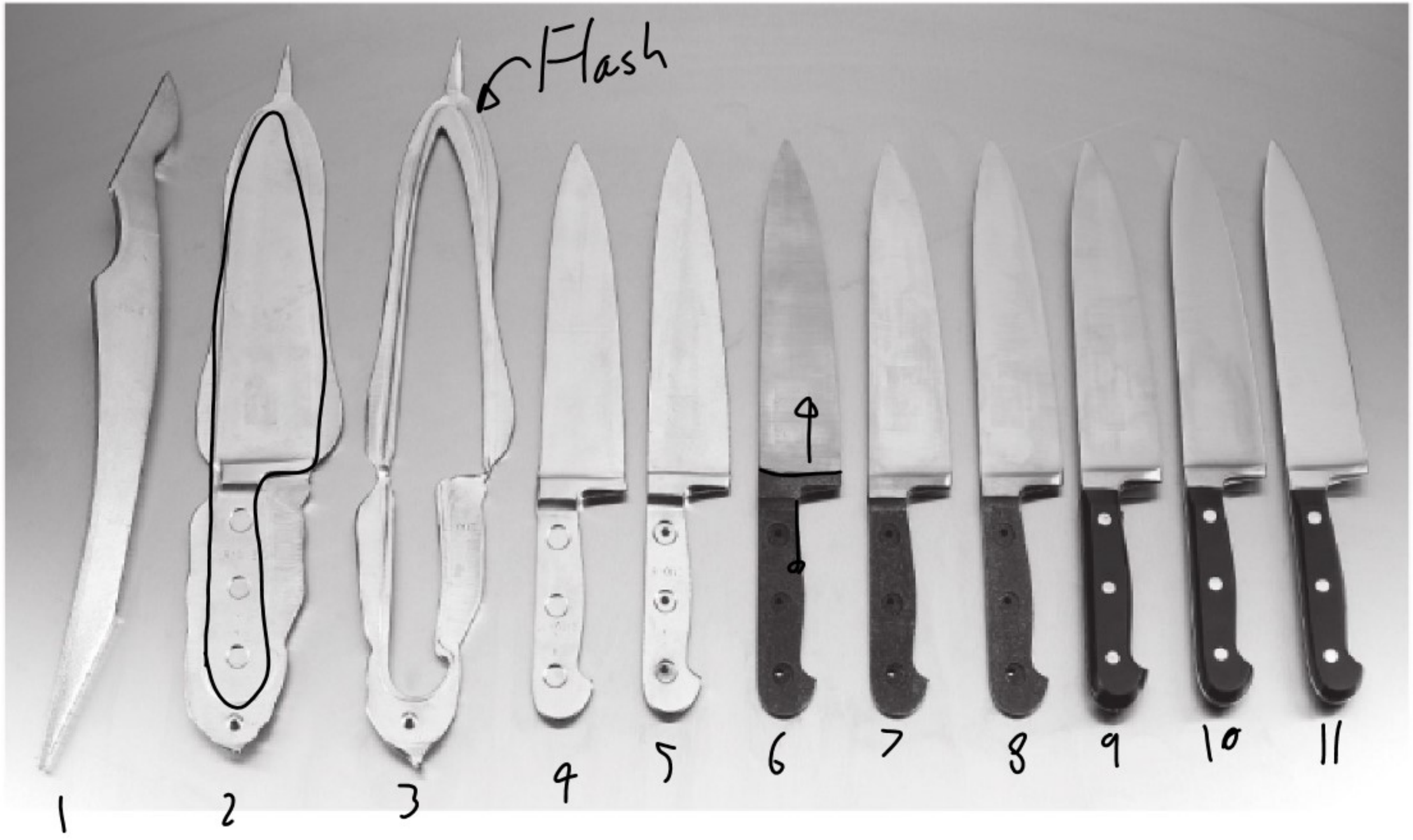
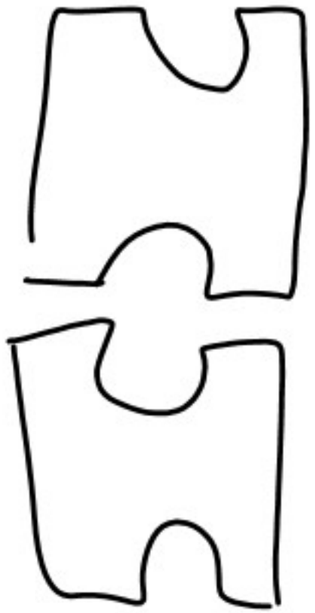
Forging

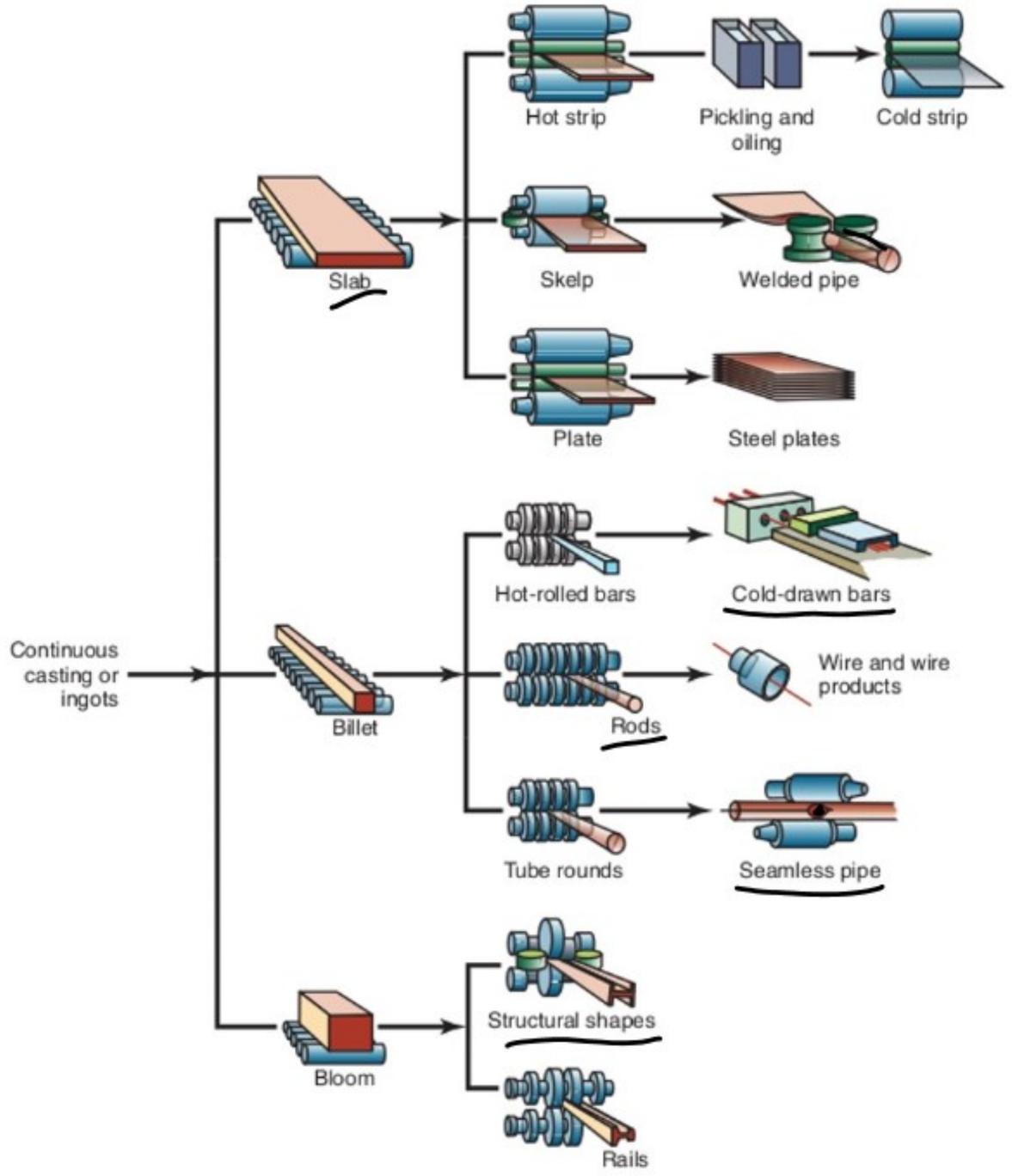
Open Die Forging




Flash
1
2
3
4
5
6
7
8
9
10
11

Rolling




Hot strip
Pickling and oiling
Cold strip
Slab
Skelp
Welded pipe
Plate
Steel plates
Hot-rolled bars
Cold-drawn bars
Continuous casting or ingots
Billet
Rods
Wire and wire products
Tube rounds
Seamless pipe
Structural shapes
Bloom
Rails

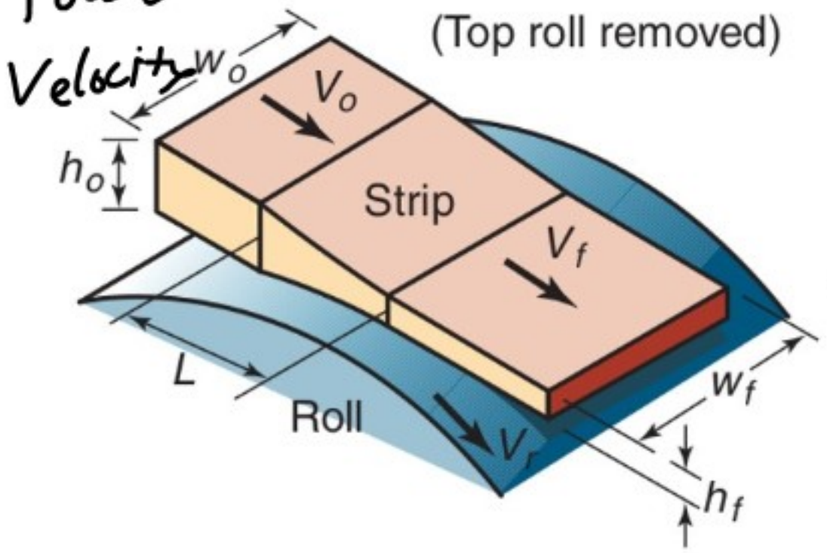
Can Calculate

Force

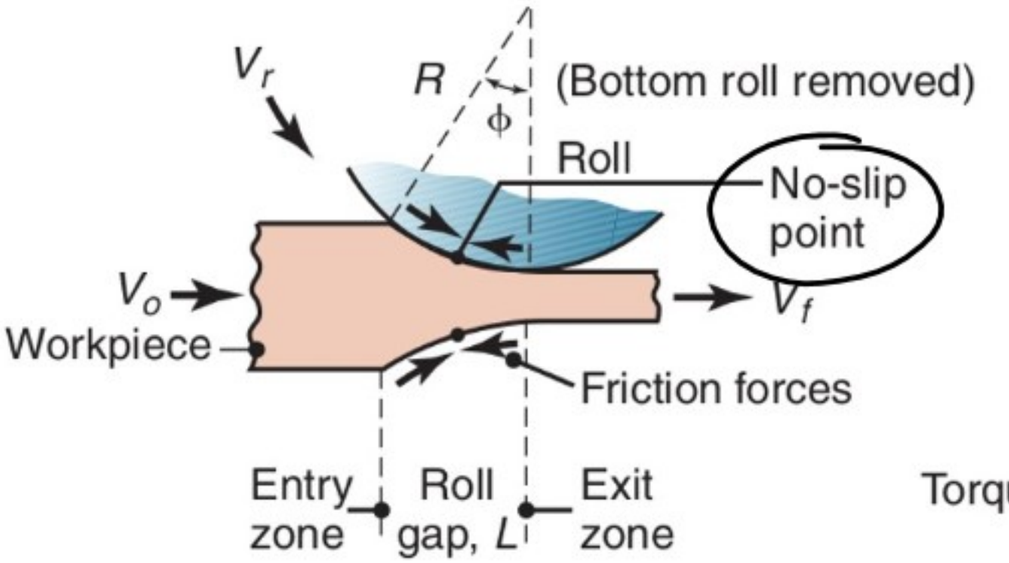
Power

Velocity

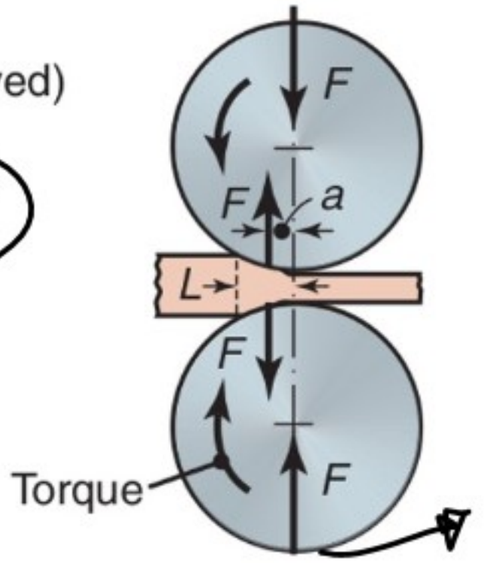
$V_r < V_f$



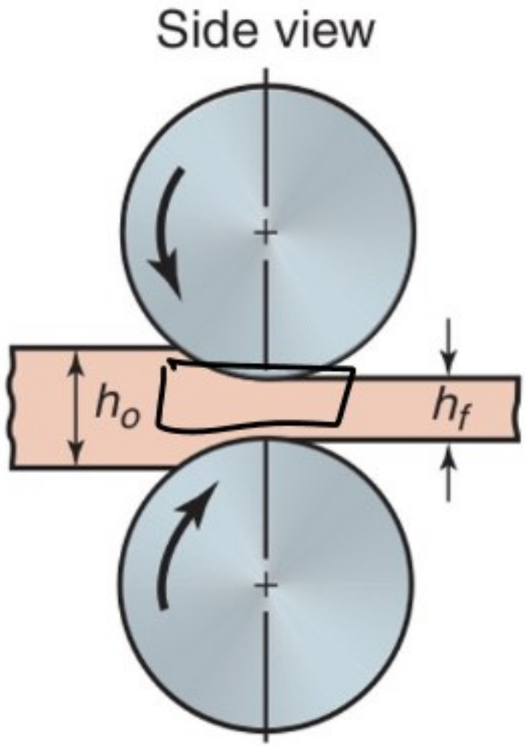
(a)



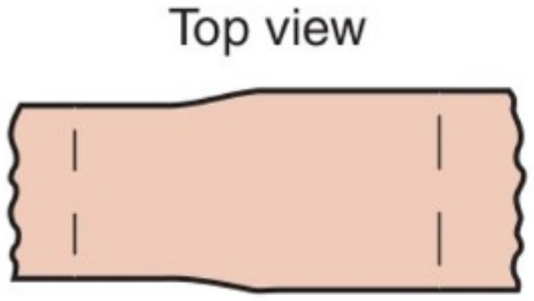
(b)



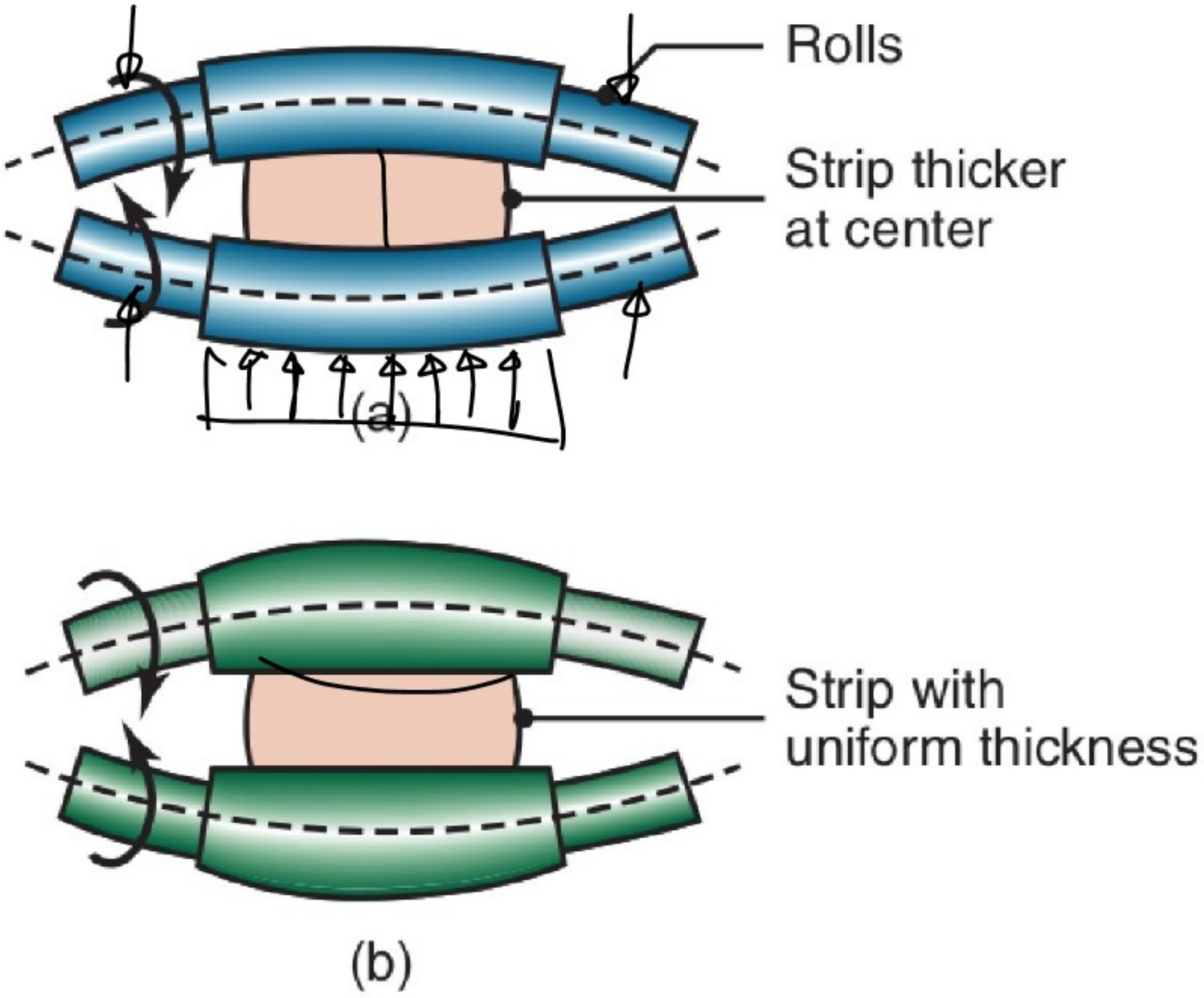
(c)

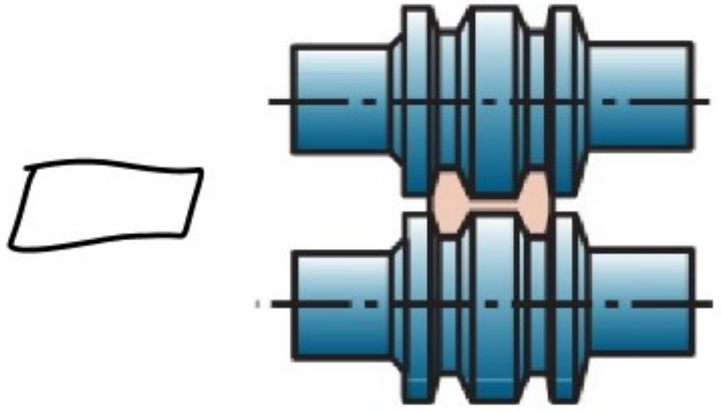


(a)

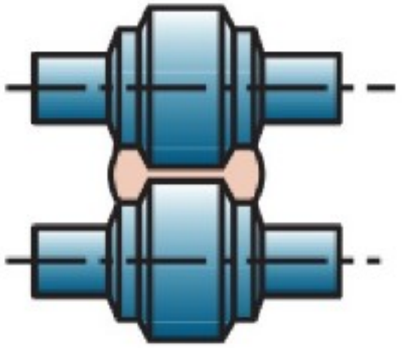


(b)

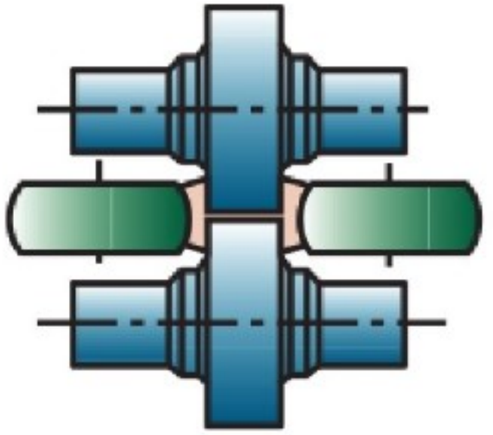

Rolls
Strip thicker
at center
(a)
Strip with
uniform thickness
(b)



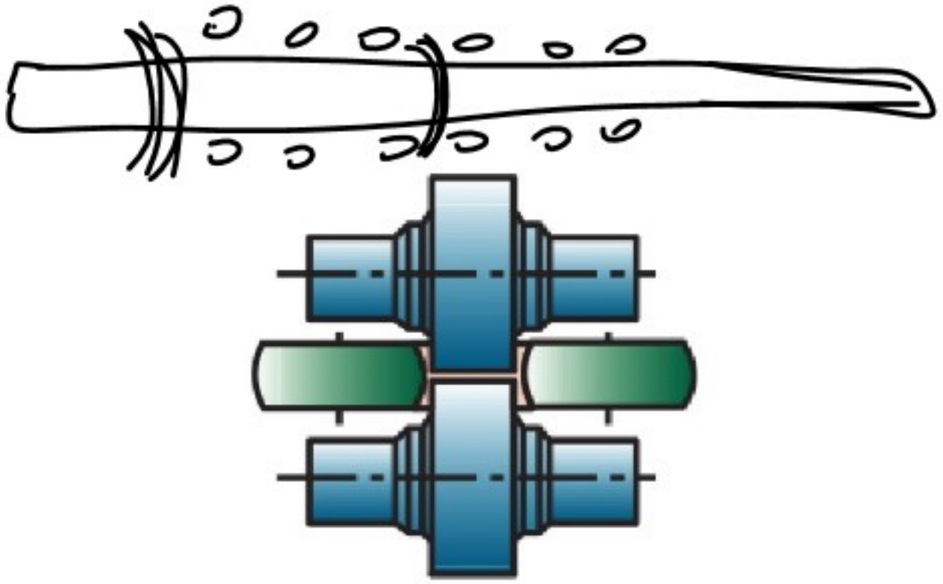
Stage 1: Blooming rolls



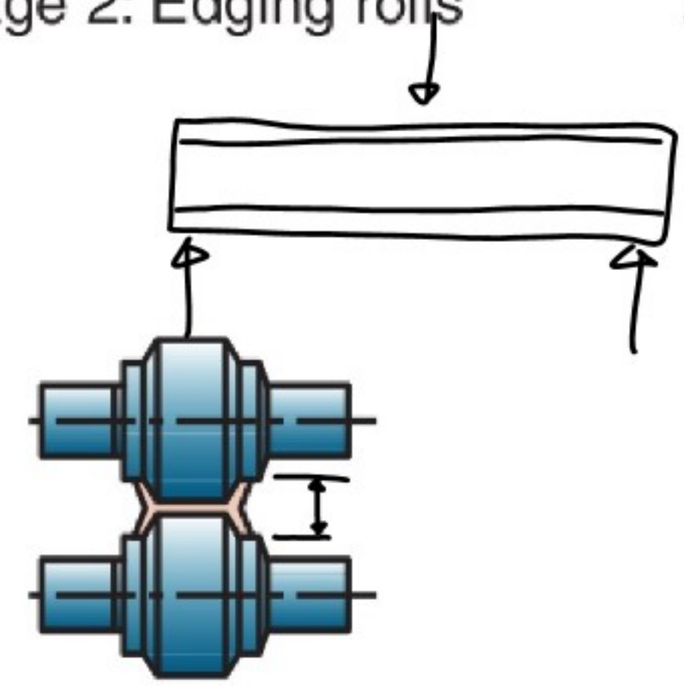
Stage 2: Edging rolls



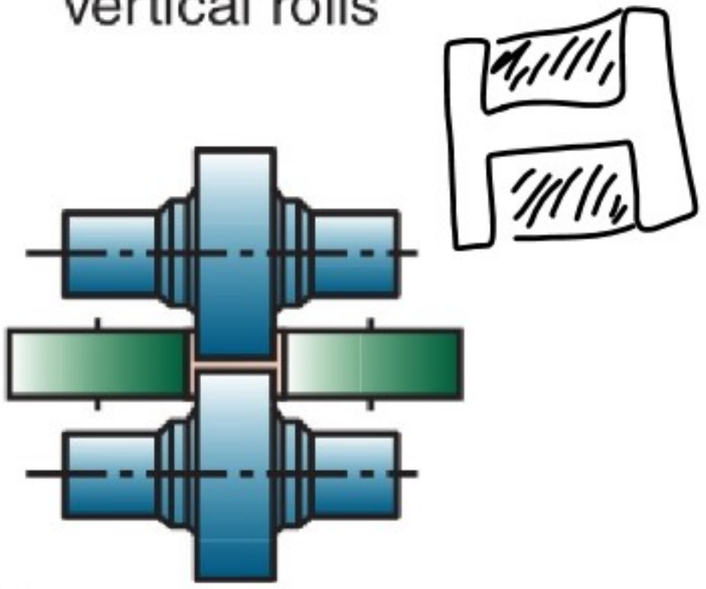
Stage 3: Roughing horizontal and vertical rolls



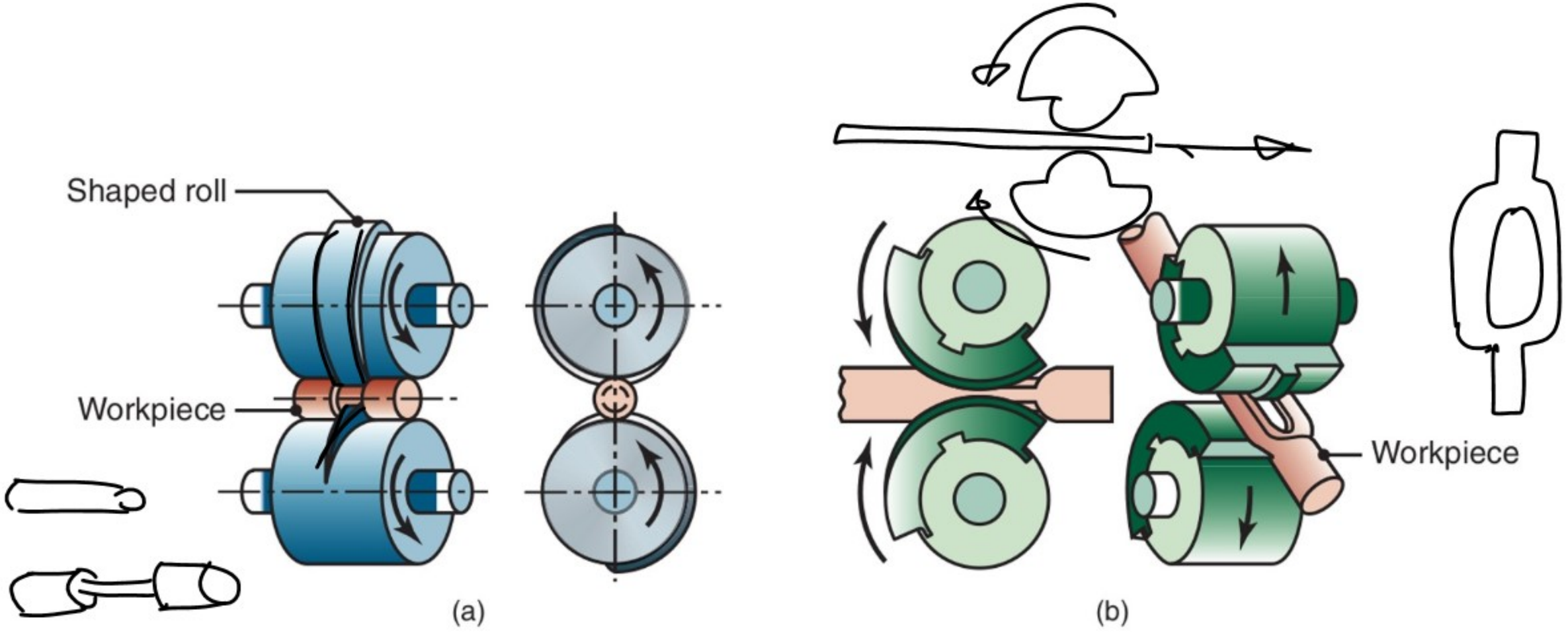
Stage 4: Intermediate horizontal and vertical rolls

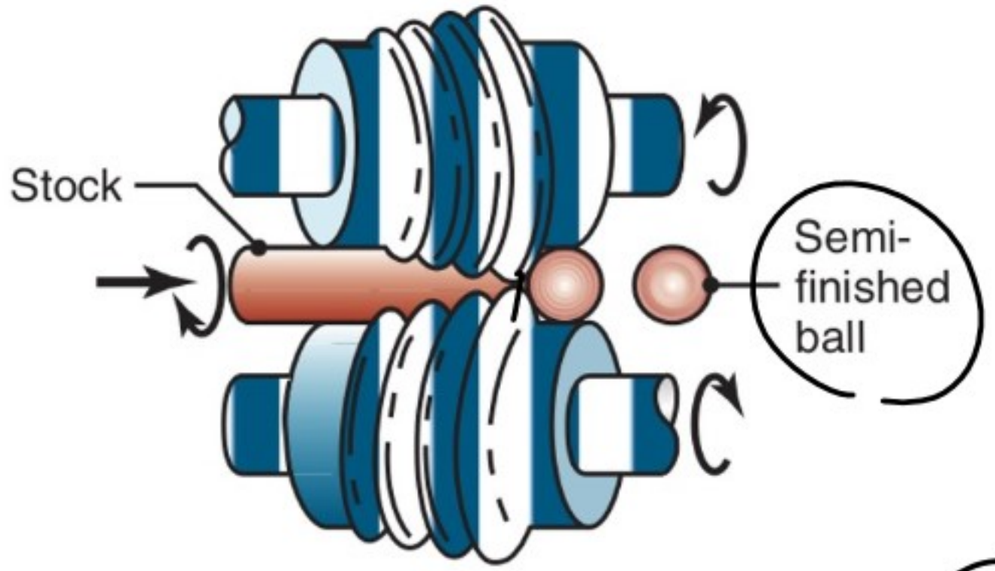


Stage 5: Edging rolls

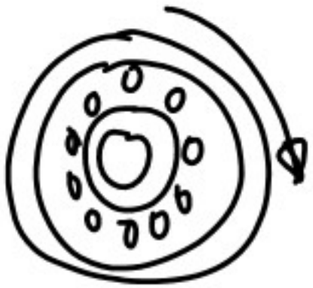


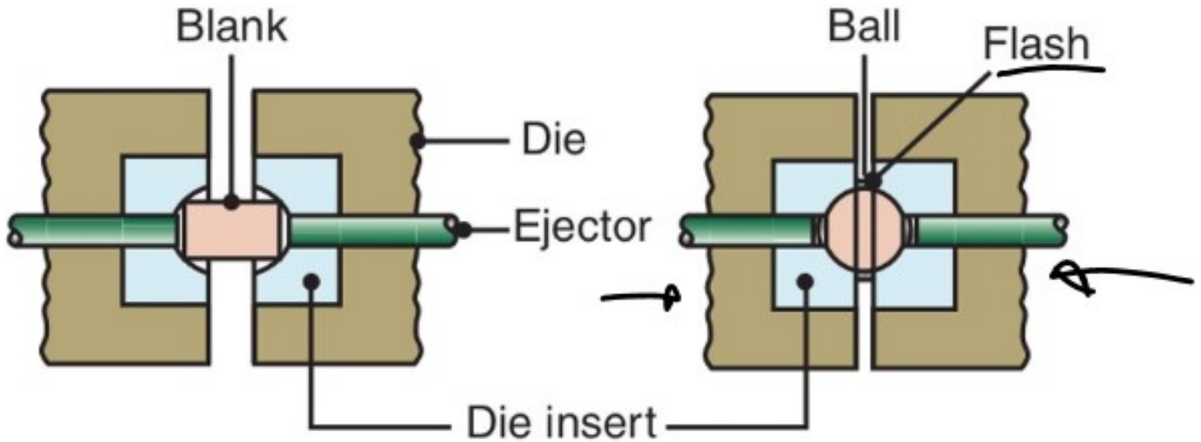
Stage 6: Finishing horizontal and vertical rolls


Shaped roll
Workpiece
(a)
Workpiece
(b)


Stock
Semi-
finished
ball

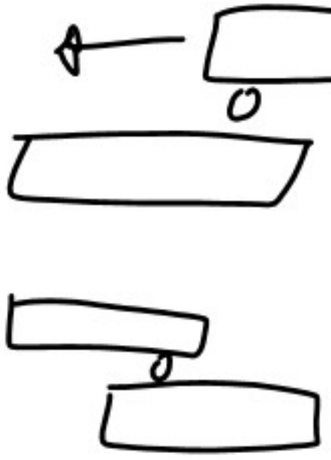
(a)

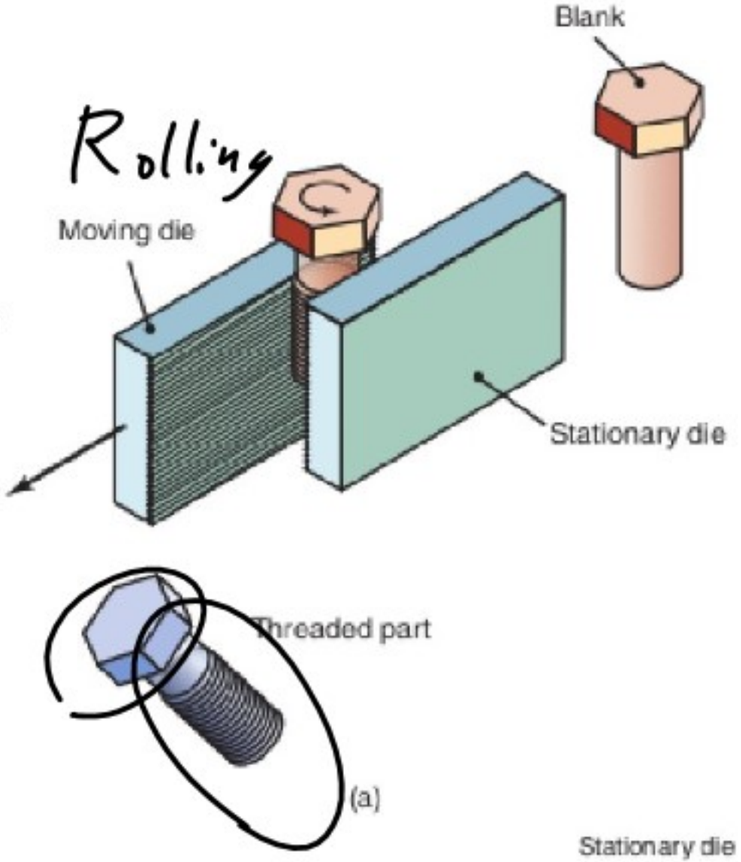


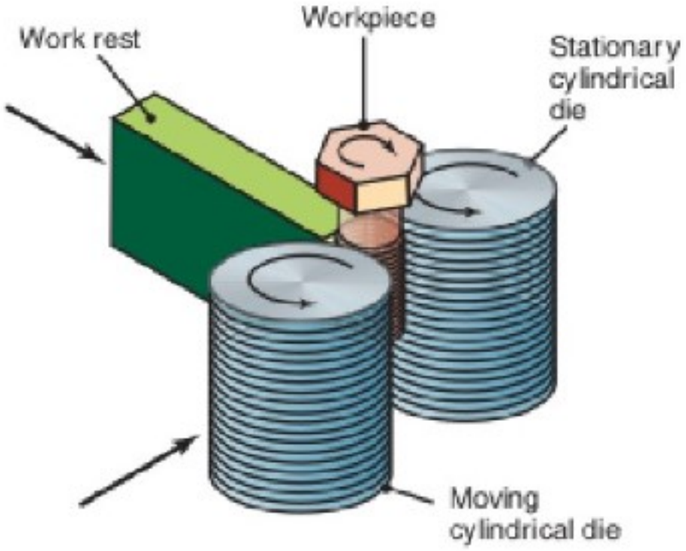

Blank
Die
Ejector
Die insert
Ball
Flash

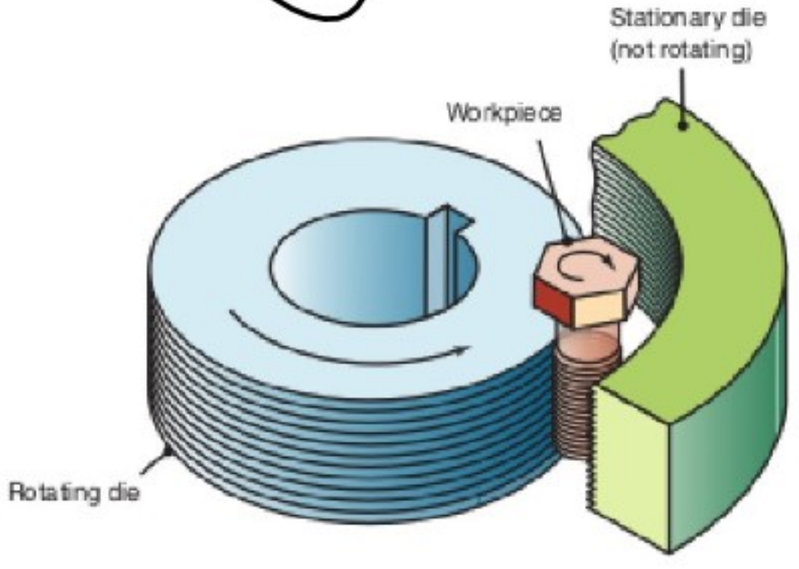
(b)

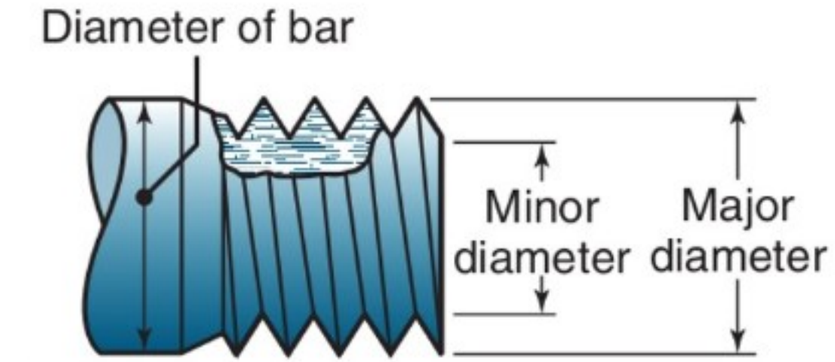
Thread Rolling





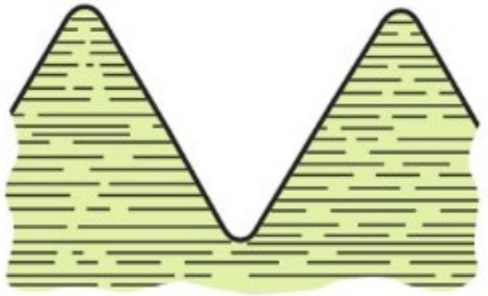






Machined or rolled thread

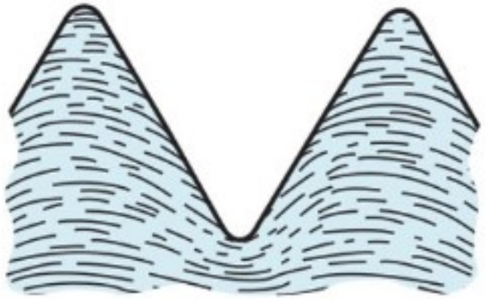
(a)



Machined thread

(b)

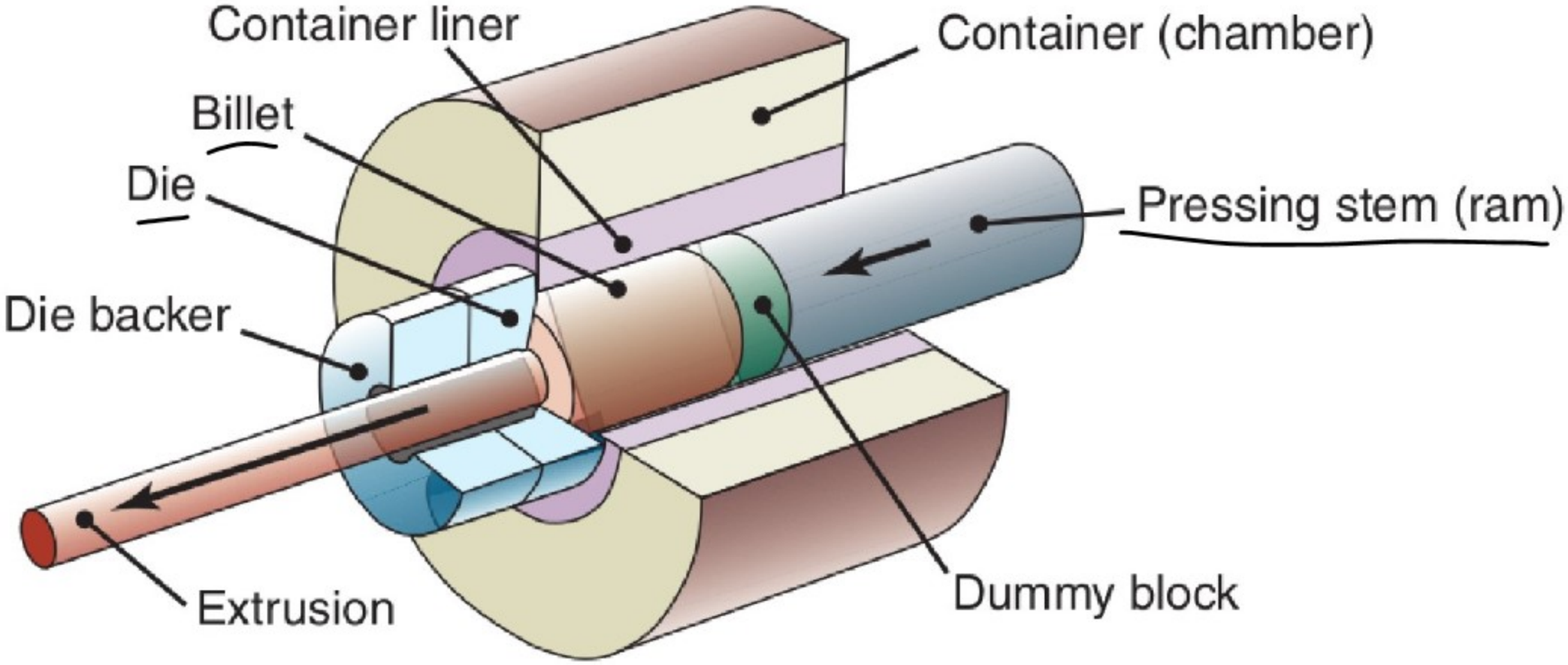
Stronger



Rolled thread

(c)

Extrusion


Container liner
Container (chamber)
Billet
Die
Pressing stem (ram)
Die backer
Extrusion
Dummy block

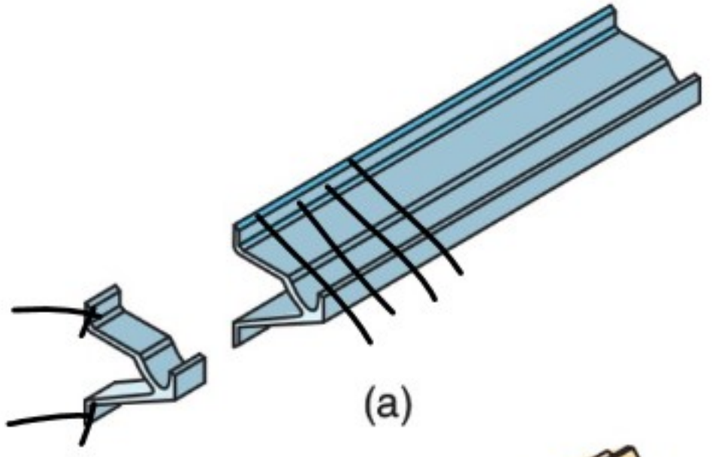
Extrusion similar to Drawing

Drawing Historically used to make wire

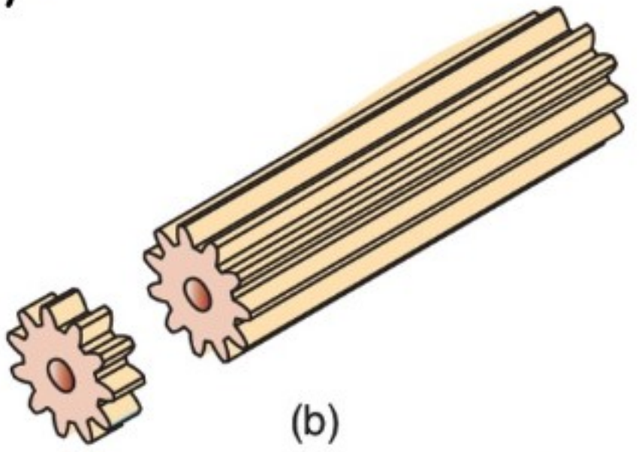
2000 BC

tolerance as low as 0.01 in

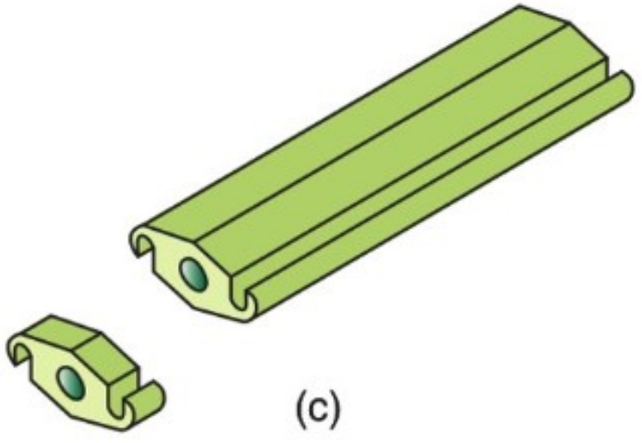
force in MN 1 MN ≃ 100 tons



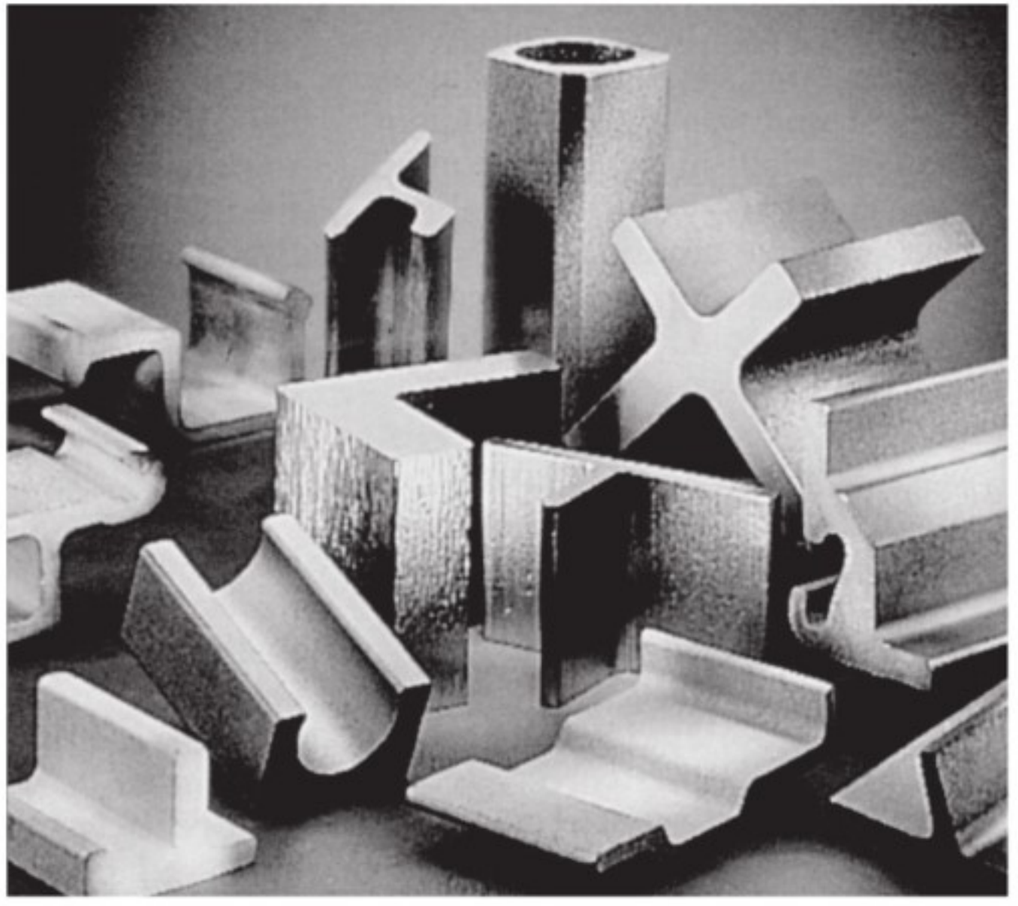
(a)



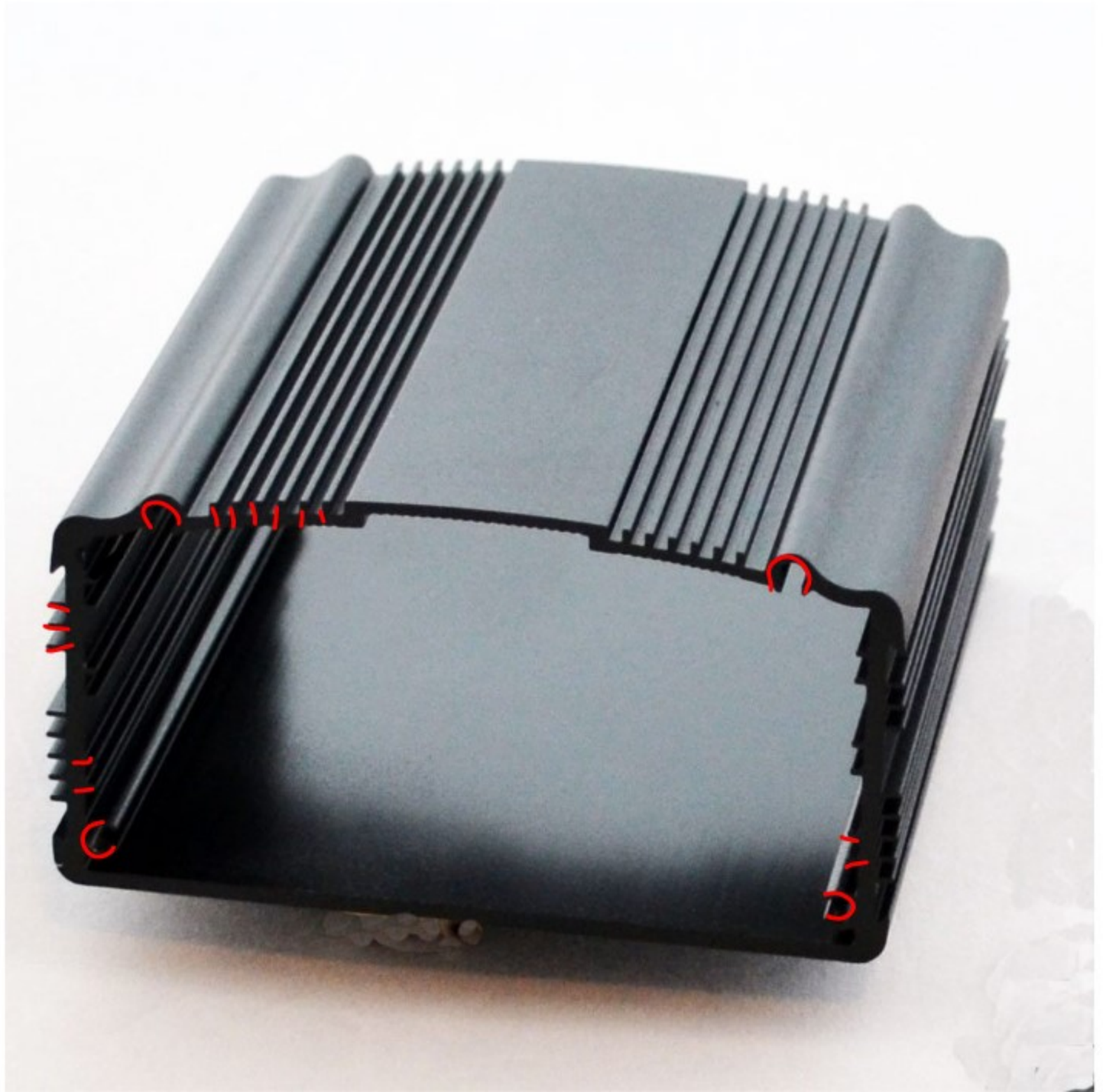
(b)



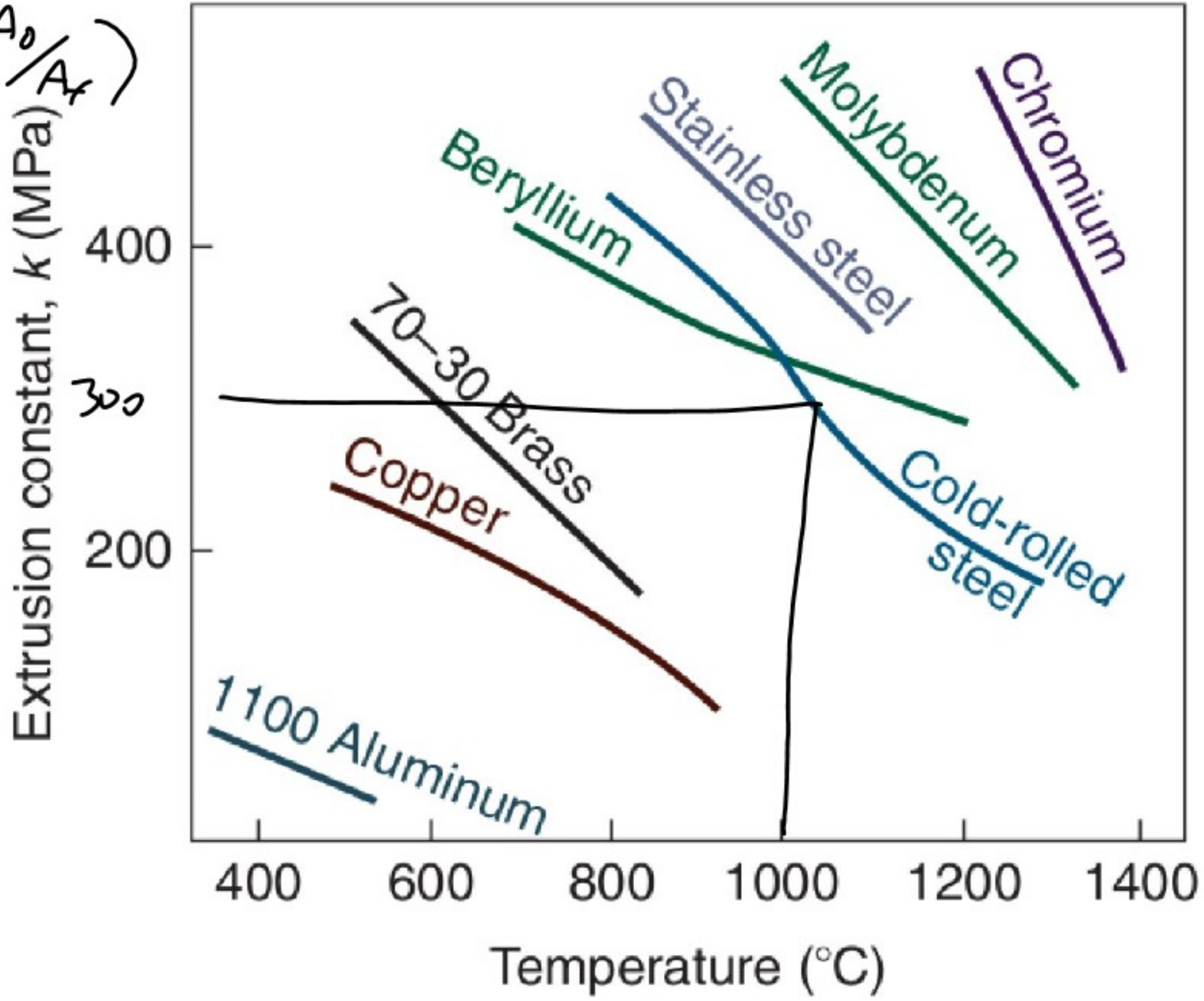
(c)



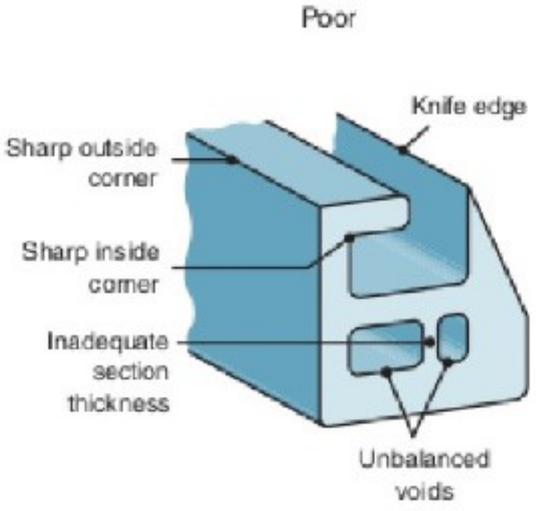
(d)

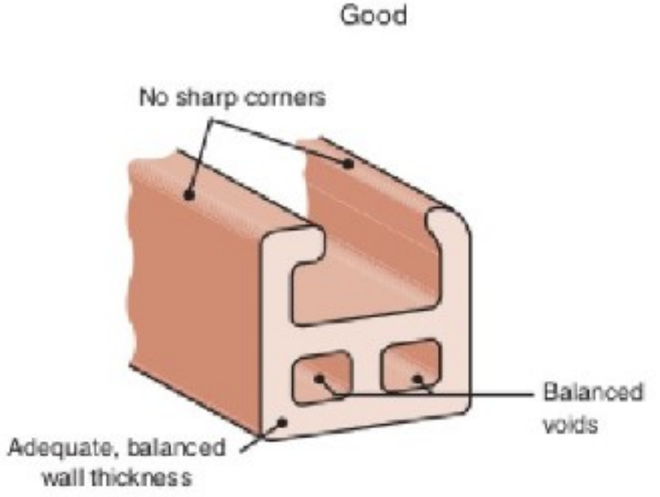


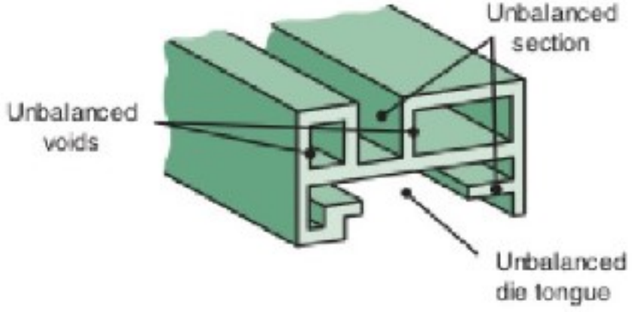
$$F = A_0 k \ln\left(\frac{A_0}{A_f}\right)$$

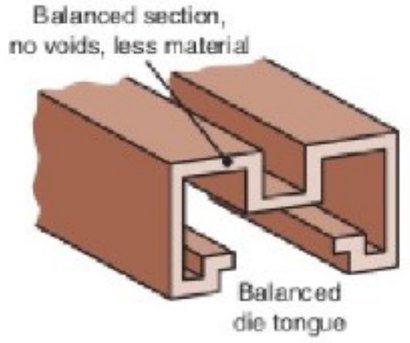


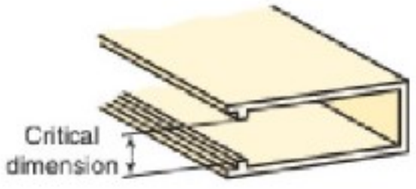

Warp

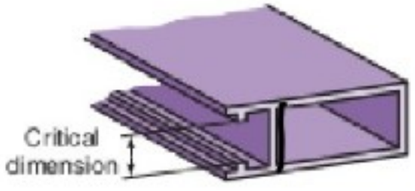

Poor
Knife edge
Sharp outside corner
Sharp inside corner
Inadequate section thickness
Unbalanced voids

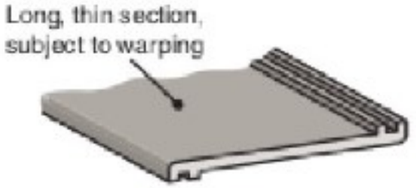

Good
No sharp corners
Balanced voids
Adequate, balanced wall thickness

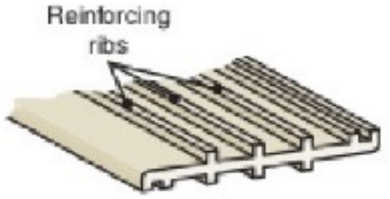

Unbalanced section
Unbalanced voids
Unbalanced die tongue


Balanced section, no voids, less material
Balanced die tongue


Critical dimension


Critical dimension


Long, thin section, subject to warping


Reinforcing ribs