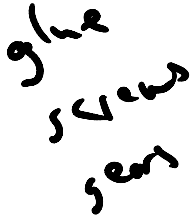
Mechanical Components

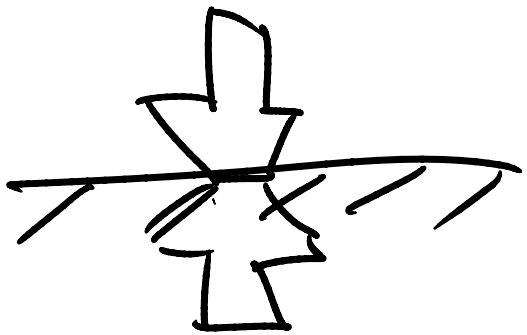
Cyrus Bazeghi

Winter 2010

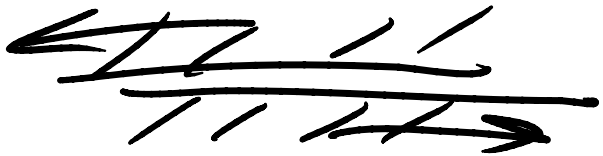


Physics Review: Forces

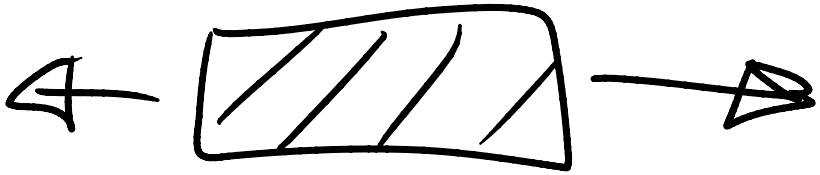
- Normal



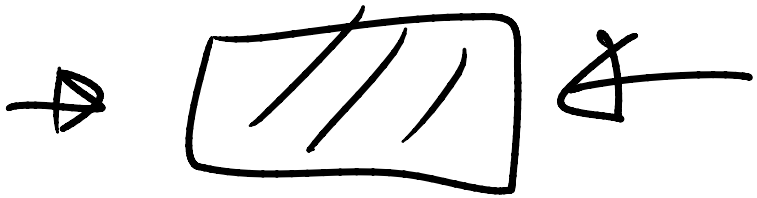
- Sheer



- Tensile



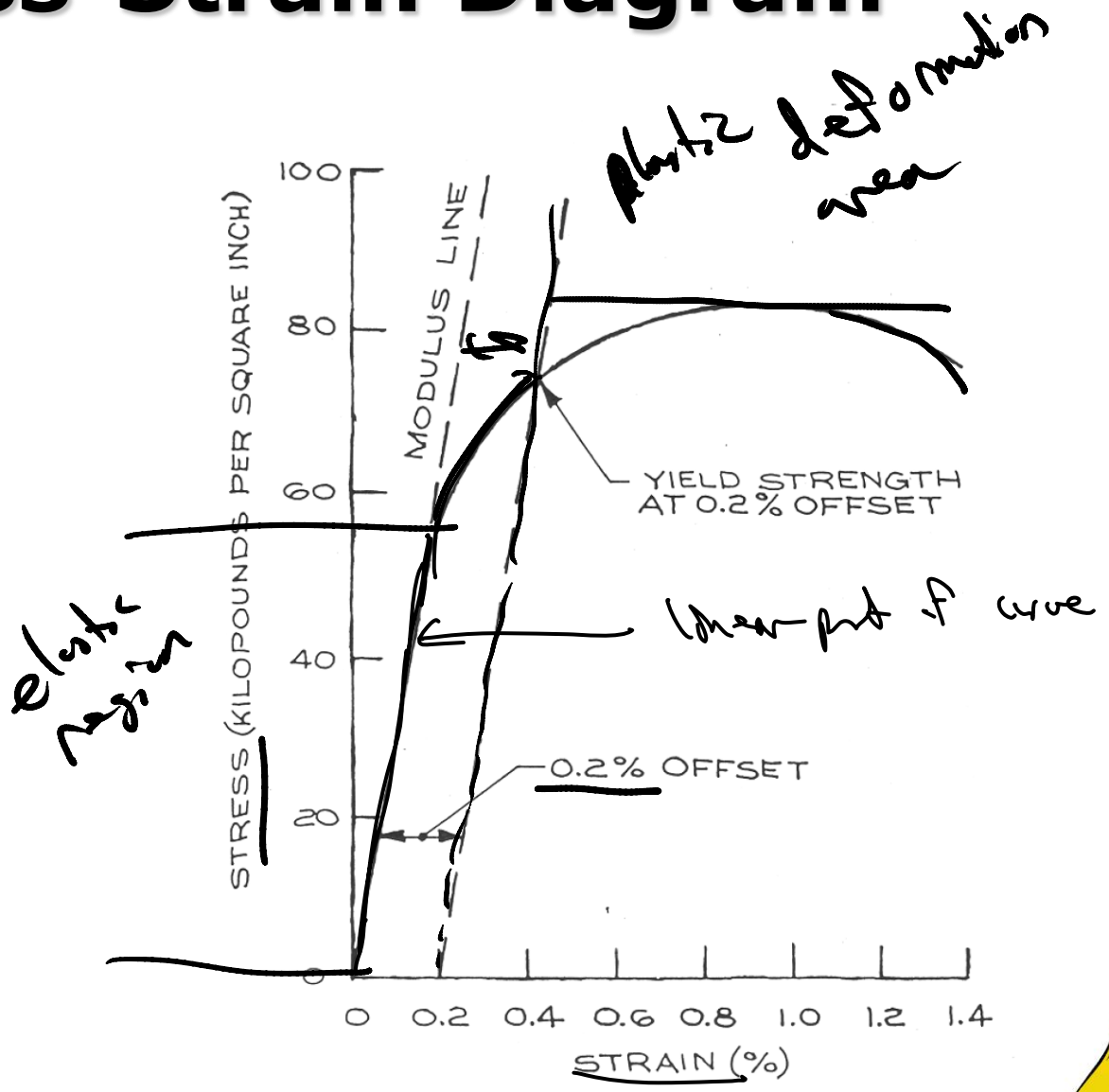
- Compressive



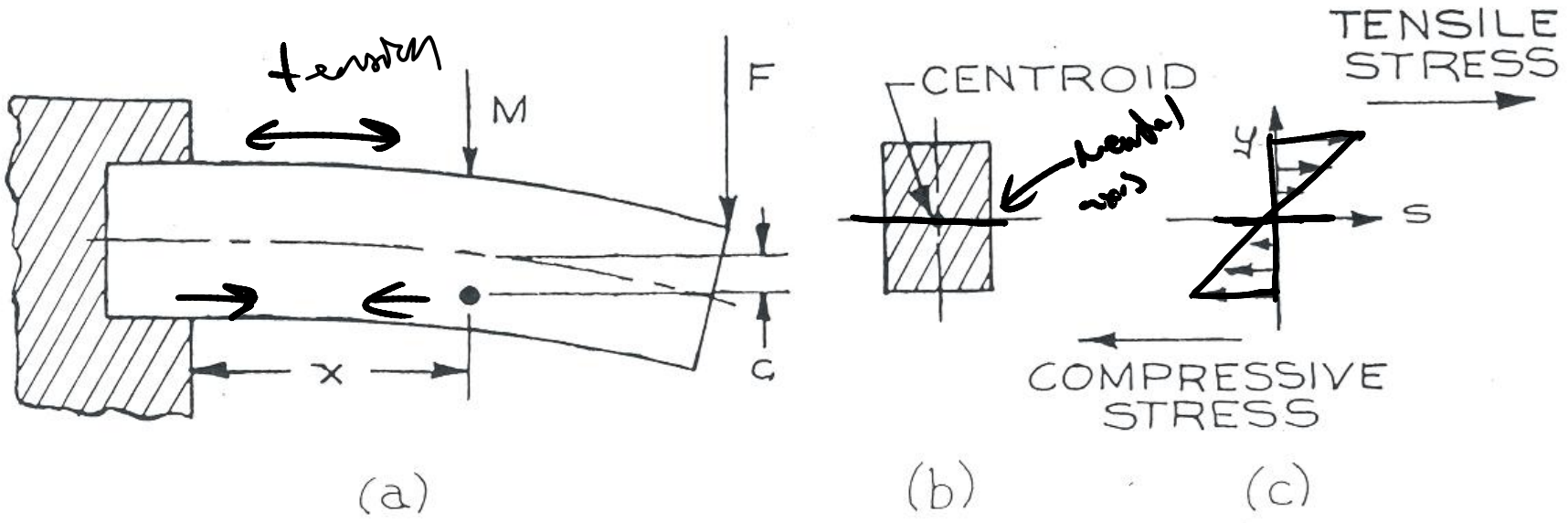
Material Properties Terms

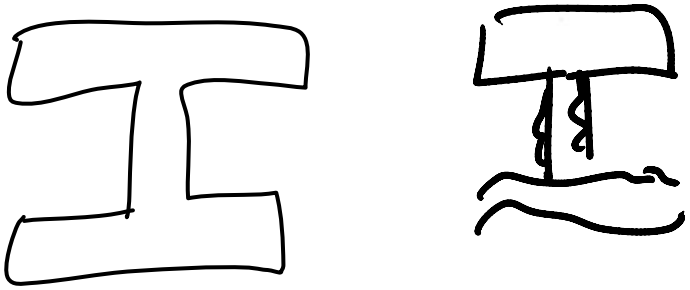
- Stress – $\frac{\text{force}}{\text{area}}$
- Strain – elongation (normalized) $\frac{\Delta L}{L}$ (%)
- Modulus of Elasticity – Young's Modulus
  spring constant of material
  stress vs. strain slope
  "Marks Handbook of Mechanical Properties"

Stress-Strain Diagram



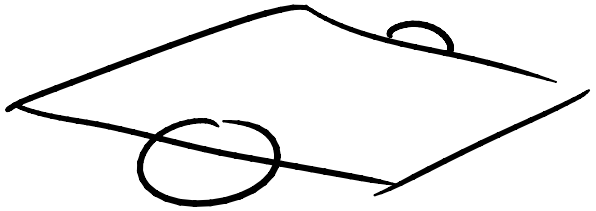
Beams in Bending

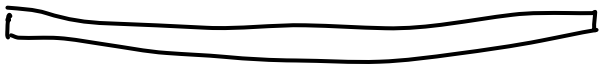


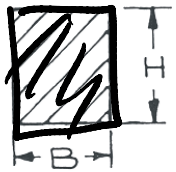


Shape is Important

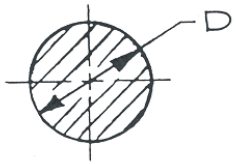
I = moment of inertia



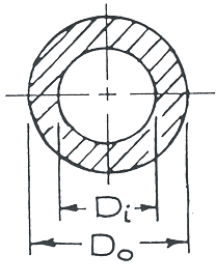




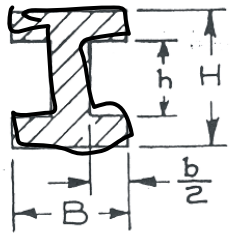
$I = \frac{BH^3}{12}$



$I = \frac{\pi D^4}{64}$

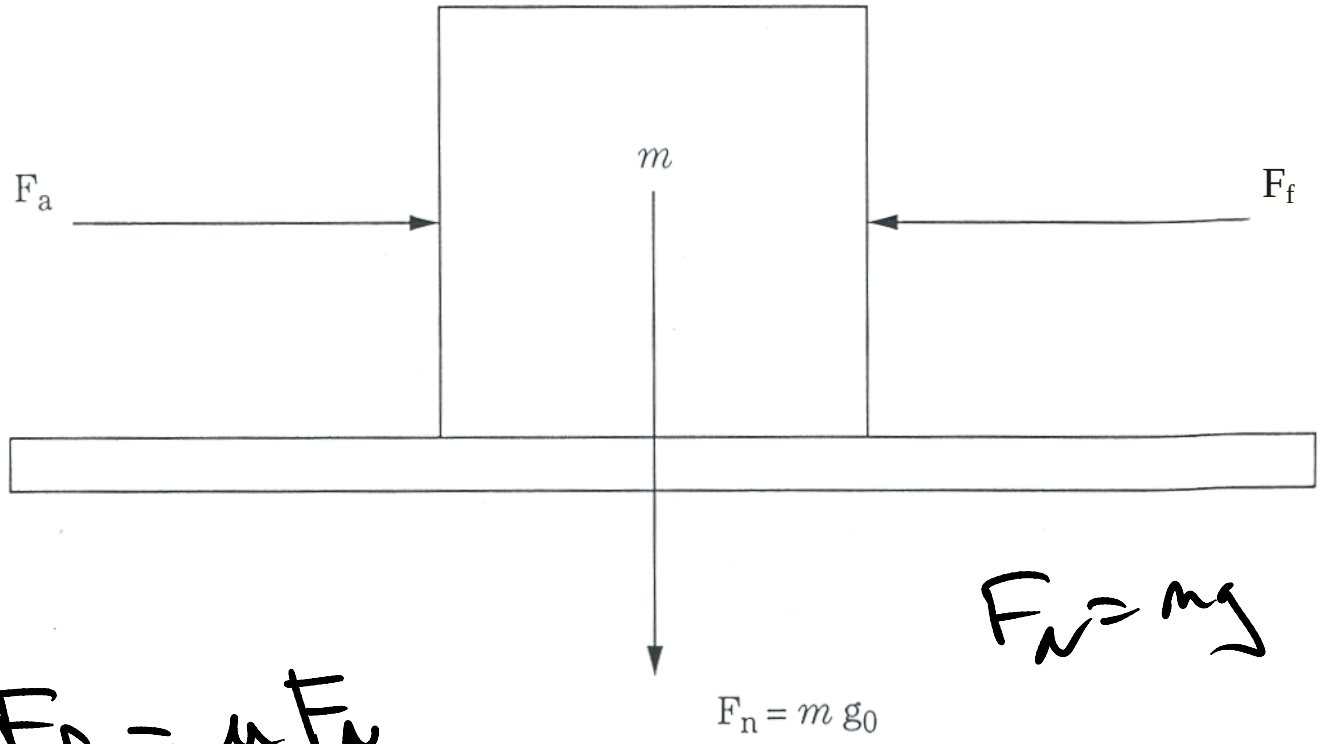


$I = \frac{\pi}{64}(D_o^4 - D_i^4)$



$I = \frac{1}{12}(BH^3 - bh^3)$

Friction



$F_N = mg$

$F_f = \mu F_N$

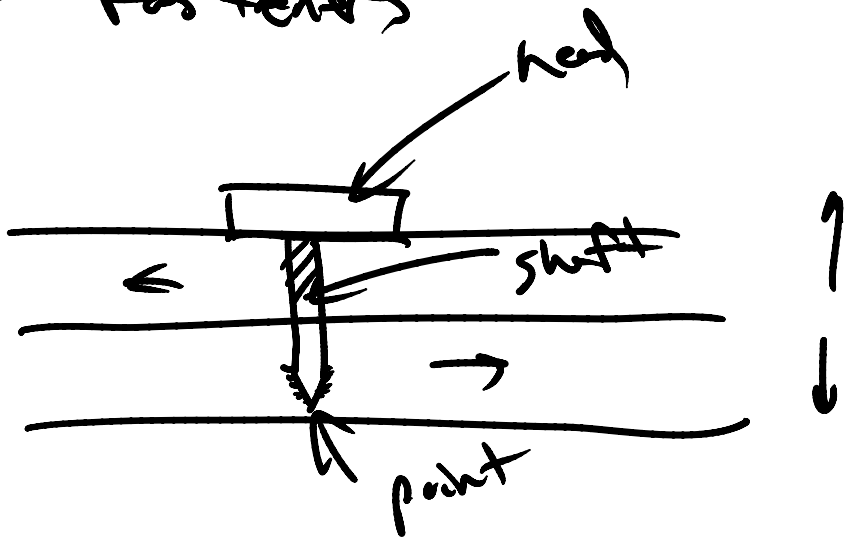
μ_s - static

$\mu_s < 1$

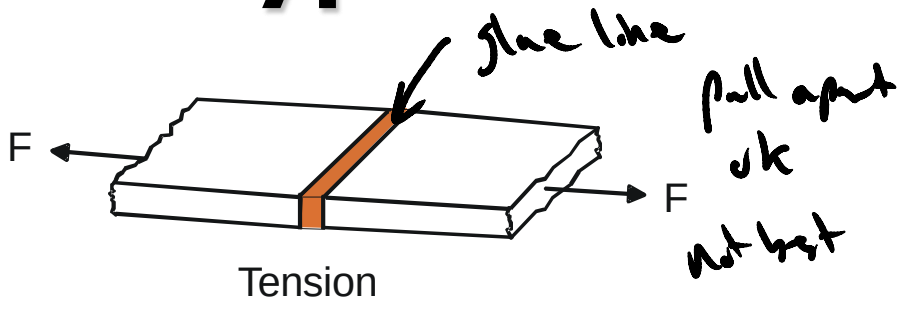
μ_k - kinetic - dynamic

Fastening Methods

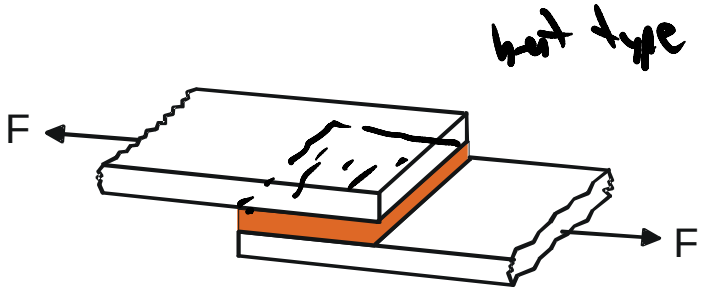
- Adhesives
- threaded Fasteners
- Rivets



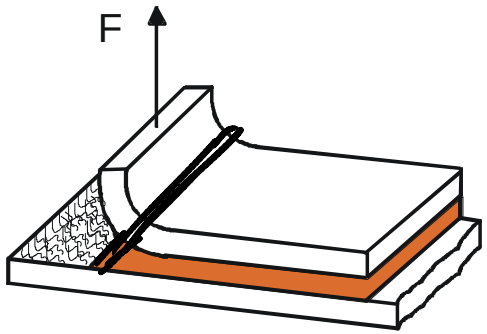
Types of Adhesive Loading



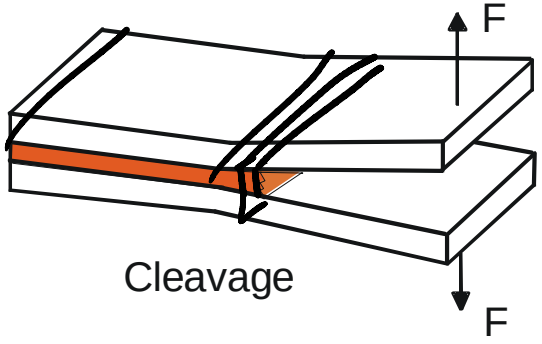
Tension



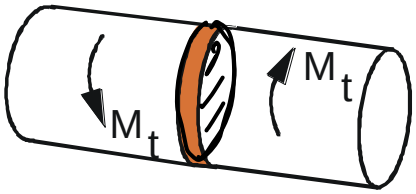
Tensile - Shear



Peeling



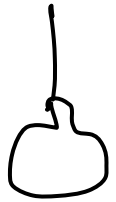
Cleavage



Torsion

Adhesive Types

Non-filling — solvent (acrylic cement)



* needs smooth, clean surface
* contact w/o voids

Cyano-acrolate (super glue)

"zip-a-gap" or "zip-kicker"

Filling type - liquid or semi-liquid - solidify to make bond

- Elmers - (Aphadic cement)
  - roughen the area - increase surface area
  - glue sticks
  - calkers (silicon)
  - liquid nails
  - Epoxy - very strong
  - glue gun - hot melt
  - rubber cement - ok
    Contact cement - better

Threaded Fasteners: Machine Screws

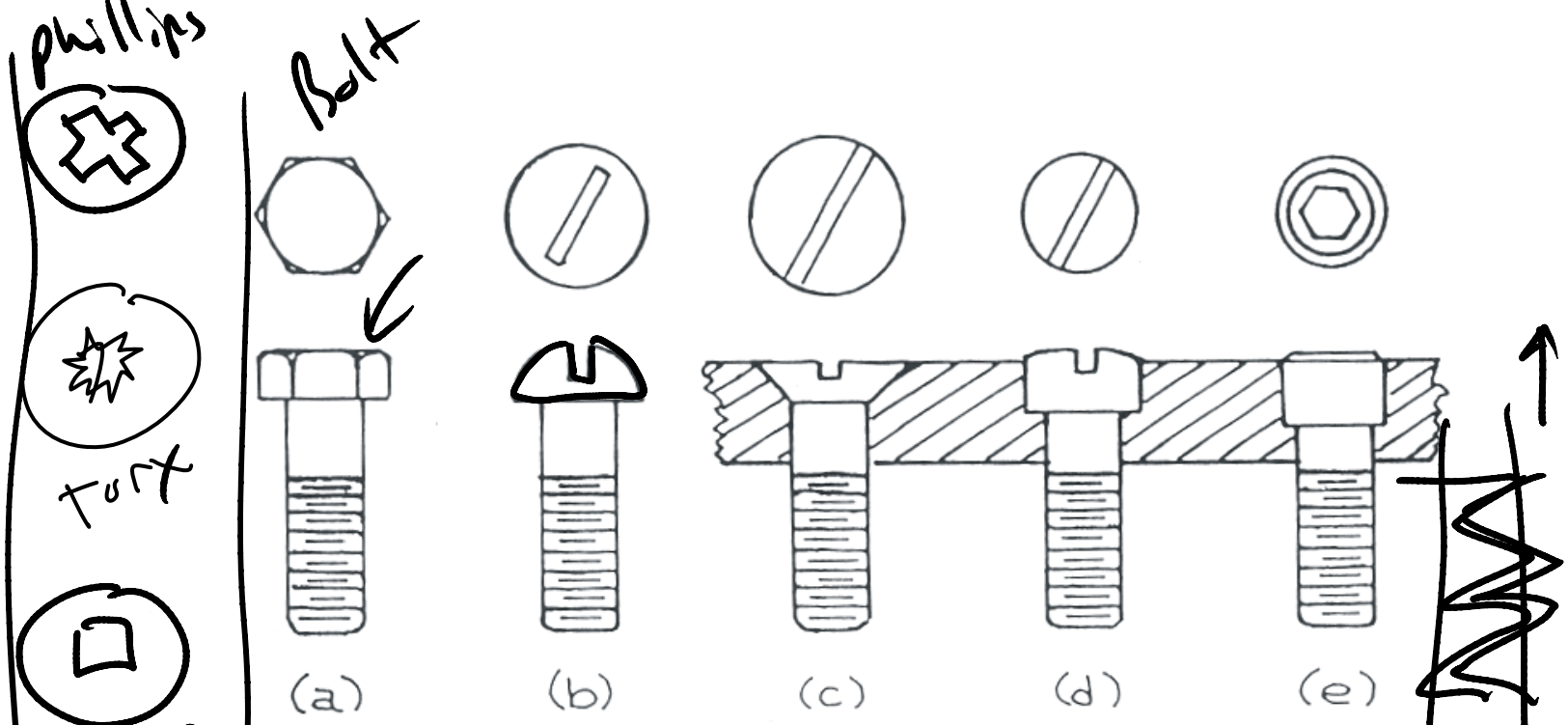
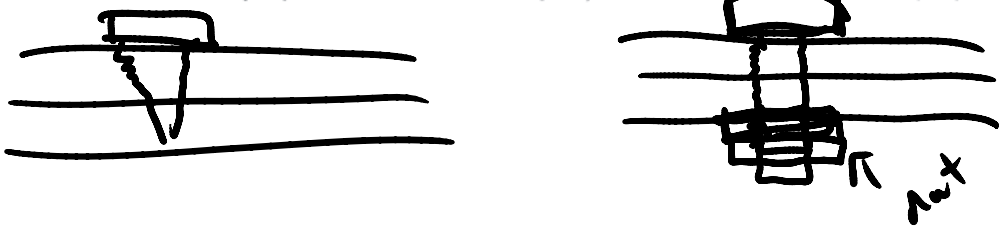


Figure 1.14 Common machine screws: (*a*) hex head; (*b*) round head; (*c*) flat head; (*d*) fillister head; (*e*) socket head.



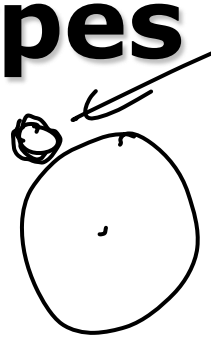
Standard Screw Sizes

Table 1.5 AMERICAN STANDARD UNIFIED AND AMERICAN NATIONAL THREADS

Size (nominal diameter)	Coarse (NC, UNC) Threads per Inch	Coarse (NC, UNC) Tap Drill[a]	Fine (NF, UNF) Threads per Inch	Fine (NF, UNF) Tap Drill[a]
0 (0.060)			80	3/64
1 (0.073)	64	No. 53	72	No. 53
2 (0.086)	56	No. 50	64	No. 50
3 (0.099)	48	No. 47	56	No. 45
4 (0.112)	40	No. 43	48	No. 42
5 (0.125)	40	No. 38	44	No. 37
6 (0.138)	32	No. 36	40	No. 33
8 (0.164)	32	No. 29	36	No. 29
10 (0.190)	24	No. 25	32	No. 21
12 (0.216)	24	No. 16	28	No. 14
1/4	20	No. 7	28	No. 3
5/16	18	Let. F	24	Let. I
3/8	16	5/16	24	Let. Q
7/16	14	Let. U	20	25/64
1/2	13	27/64	20	29/64
9/16	12	31/64	18	33/64
5/8	11	17/32	18	37/64
3/4	10	21/32	16	11/16
7/8	9	49/64	14	13/16
1	8	7/8	12	59/64

Drive Types

Friction —

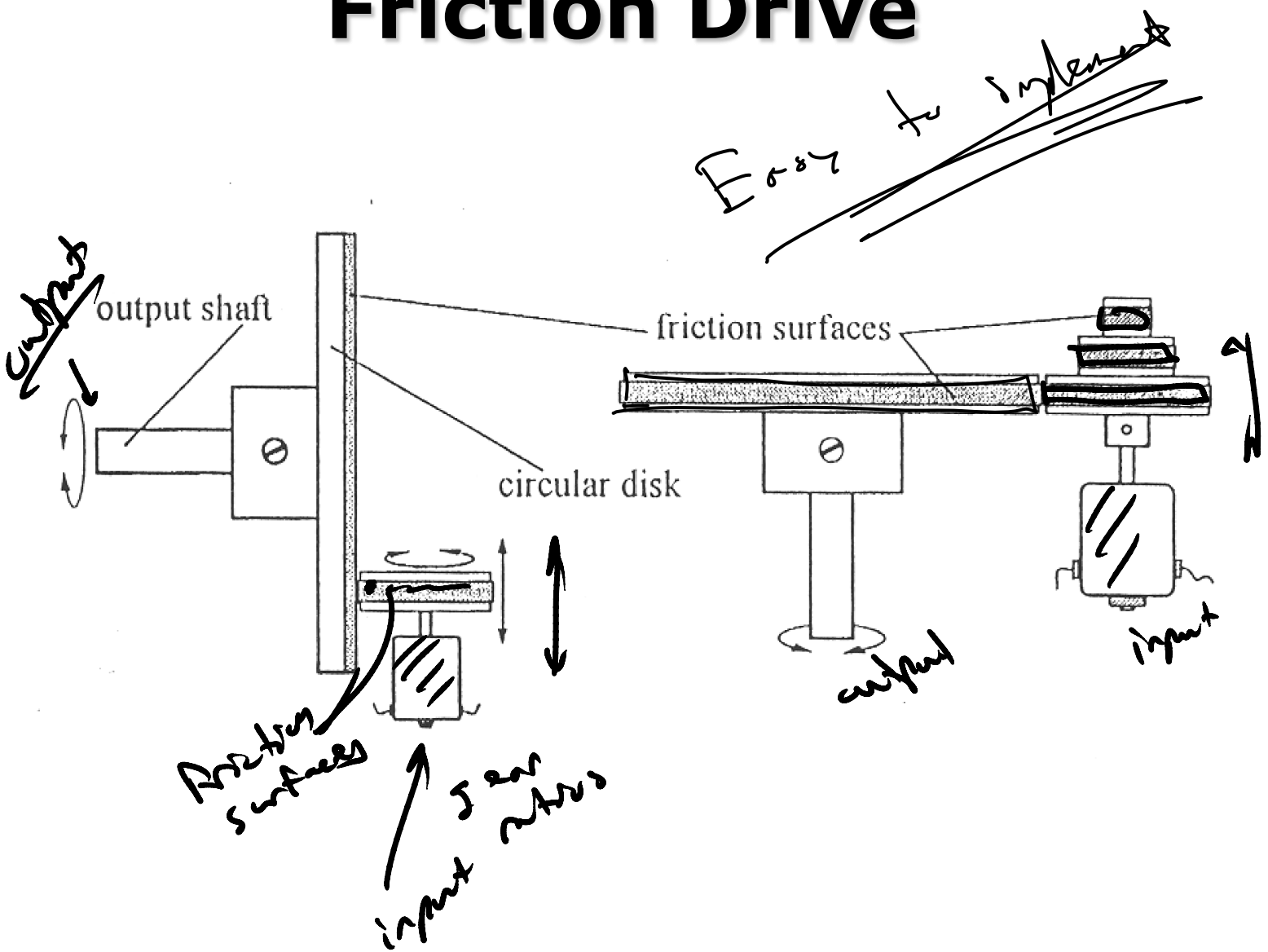


Belt

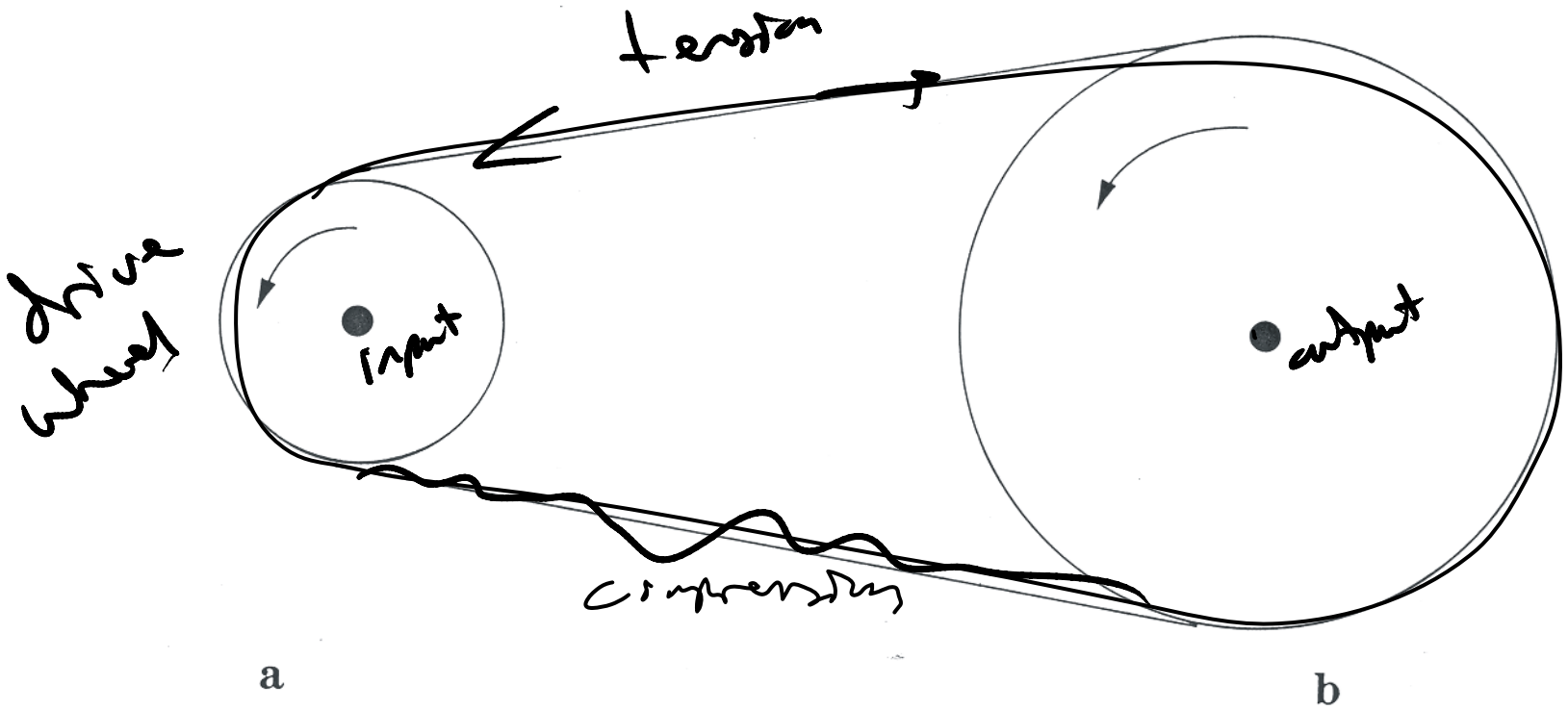
Gears

Direct — bolt onto end of motor

Friction Drive

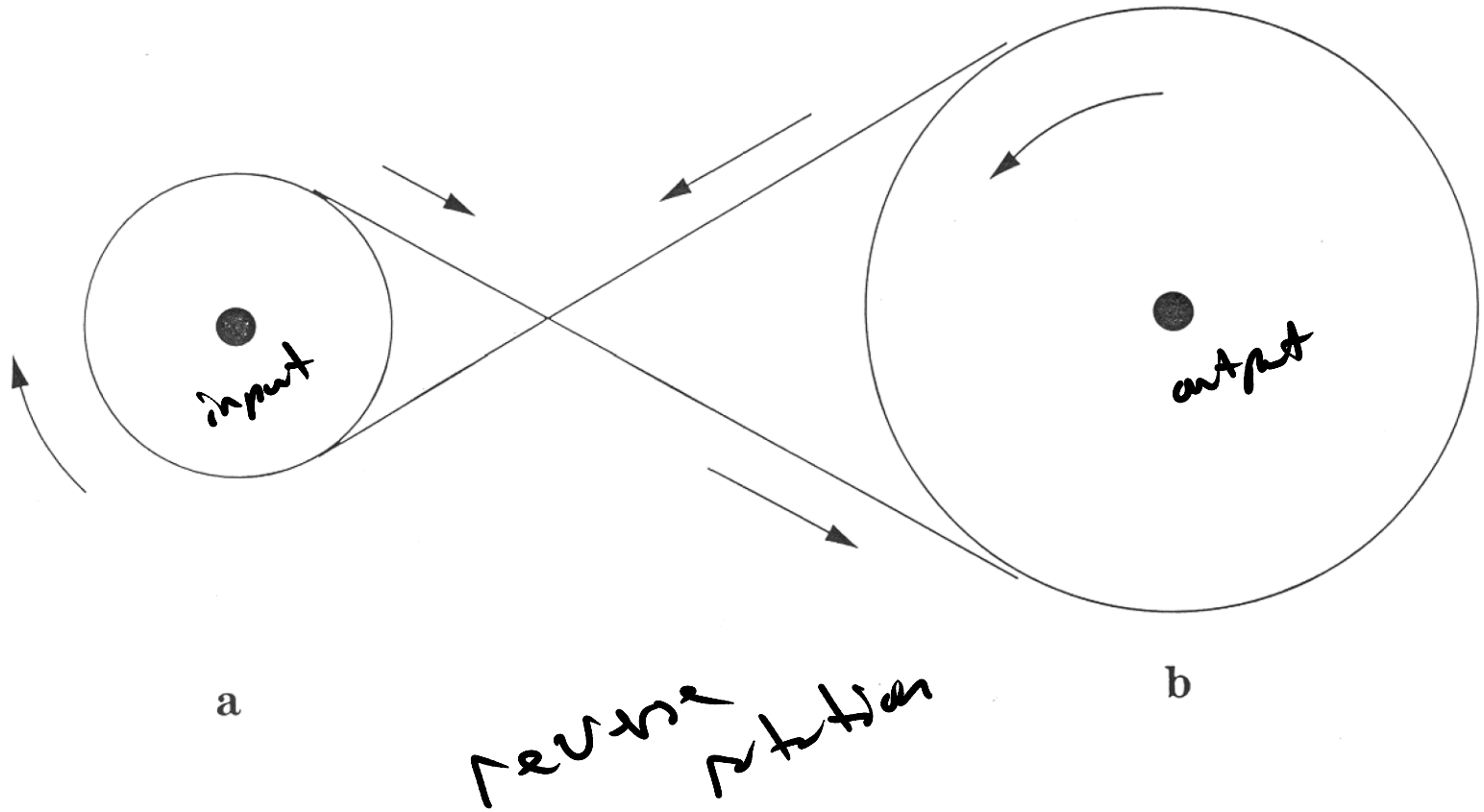


Belt Drive (1.2)

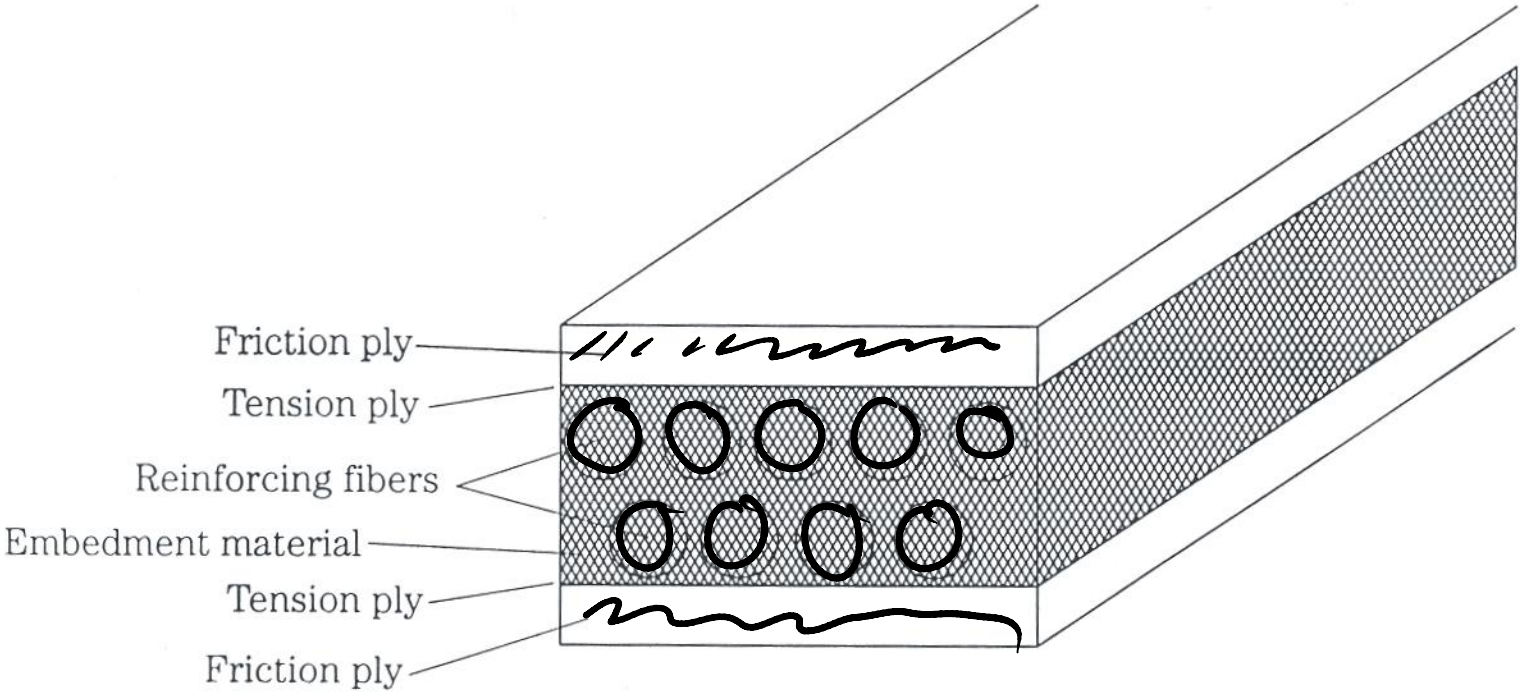


pretty easy to make

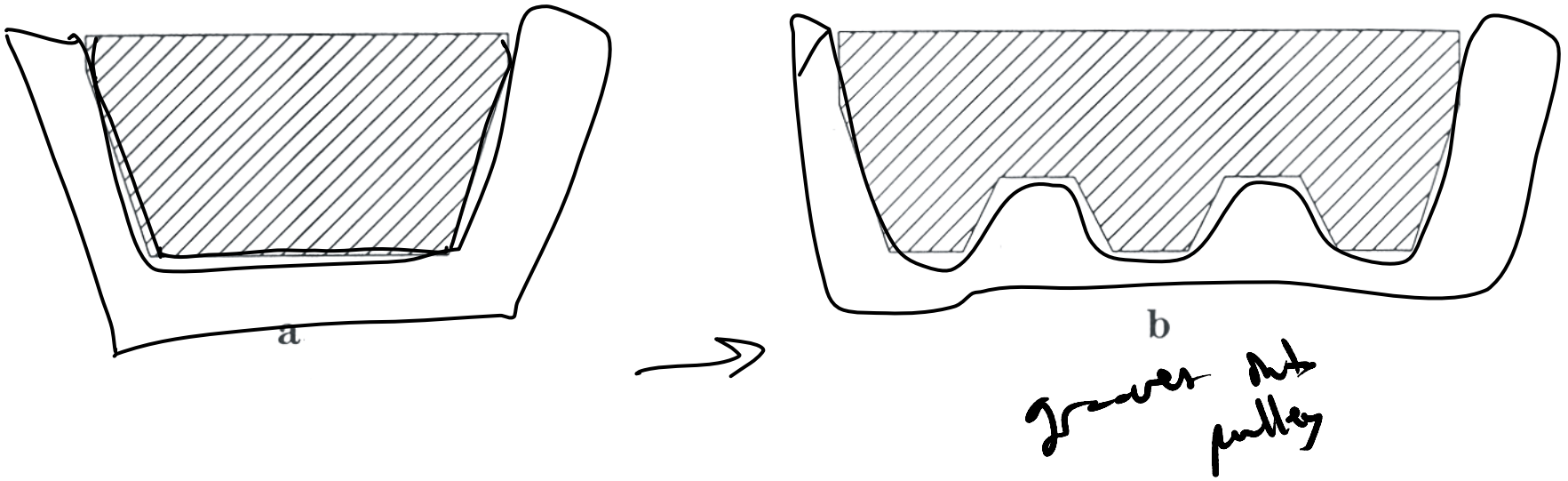
Belt Drive (2.2)



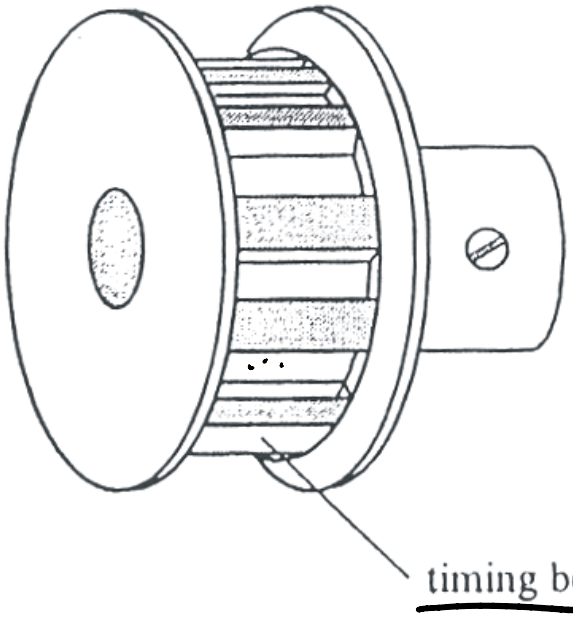
Belt Drive Construction

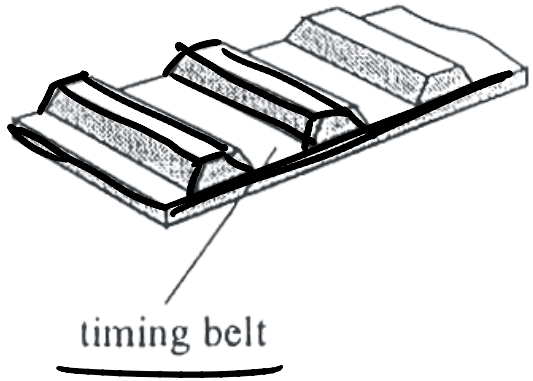


Belt Profiles



Toothed Belt Drive

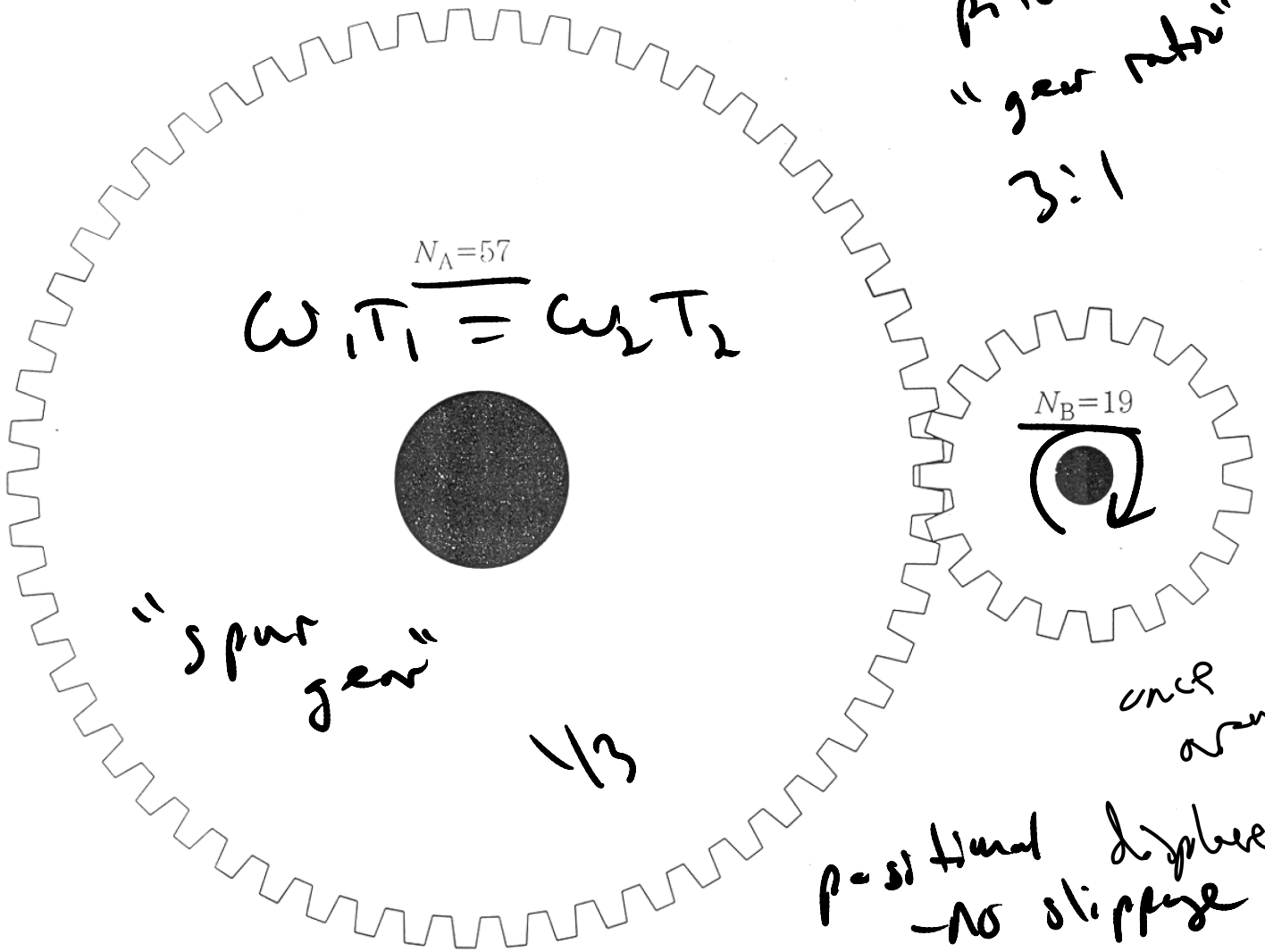




Belt Drive on a HOG

- Clunk
- Less quiet vs. chain
- Little stretch
- No maintence

Gear Drive



"pitch" teeth
"gear ratio"
3:1

$\omega_1 T_1 = \omega_2 T_2$

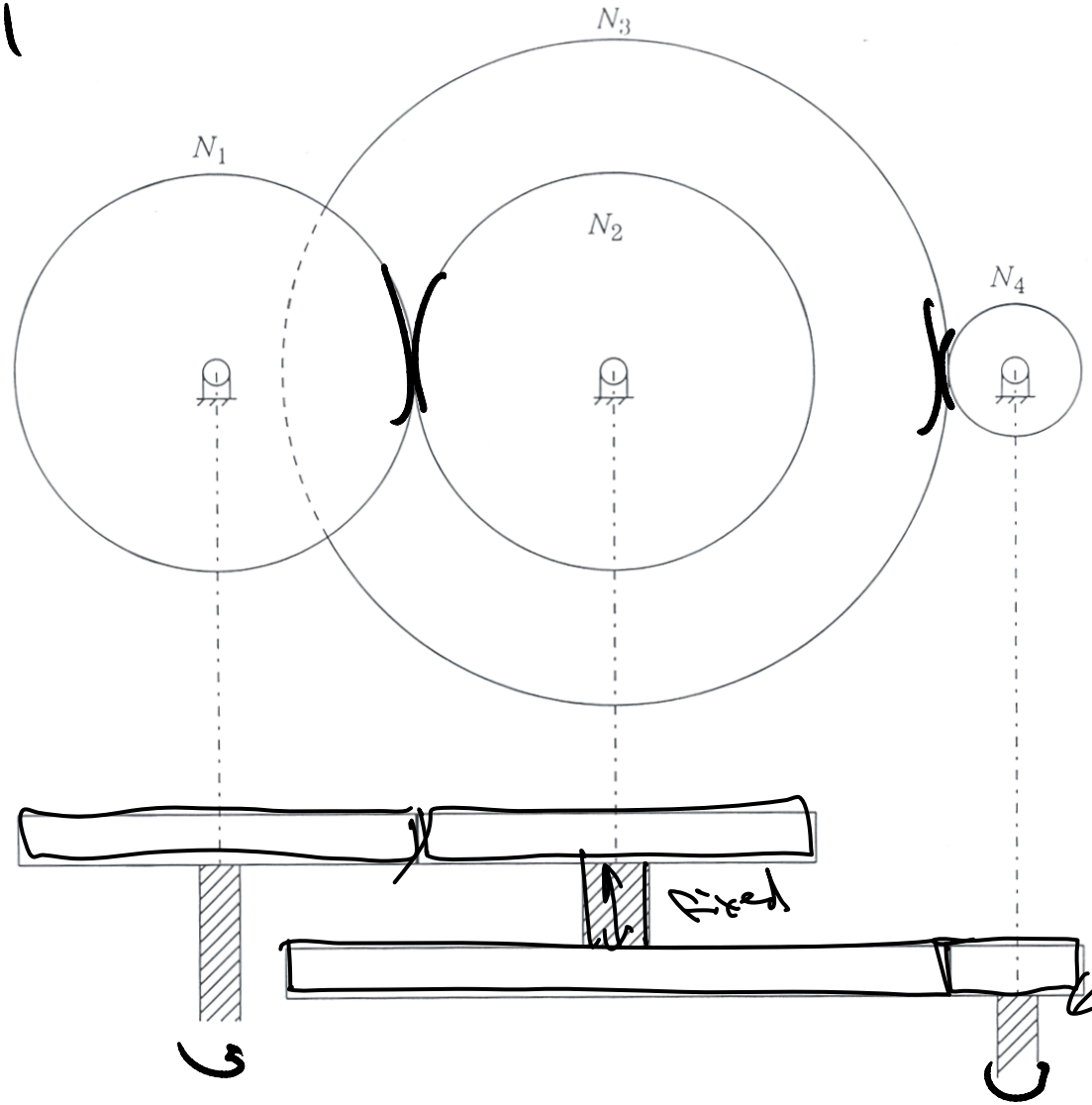
"spur gear"

1/3

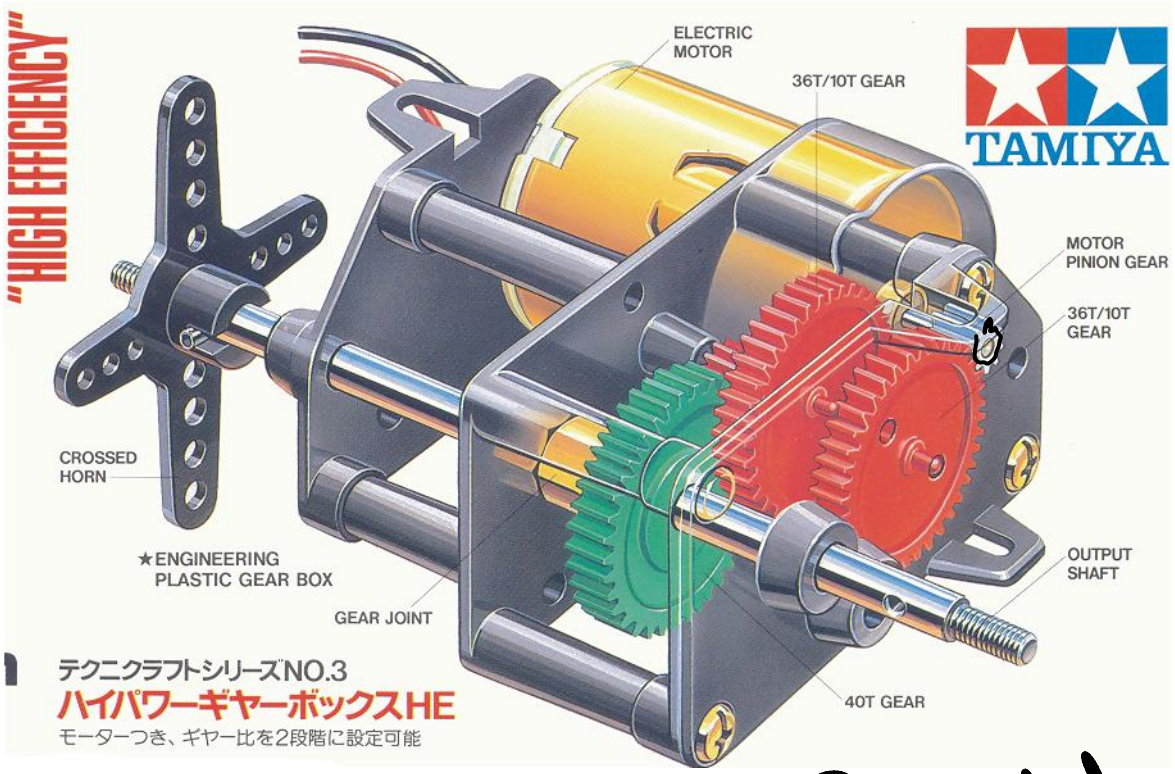
once around

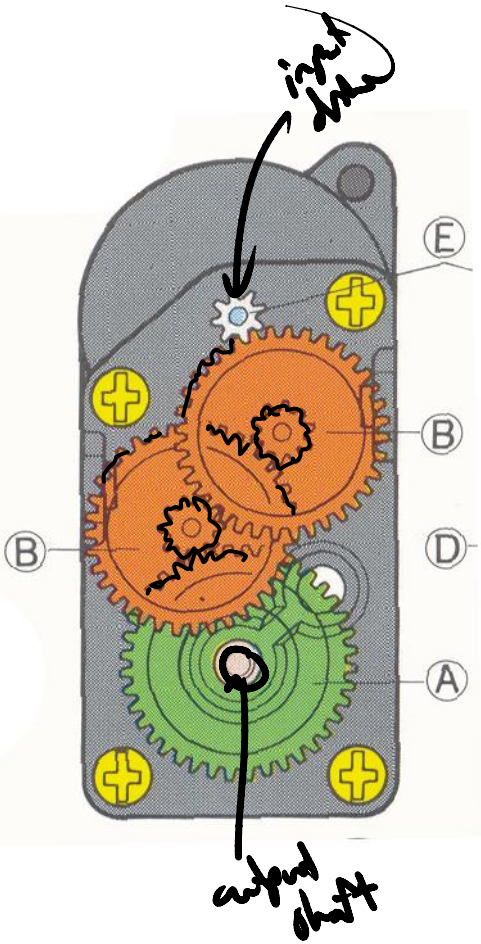
positional displacement
-no slippage

Compound Gear Train (1.2)



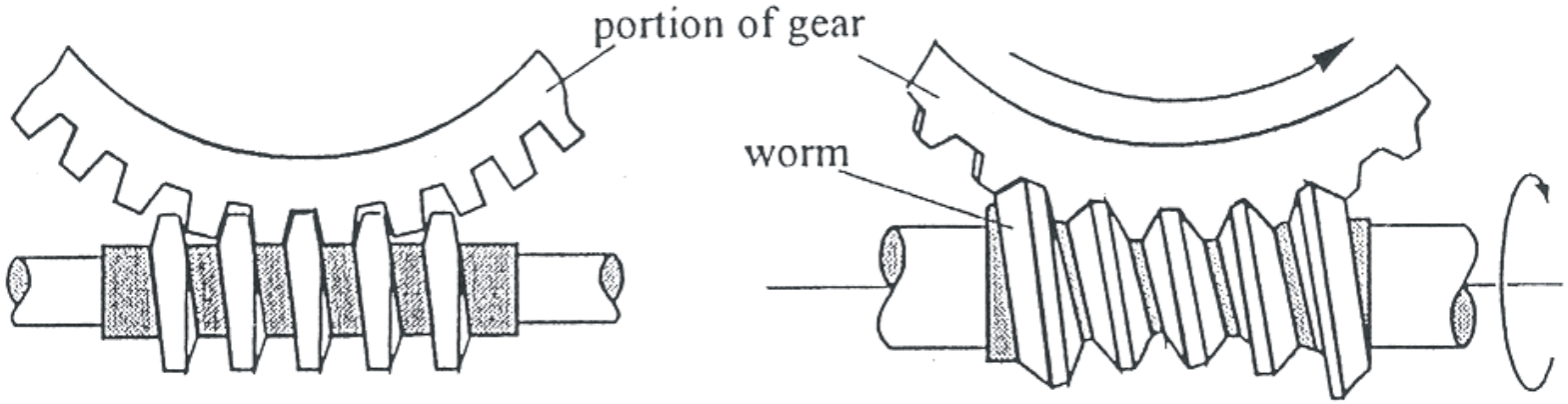
Compound Gear Train (2.2)





64.8:1 standard ratios
47:1

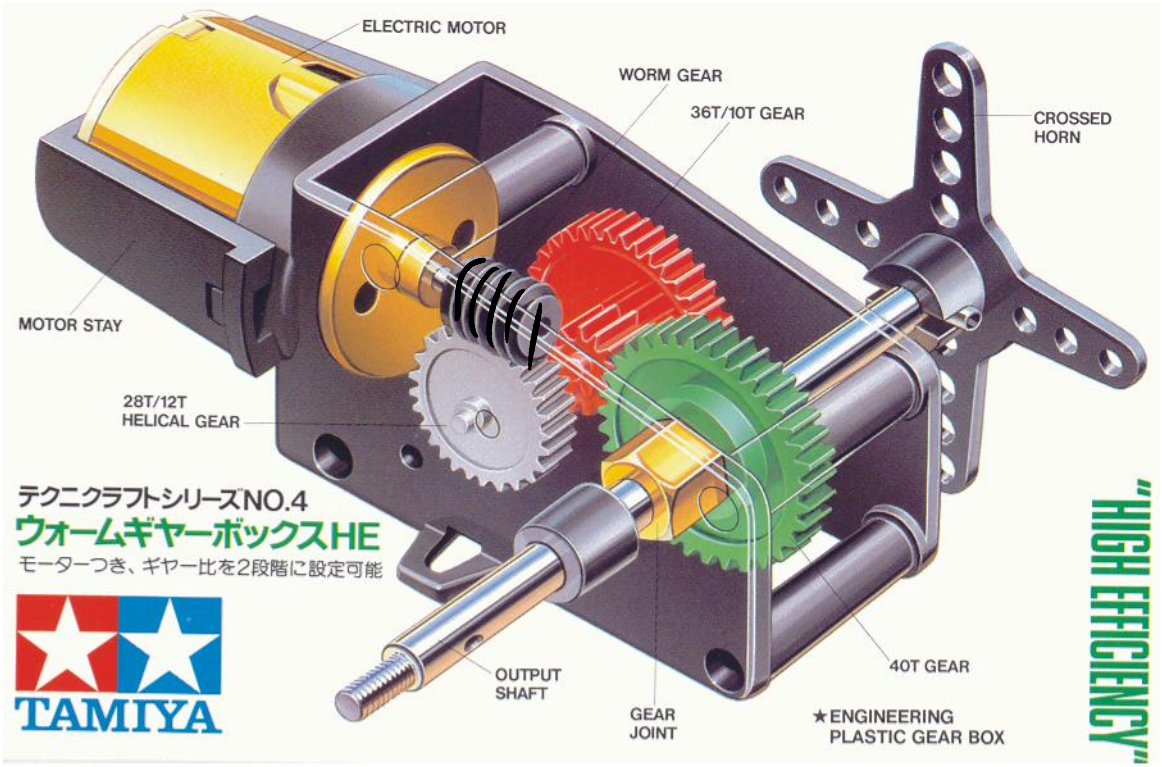
Worm Drive (1.2)

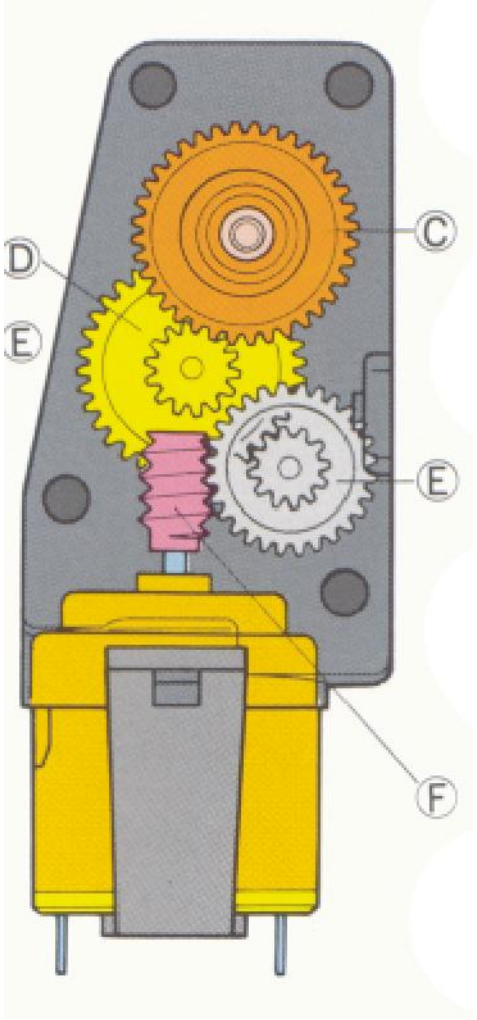


very high gear ratio's

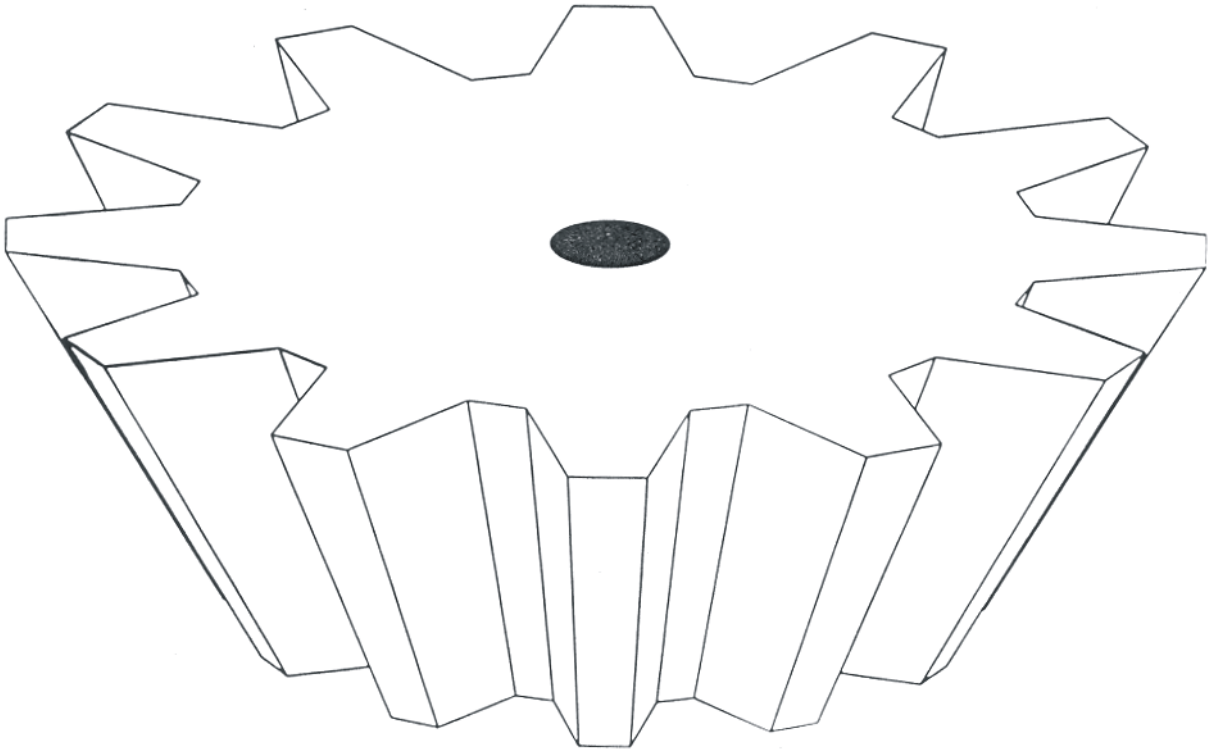
not usually backdrivable
Lock in place

Worm Drive (2.2)

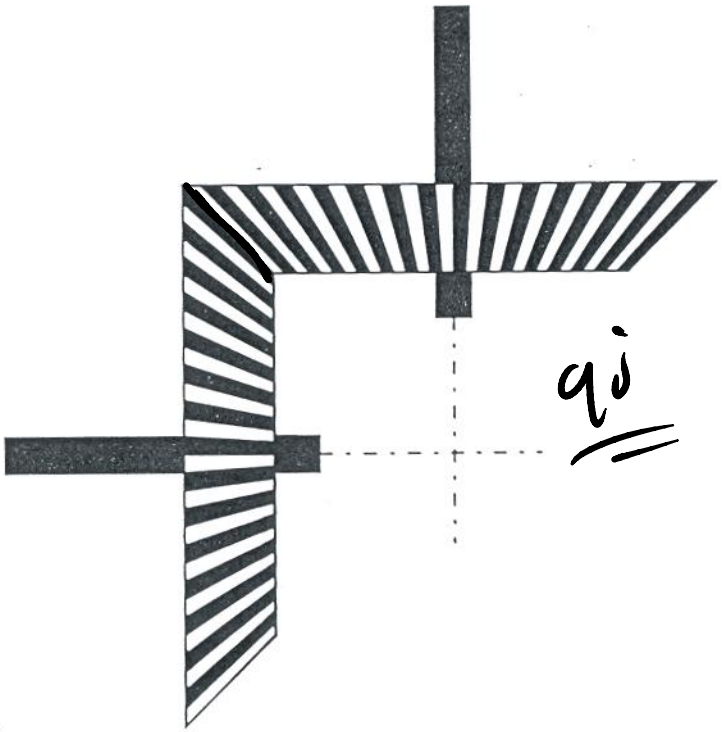


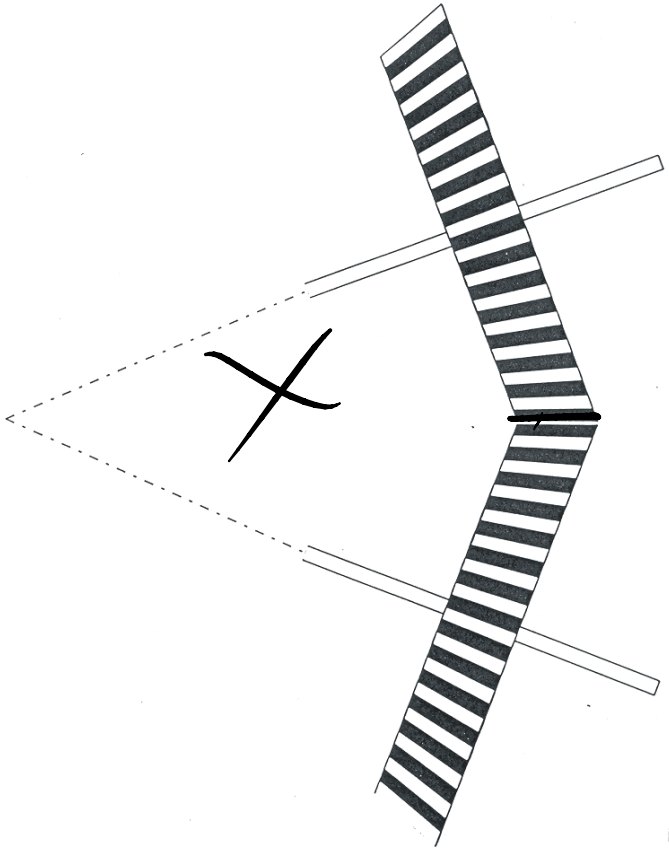


Bevel Gear

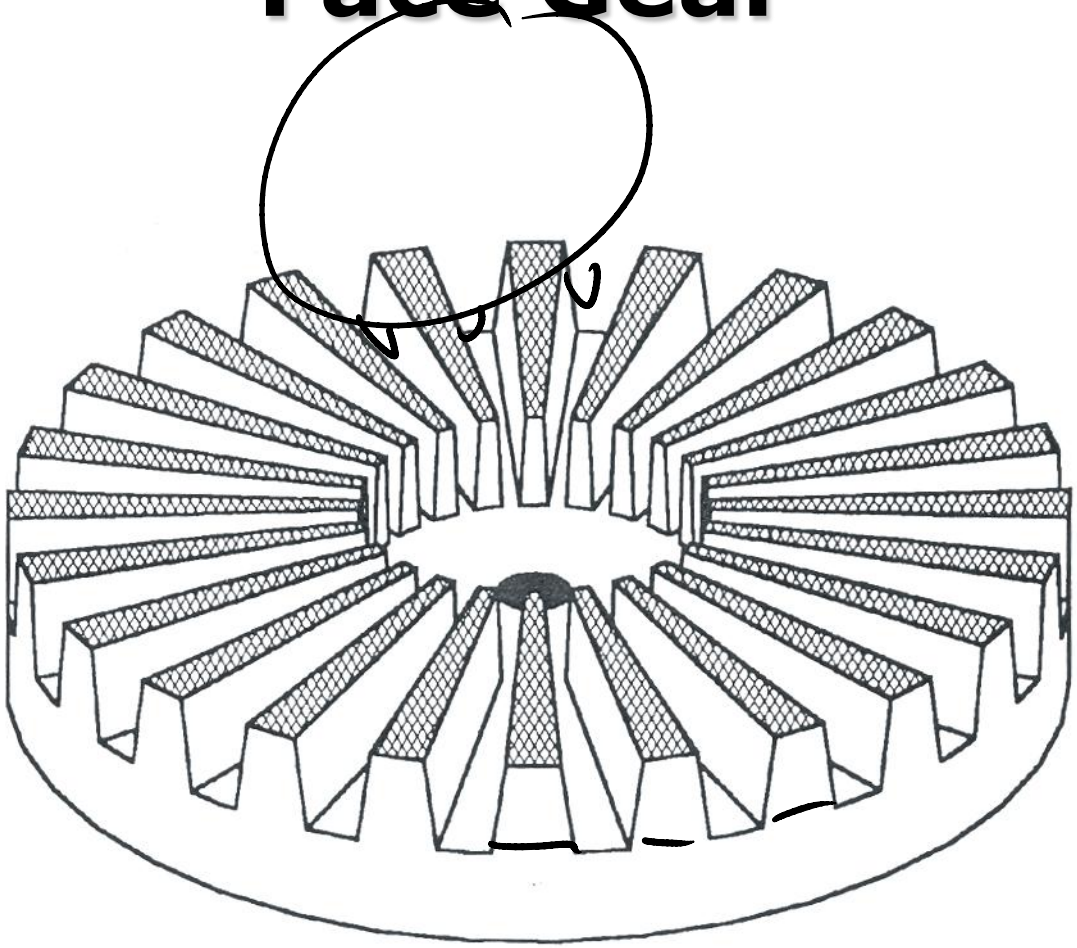


Changing Direction of the Axis of Rotation

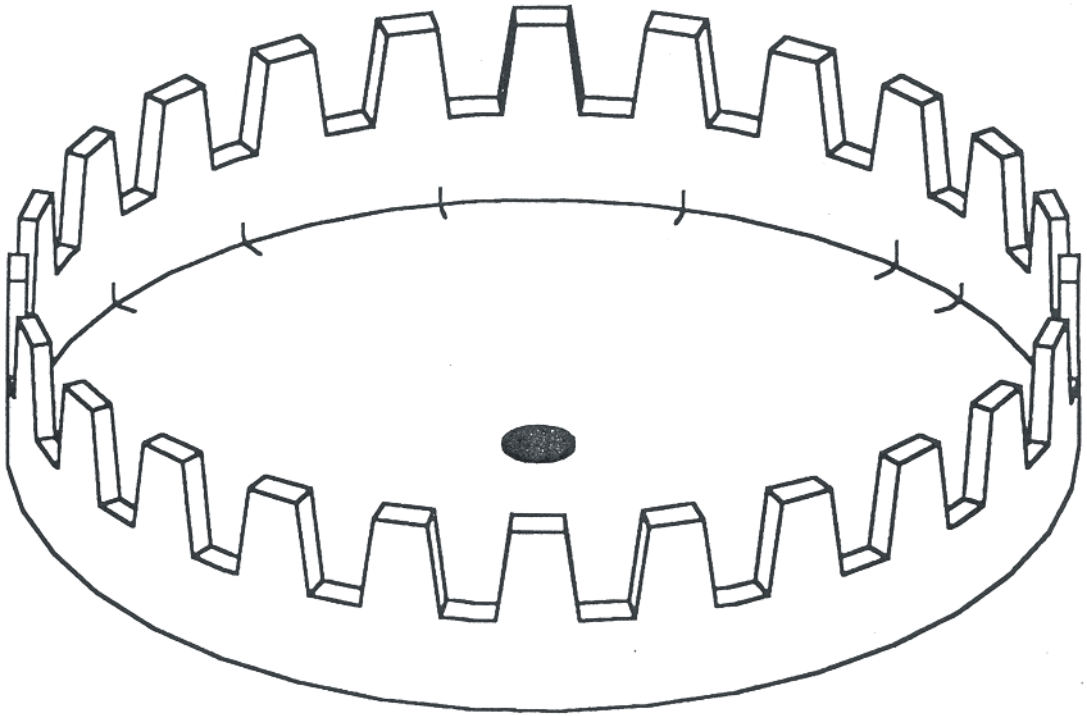




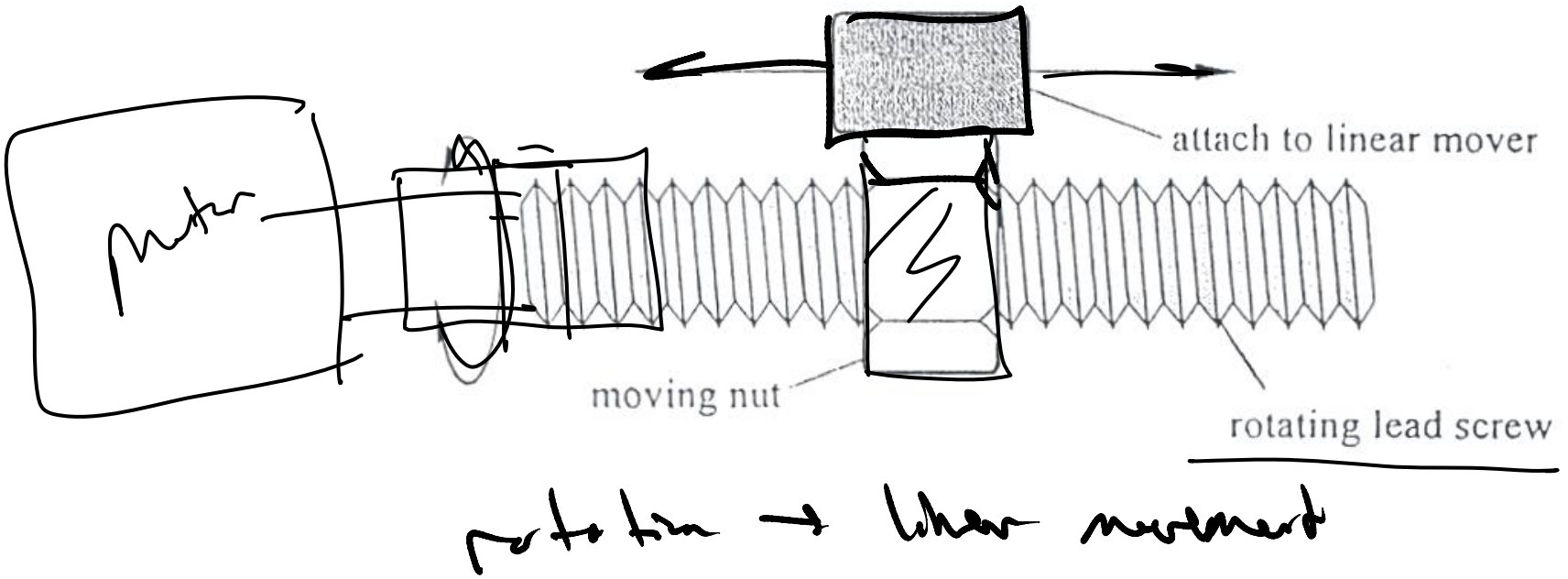
Face Gear



The Crown Gear

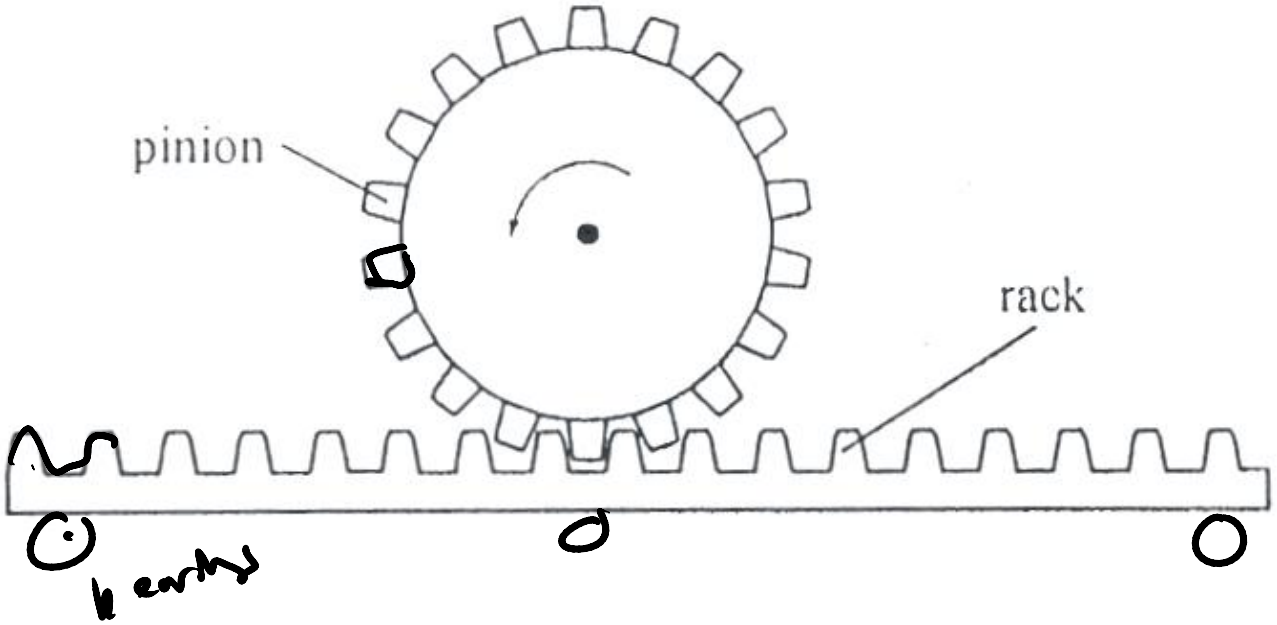


Lead Screw Drive

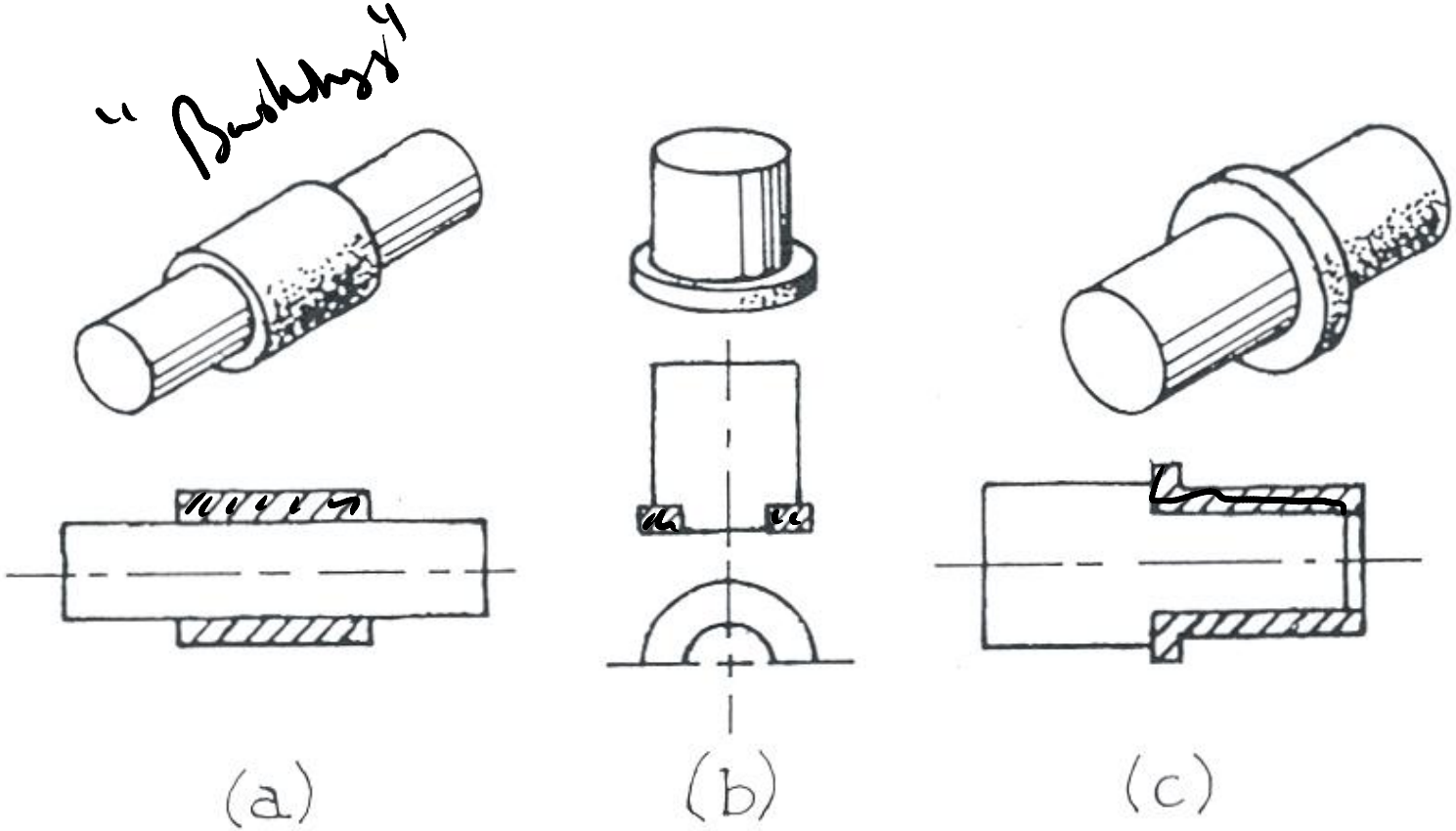


rotation → linear movement

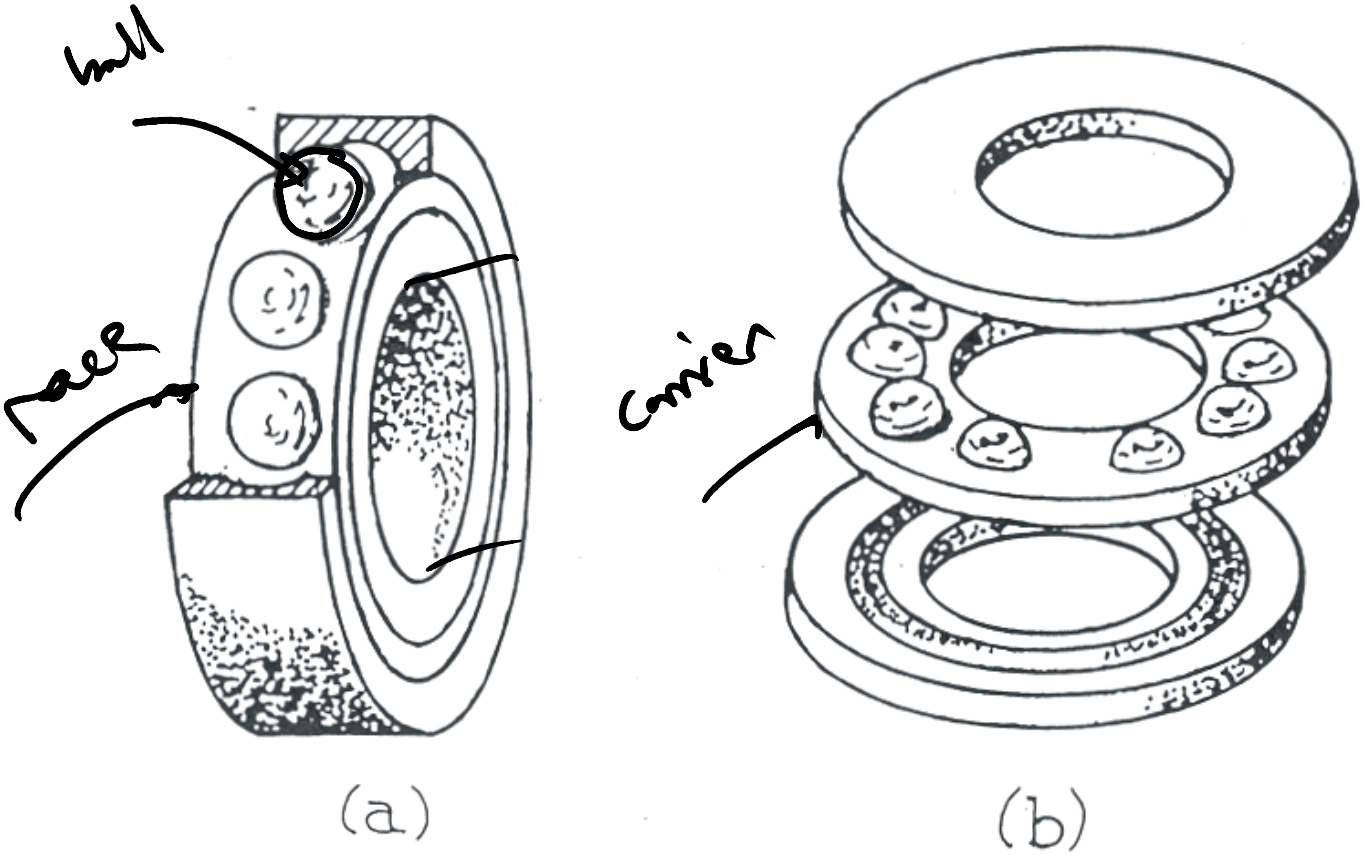
Rack and Pinion



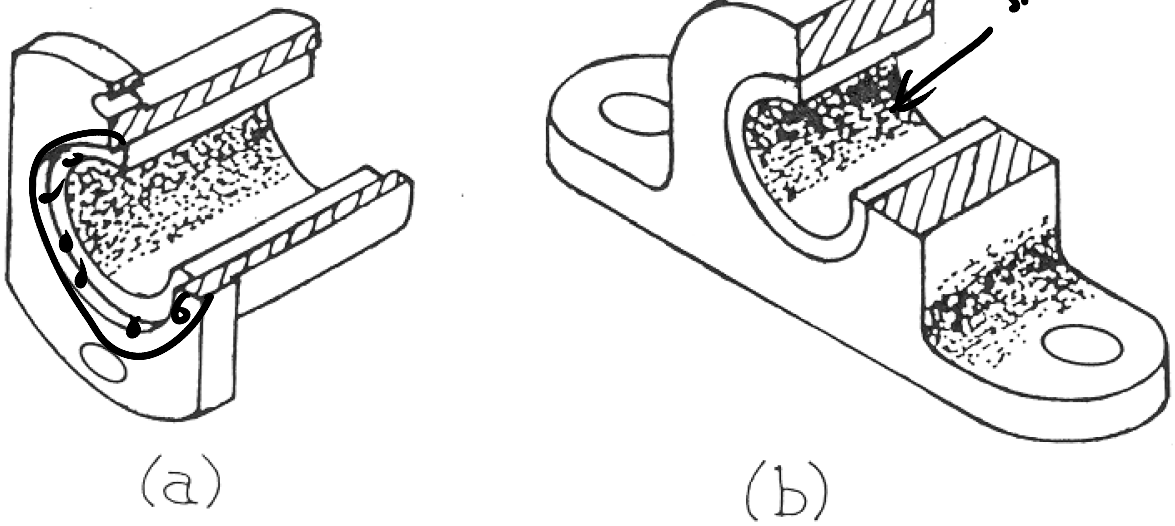
Plain Bearings



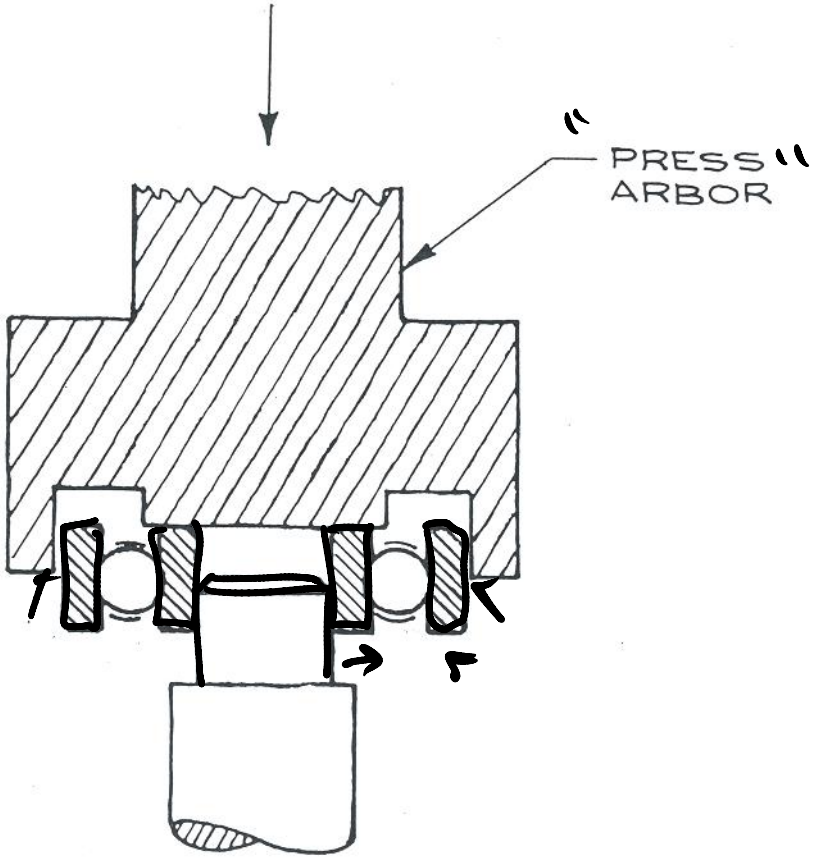
Ball Bearings



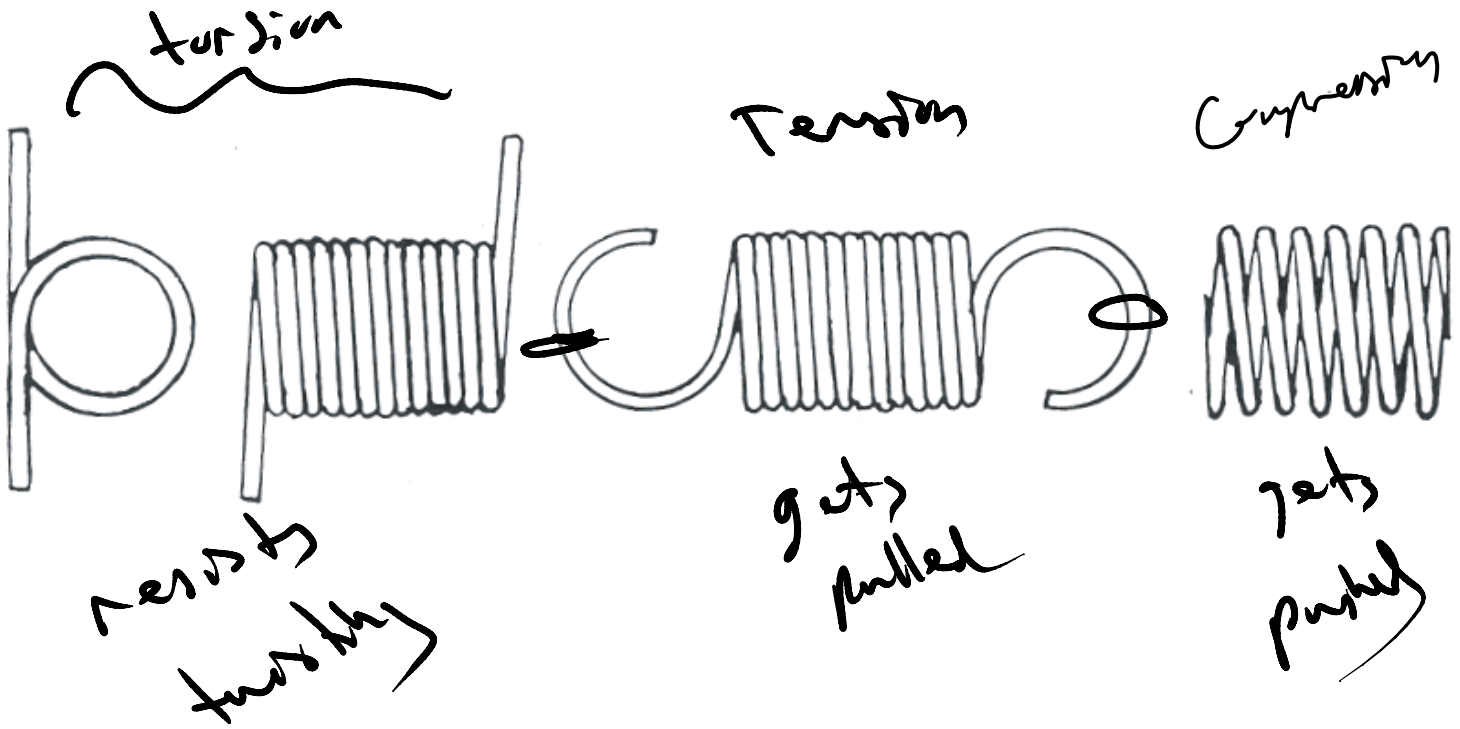
Pillow Blocks



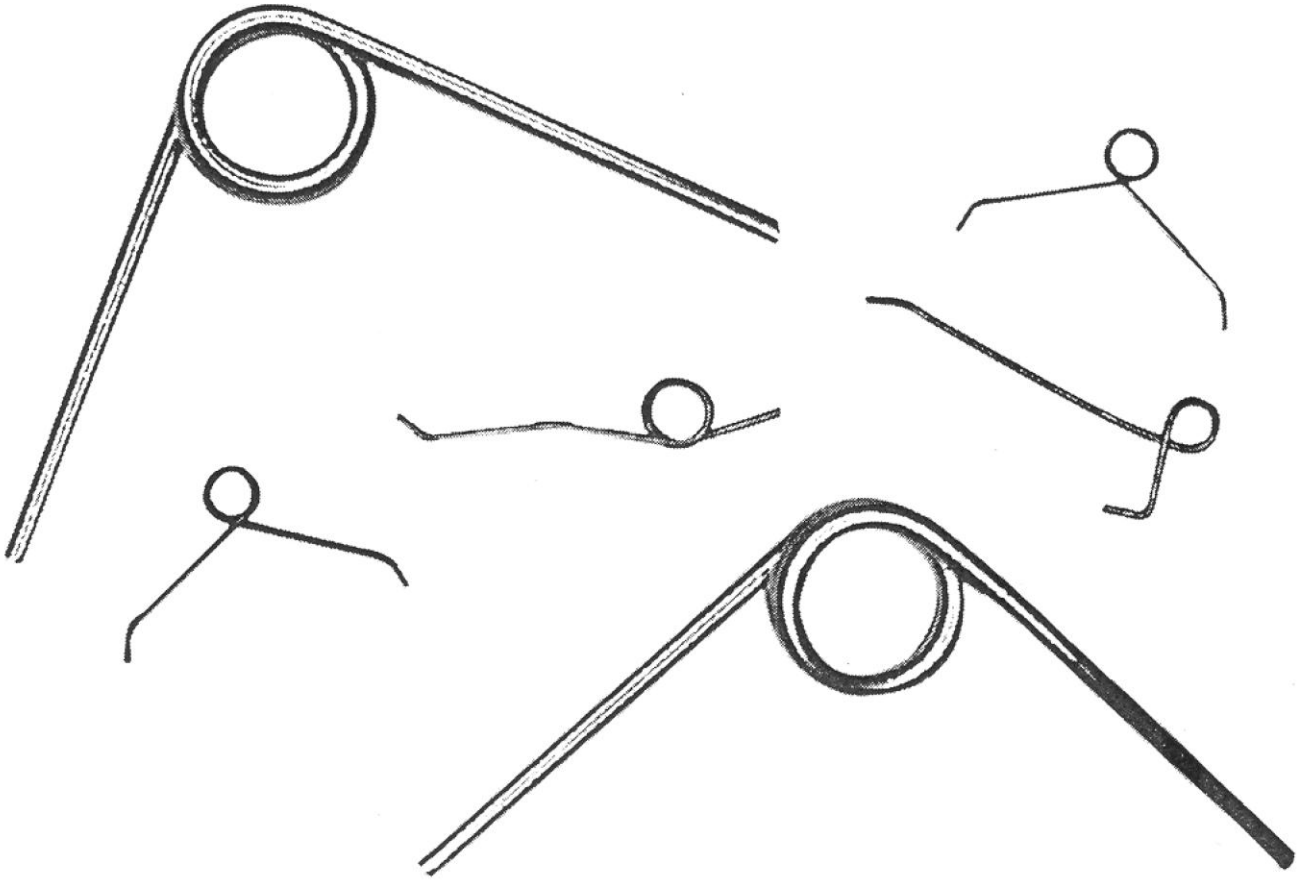
Mounting Ball Bearings



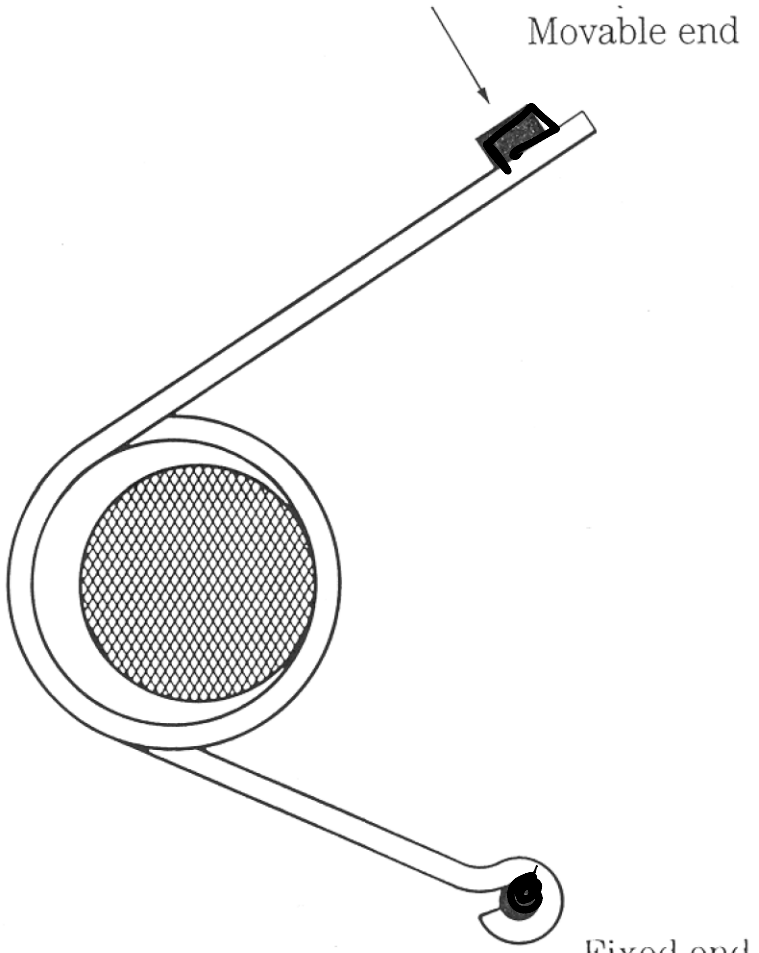
Springs


torsion
Tension
Compression
resists twisting
gets pulled
gets pushed

Helical Torsion Springs

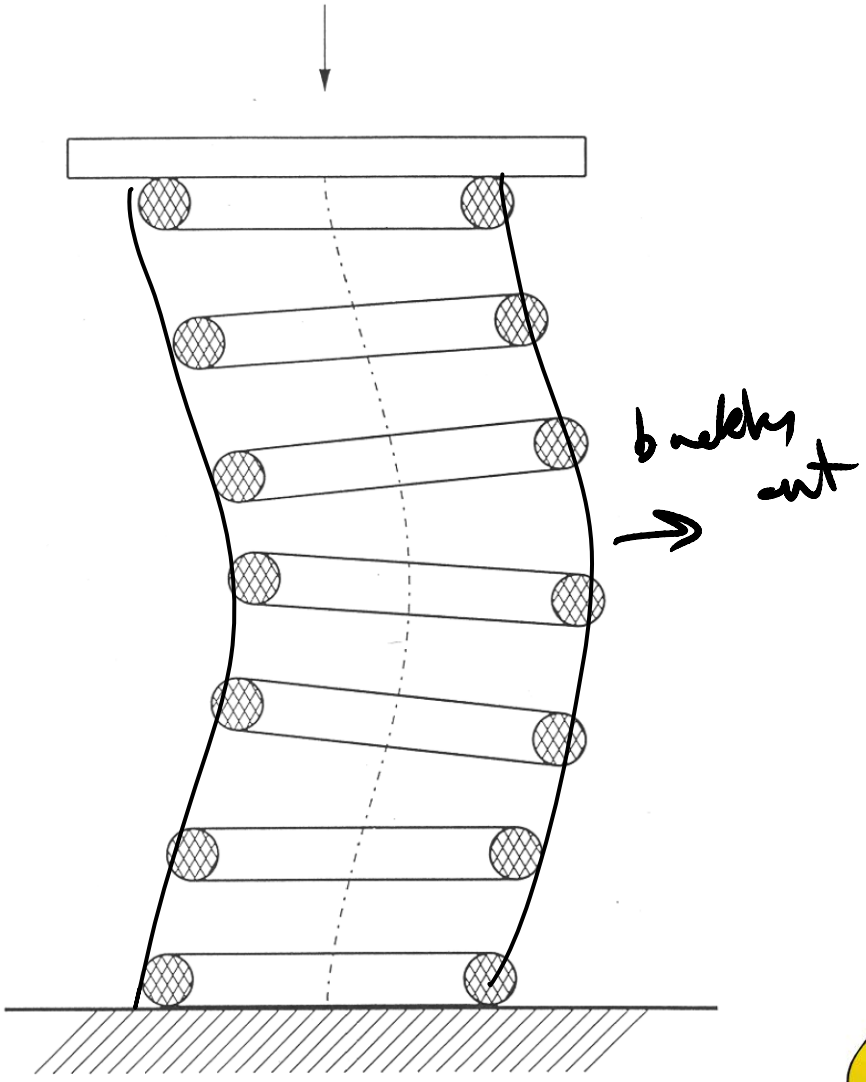


Helical Torsion Spring Installation

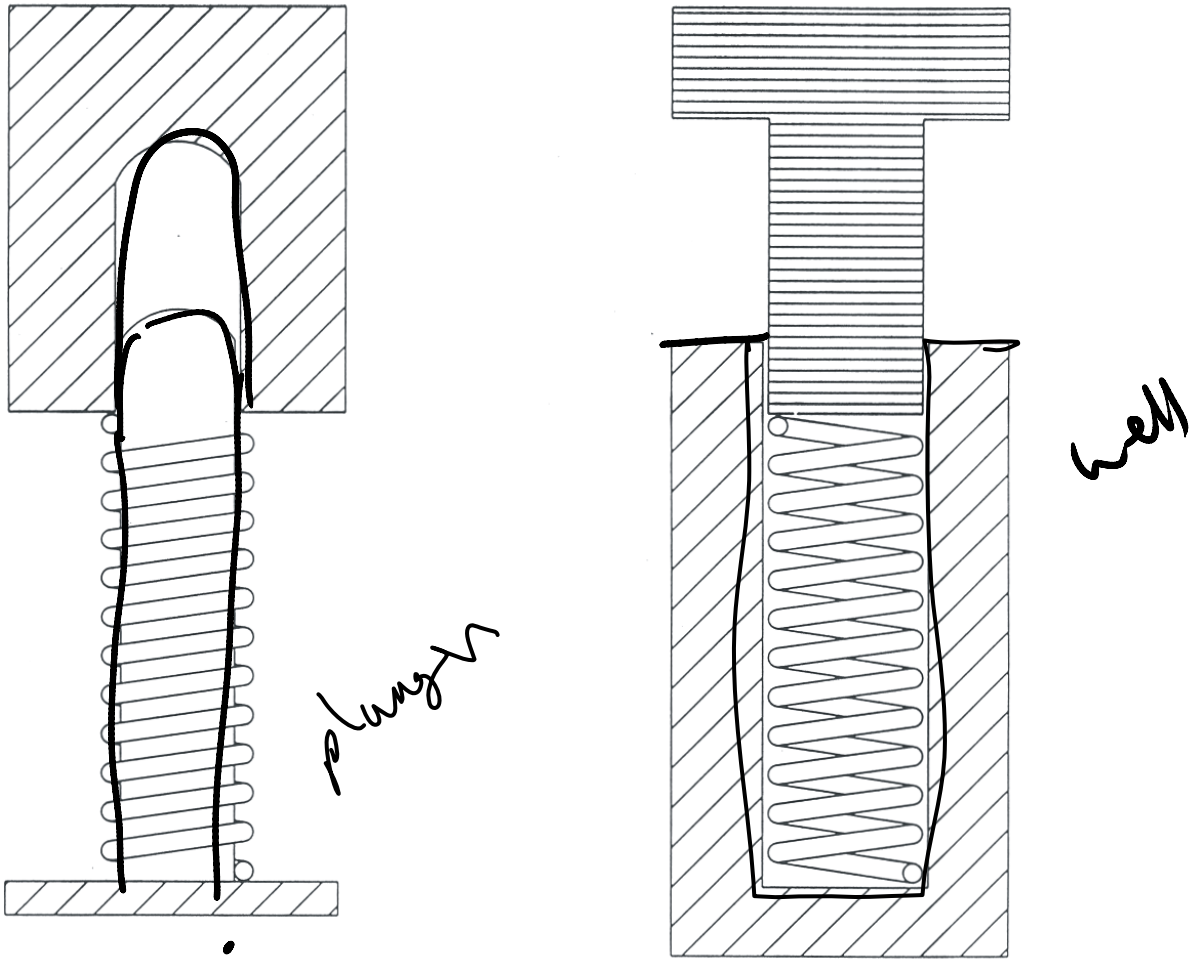


8-17
Typical installation of a helical torsion spring.

Distortion in Compression Springs



Capturing a Compression Spring



Questions?