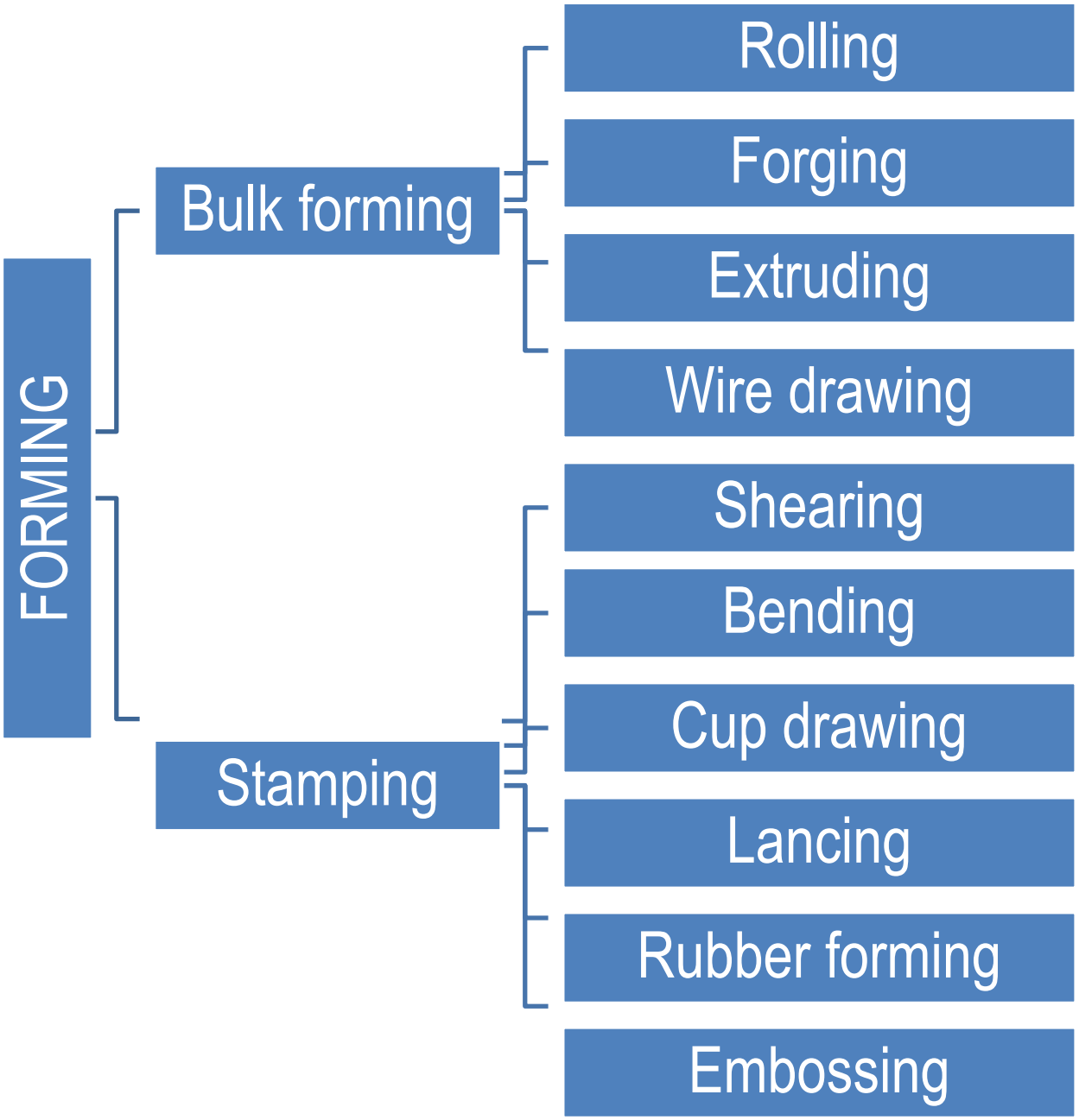
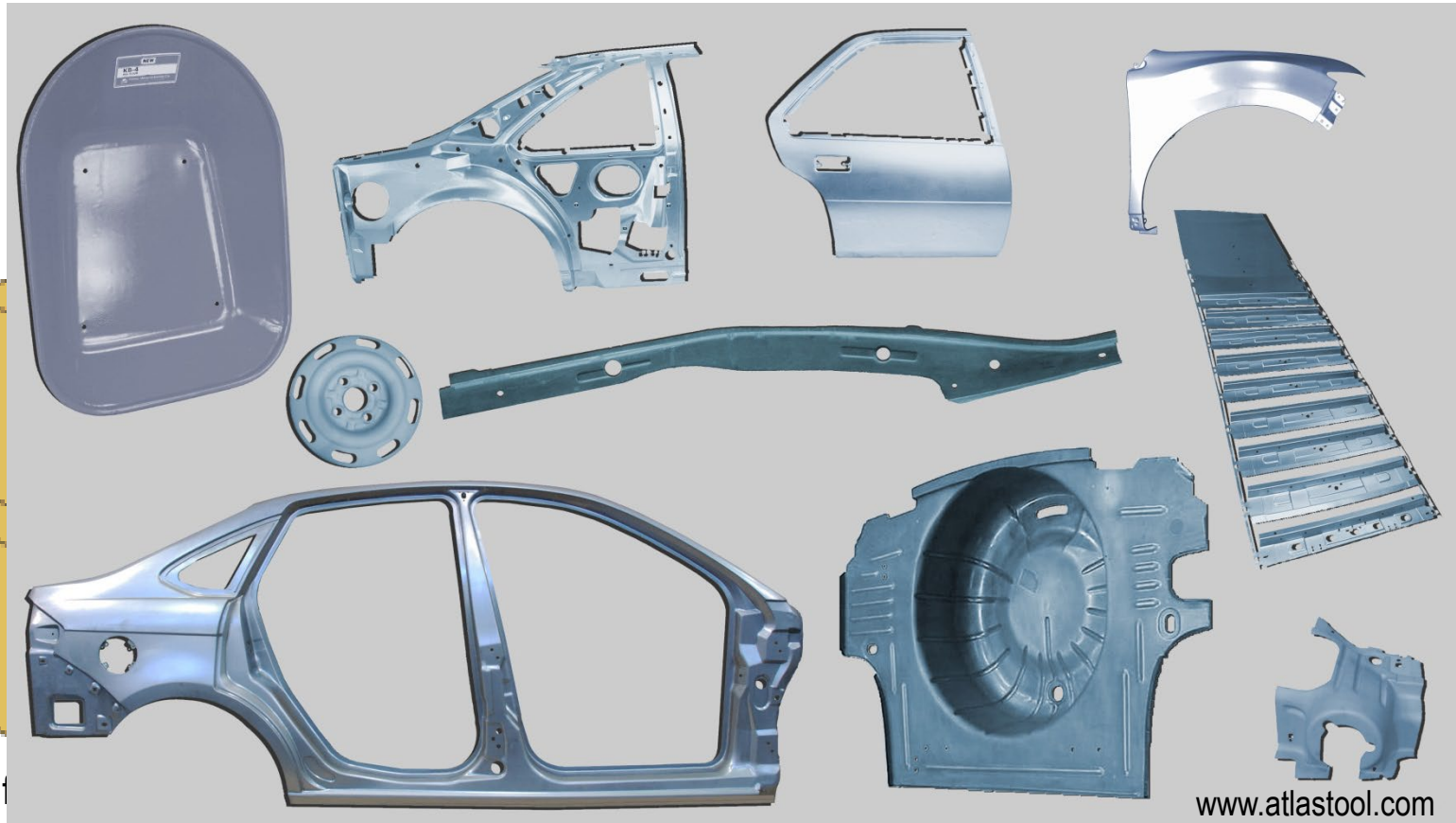
Lec 05: STAMPING

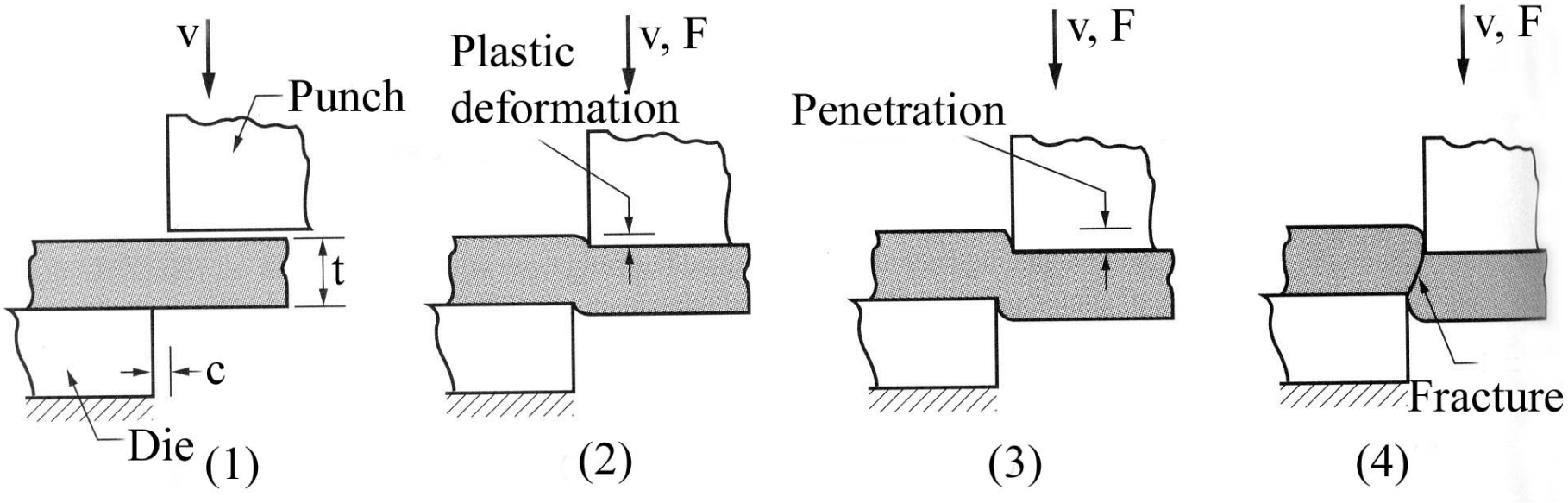

FORMING
Bulk forming
Rolling
Forging
Extruding
Wire drawing
Stamping
Shearing
Bending
Cup drawing
Lancing
Rubber forming
Embossing

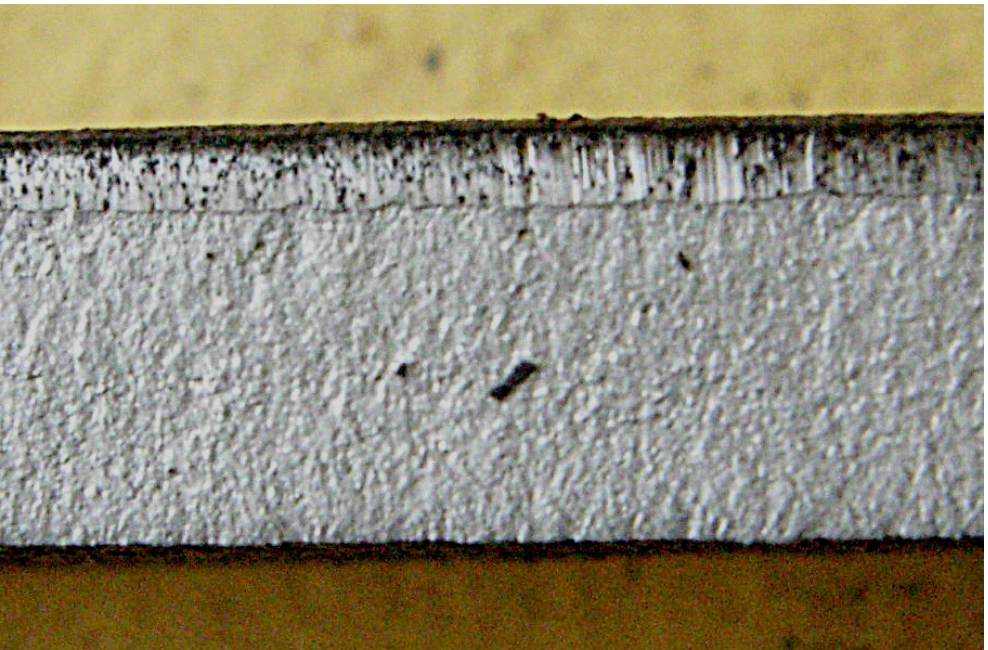
5. Stamping

	Thickness (mm)	(in)
Plate	t > 6.0	t > 0.250
Sheet	5.9 > t > 0.4	0.249 > t > 0.015
Foil	0.3 > t > 0.02	0.014 > t > 0.000,8



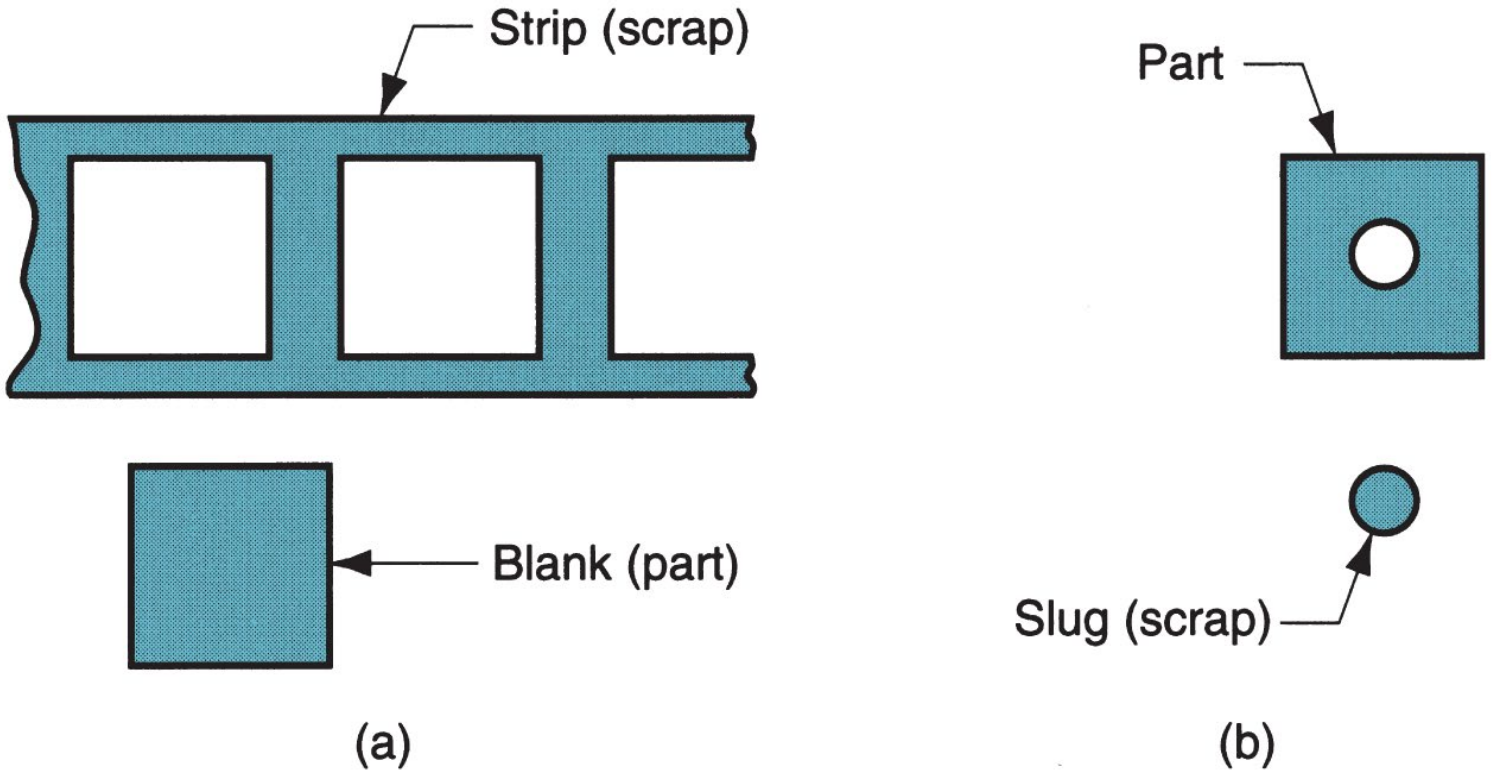
5.1 Stamping: shearing





Sheared zone

Fractured zone

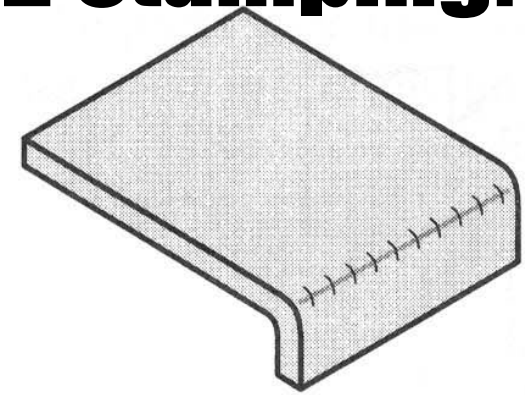

Strip (scrap)
Blank (part)
(a)
Part
Slug (scrap)
(b)

Shearing analysis: force F? power P?

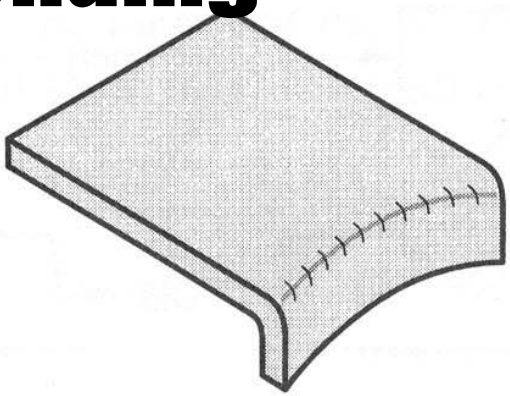
$$P = FV \quad (\text{since F//V})$$

Fs: shearing force
As: sheared area
Ss: shear strength
Su: tensile strength
P: power
v: speed

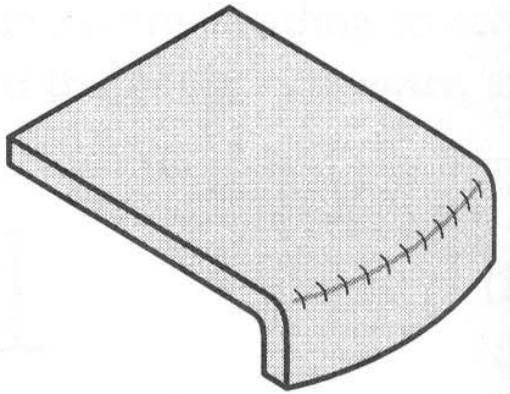
5.2 Stamping: bending



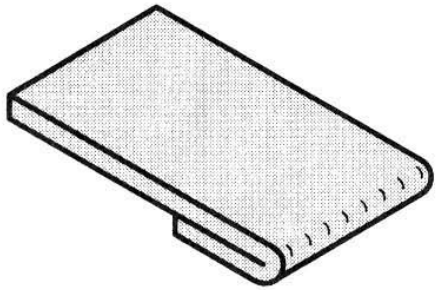
Straight flanging



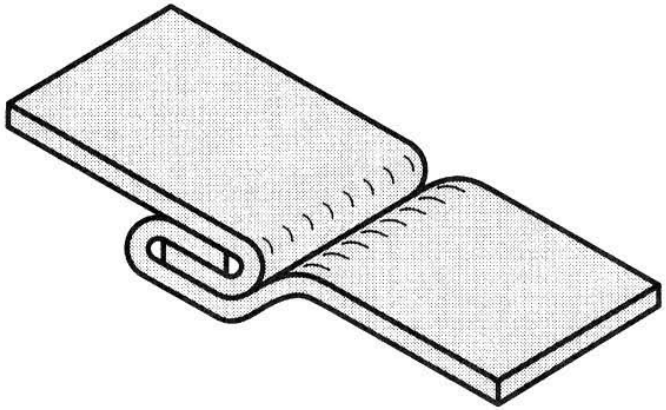
stretch flanging



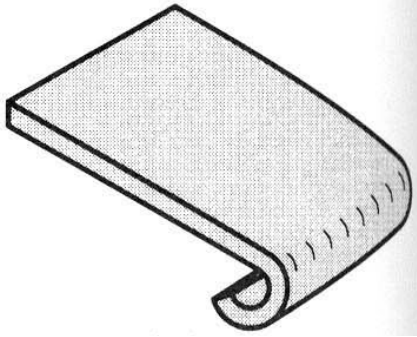
shrink flanging



Hemming

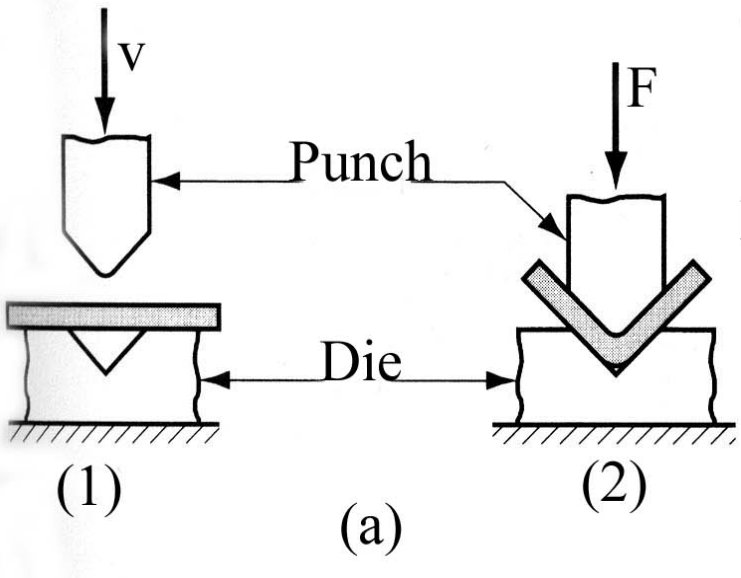


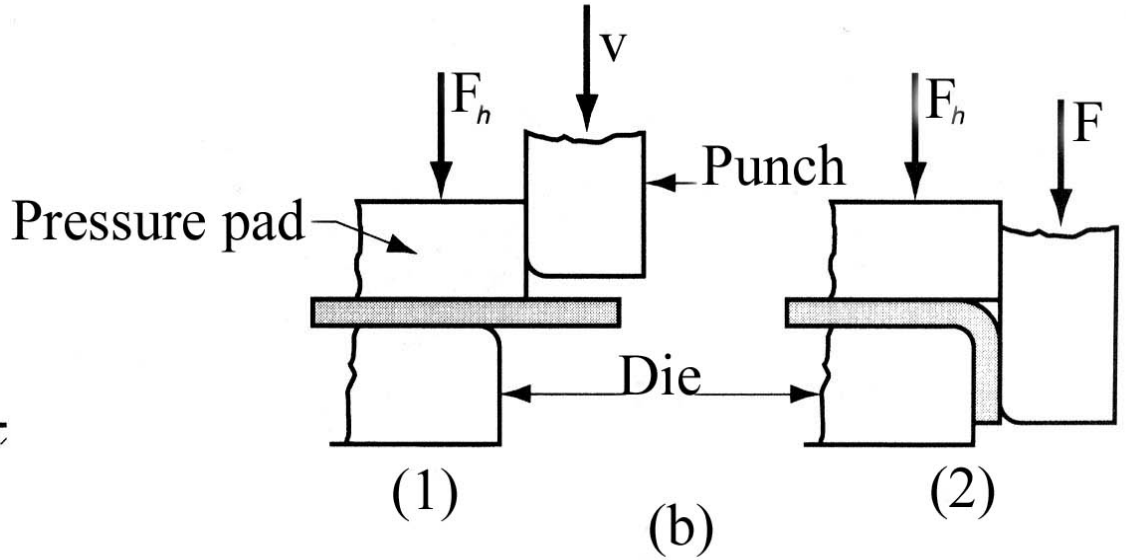
seaming



curling

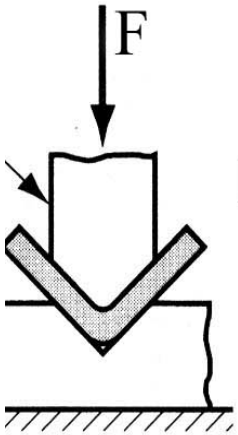
5.2 Stamping: bending

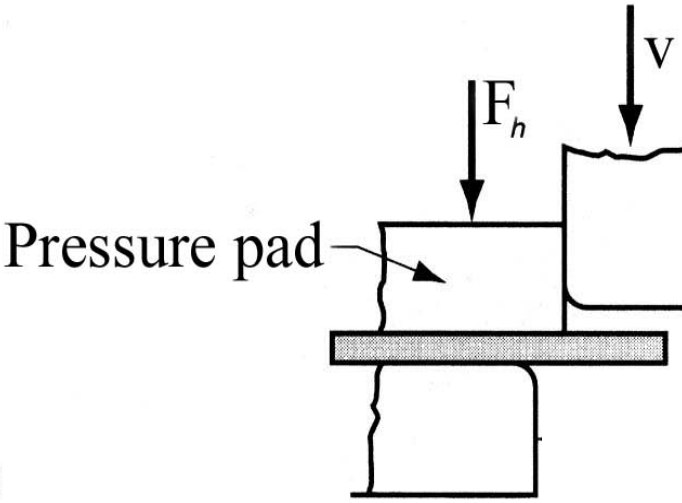




Bending analysis:

shearing force F, power P?





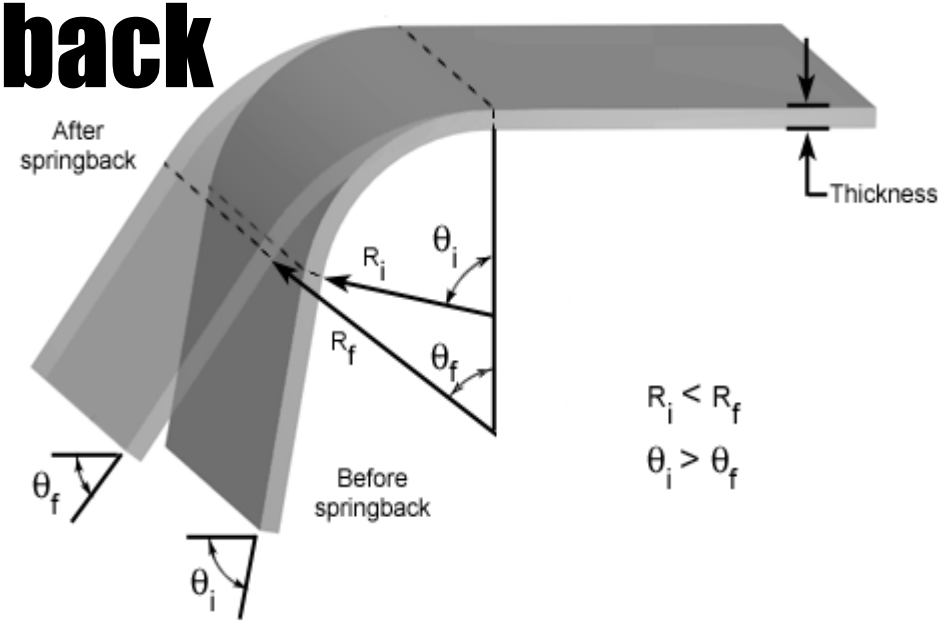
$$P = FV \qquad (\text{since F//V})$$

$$F = \frac{KS_u w t^2}{D}$$

F: bending force
S_u: tensile strength
w: sheet width
t: sheet thickness
D: die opening
K: constant

5.2 Stamping: spring back

http://riiskadesign.com/spring-back-bankers-chair



http://www.custompartnet.com/wu/sheet-metal-forming

Springback

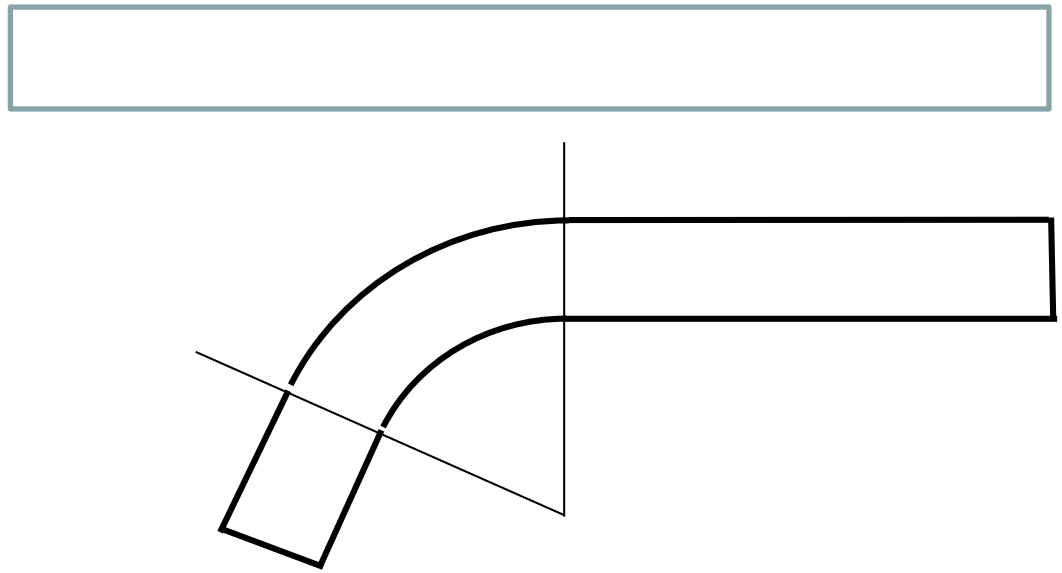
- Elastic recovery
- Unavoidable
- Correctable

Correction

- Overbending
- Bottoming
- Annealing

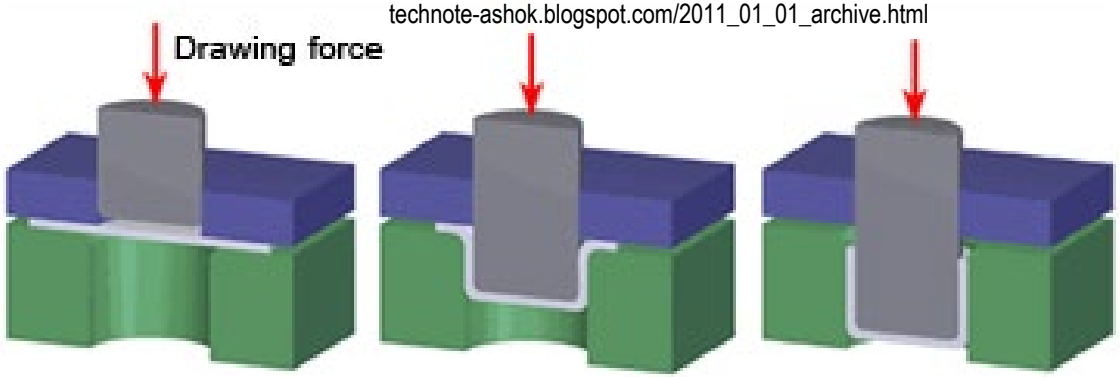
5.2 Stamping: bend allowance

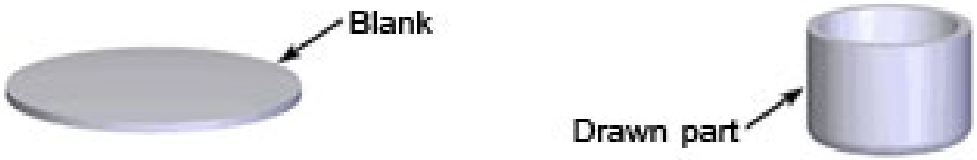
- Starting dimension before bending
- Small bending radius→ stretching rod/sheet
- Correct with bending allowance



5.3 Stamping: (cup) drawing

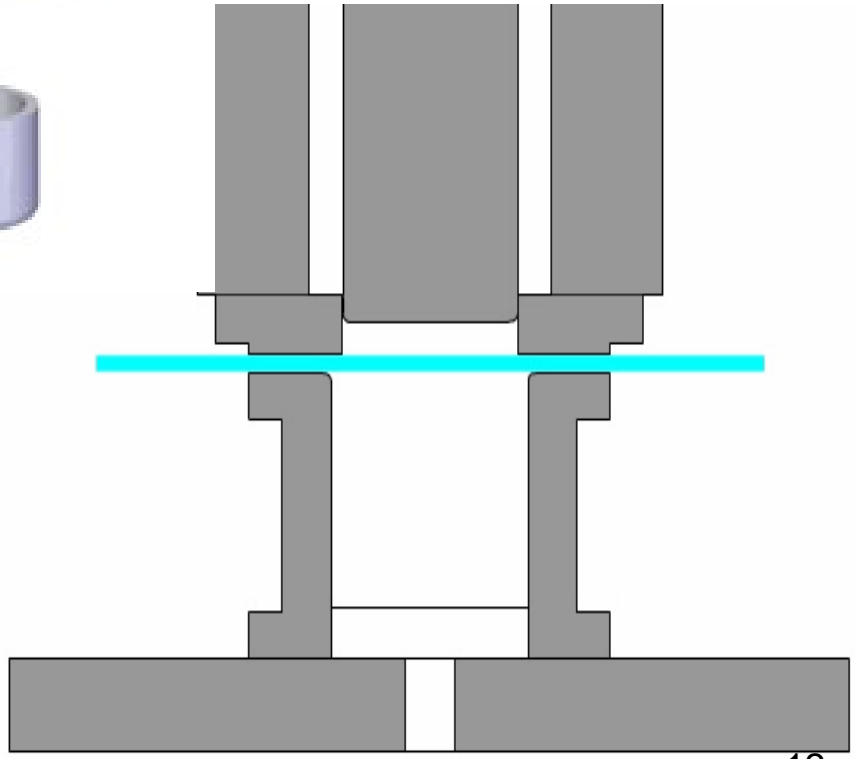
technote-ashok.blogspot.com/2011_01_01_archive.html





Video

www.ball.com



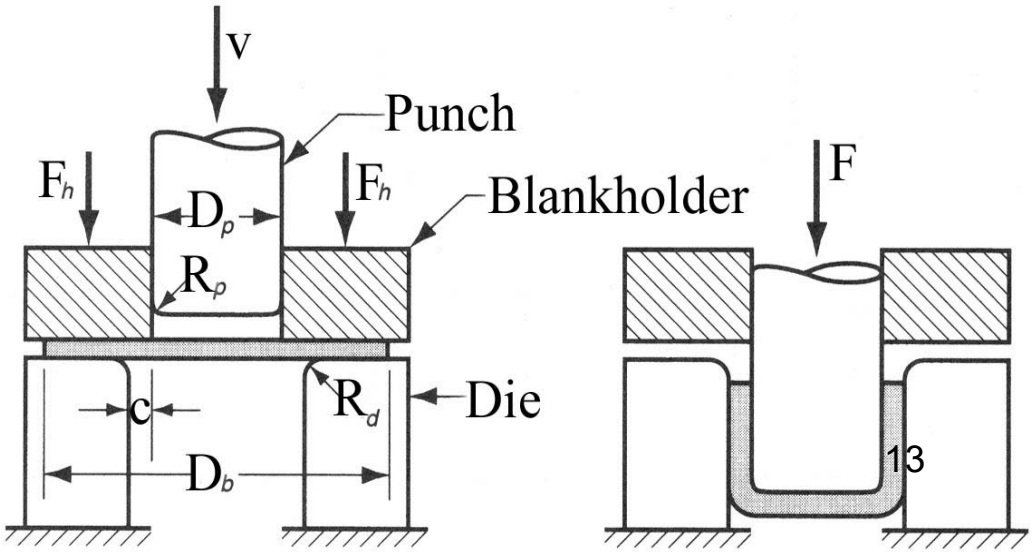
Cup drawing analysis: force F? power P?

$$F_h = 0.015\pi S_y \left[D_b^2 - \left(D_p + 2.2t + 2R_d \right)^2 \right]$$

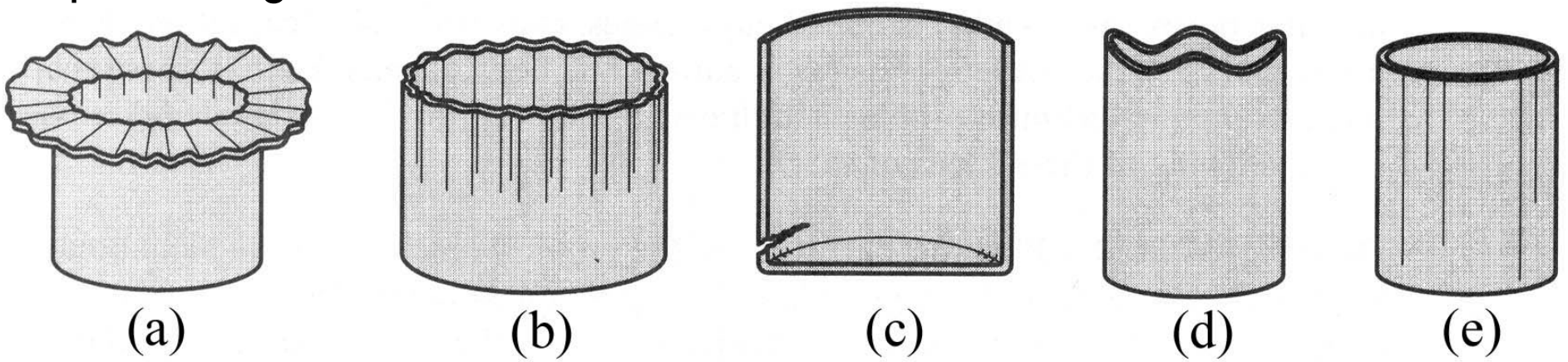
$$F = \pi D_p t S_u \left(\frac{D_b}{D_p} - 0.7 \right)$$

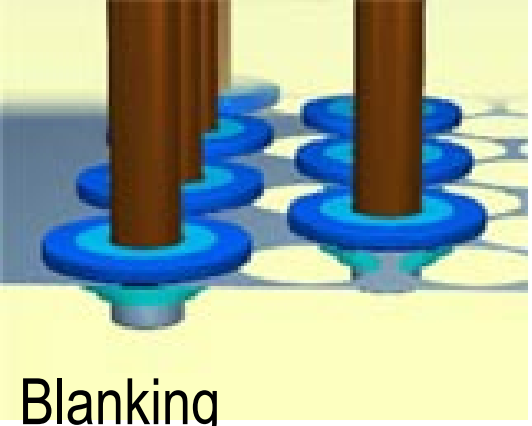
$$P = FV \quad \text{(since F//V)}$$

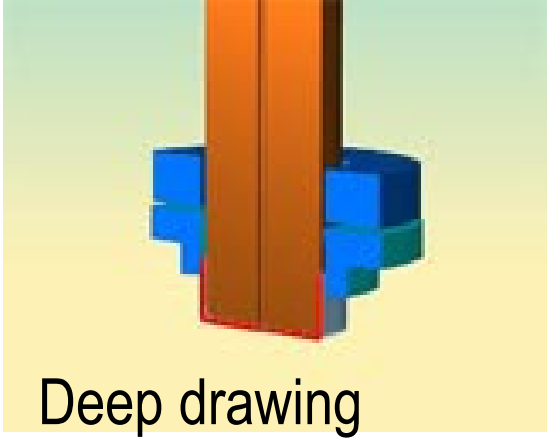
F: drawing force
F_h: holding force
S_y, S_u: yield, tensile strength
D_b, D_p: blank, punch diameter
t: sheet thickness
R_d: die radius

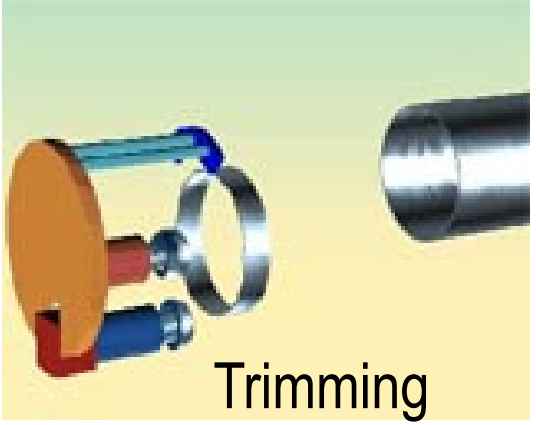


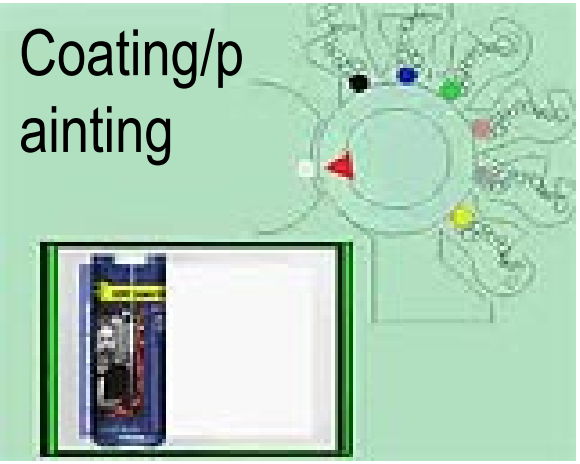
Cup drawing defects

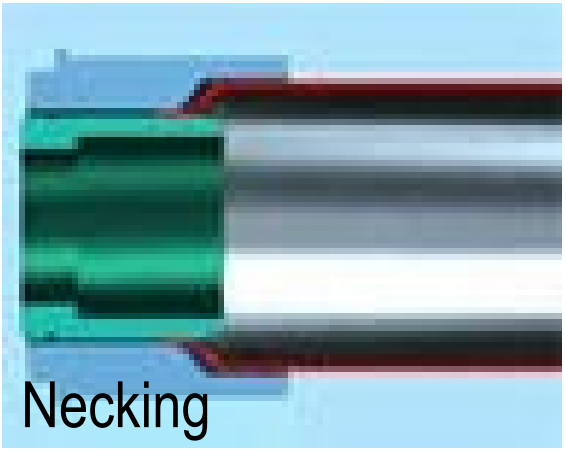


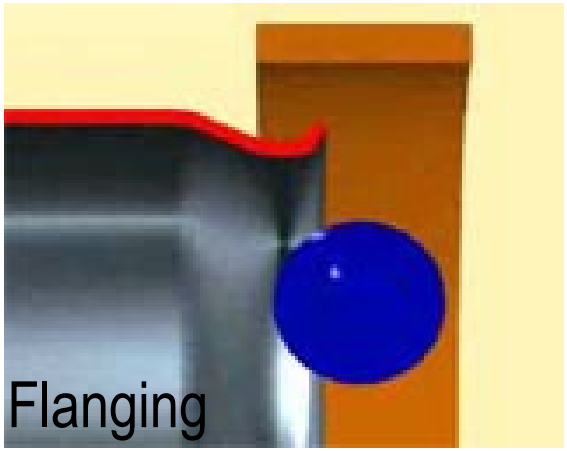

Blanking


Deep drawing

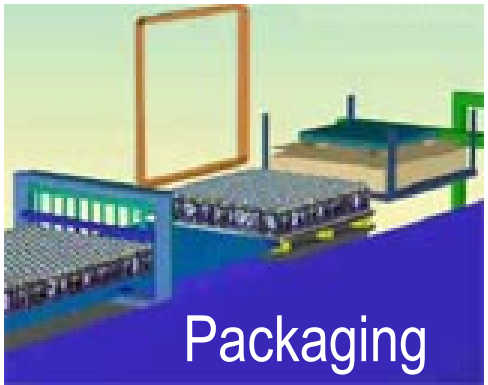

Trimming


Coating/painting


Necking

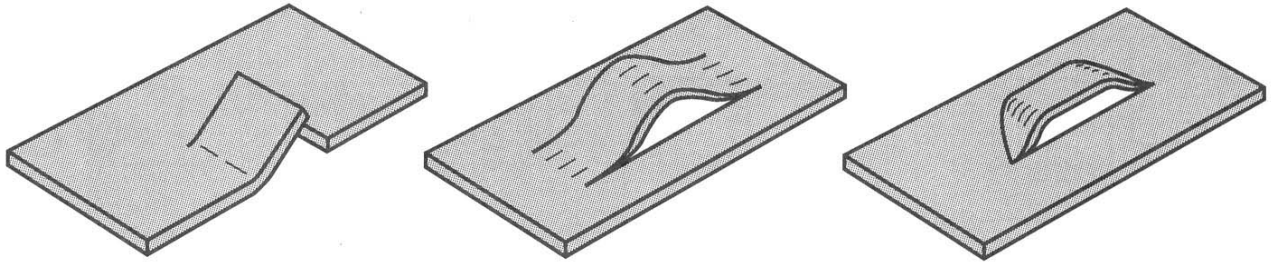

Flanging

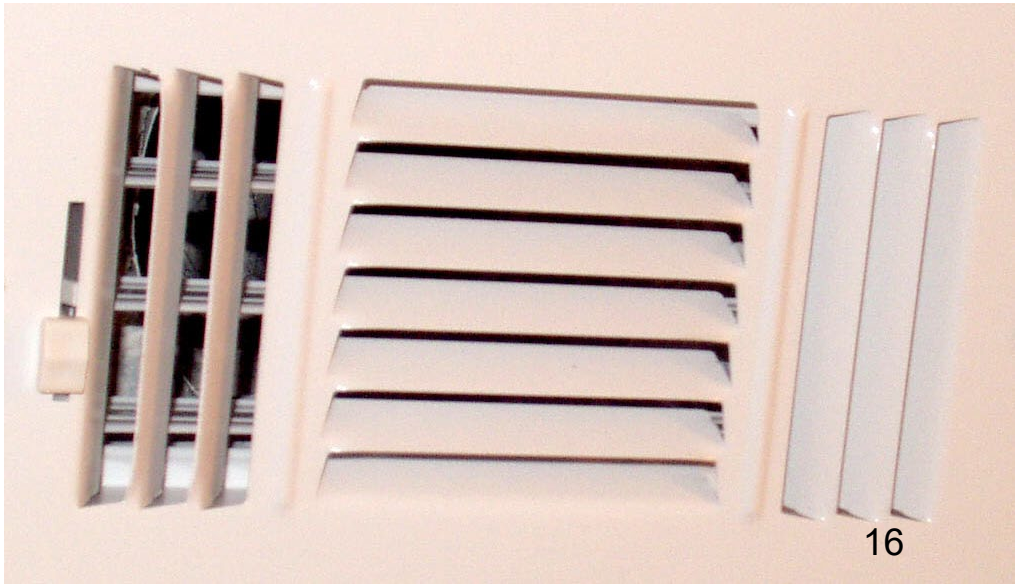

QA


Packaging

Ref.: www.ball-europe.com/382_722_ENG_PHP.html?parentid=716

5.4 Stamping: lancing

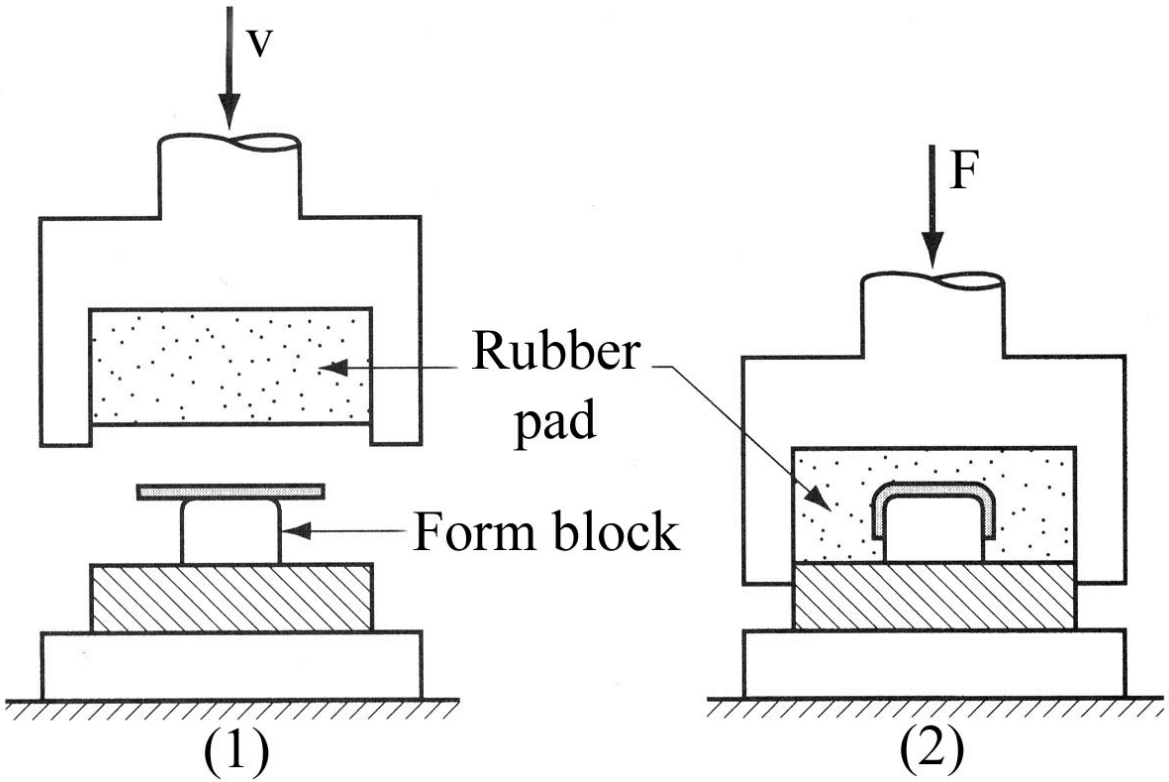




www.youtube.com/watch?v=oy4QipCtrpk

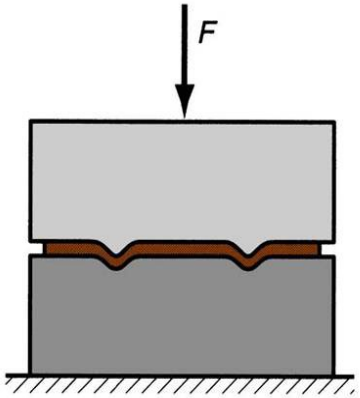
5.5 Stamping: rubber (Guerin) forming

- ✓ Simpler than cup drawing, forging, lower cost, prototyping
- – Wear/tear of rubber, simple shape only, thin sheet only

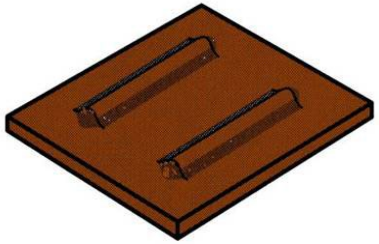


5.6 Stamping: embossing

- To deform and form raised/indented features on thin sheet.
- Another version of forging, rolling, or cup drawing

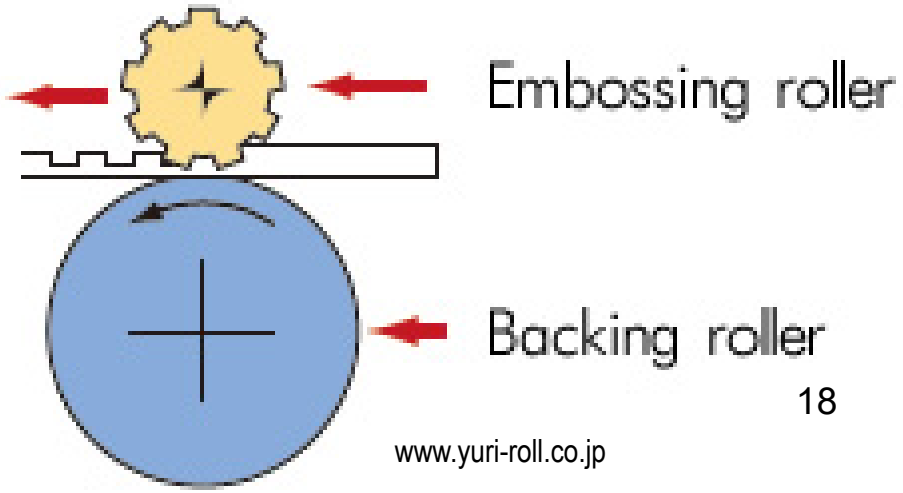


(a)



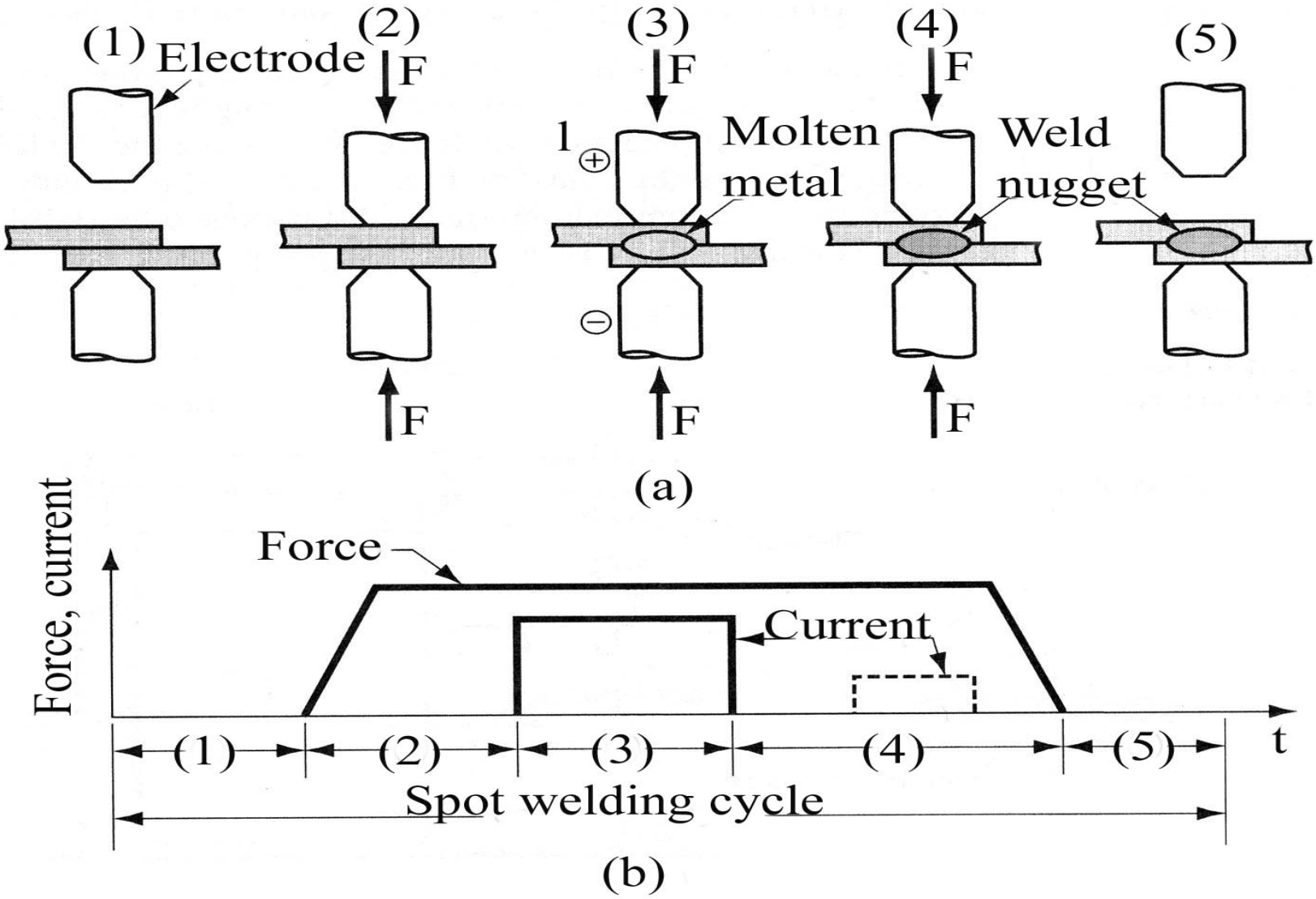
(b)

www.quia.com

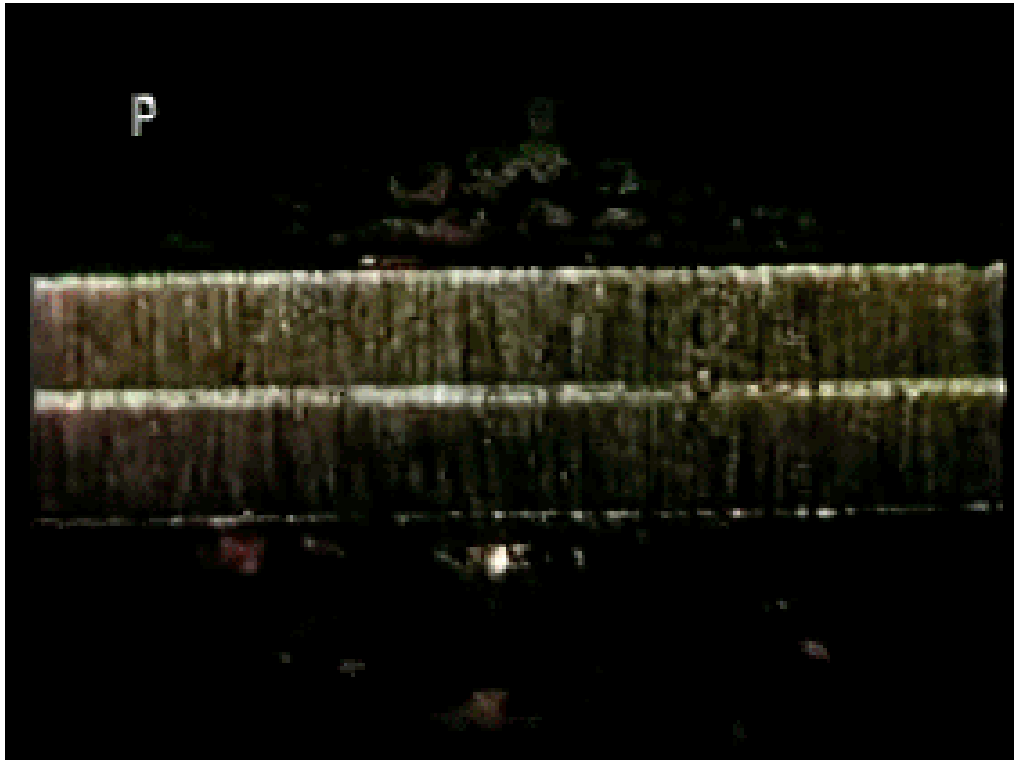


www.yuri-roll.co.jp

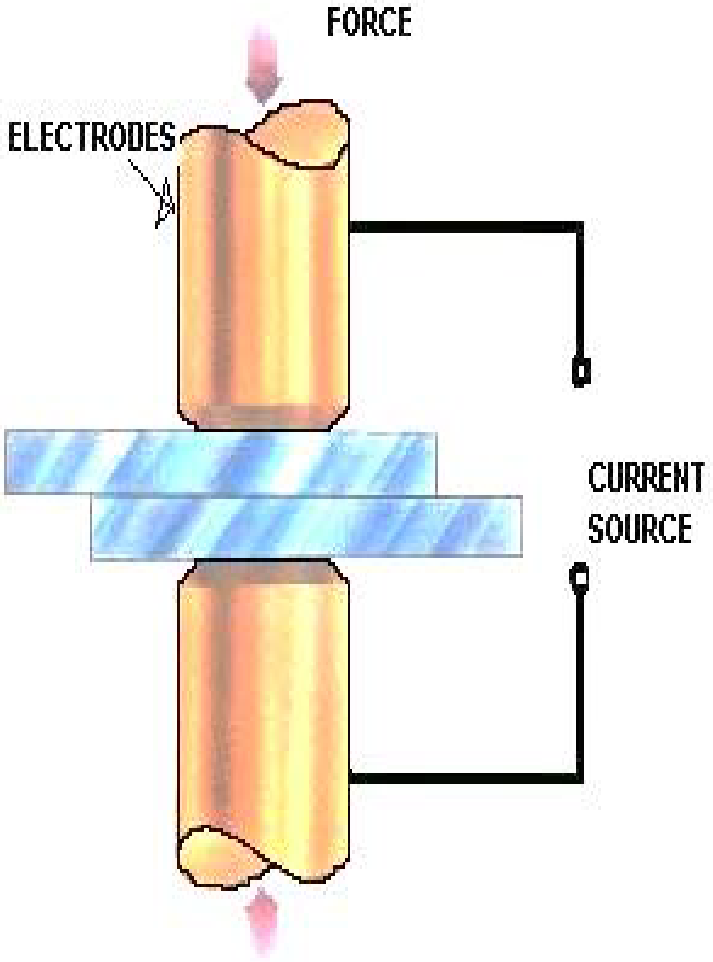
Fusion: Resistance welding



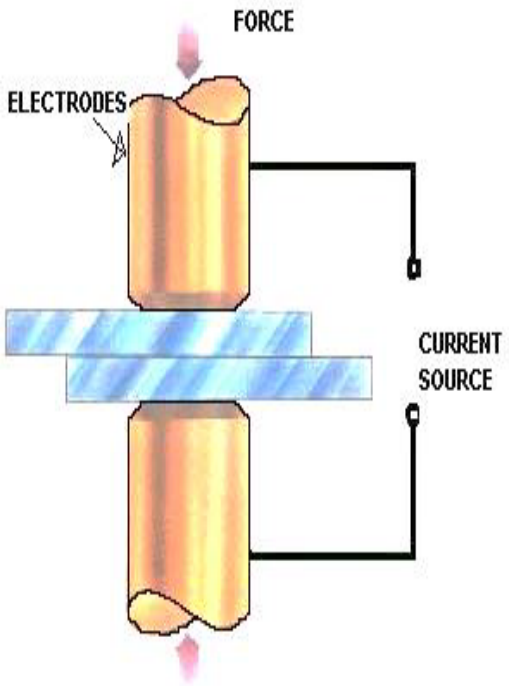
Fusion: Resistance welding



Source: http://www.forwel.com/e_technical.htm



Fusion: Resistance welding

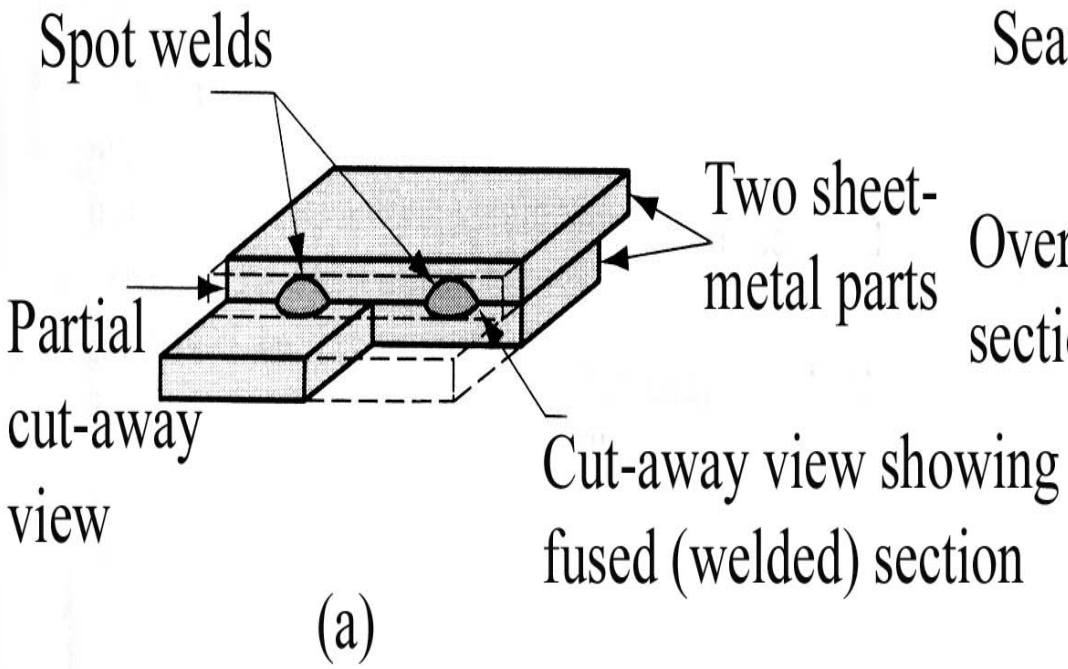


- Energy for welding
  $E_w = \varepsilon P\, t = \varepsilon(RI^2)\, t$
- Steel interface has highest R at same current, time → highest E_w → melts first

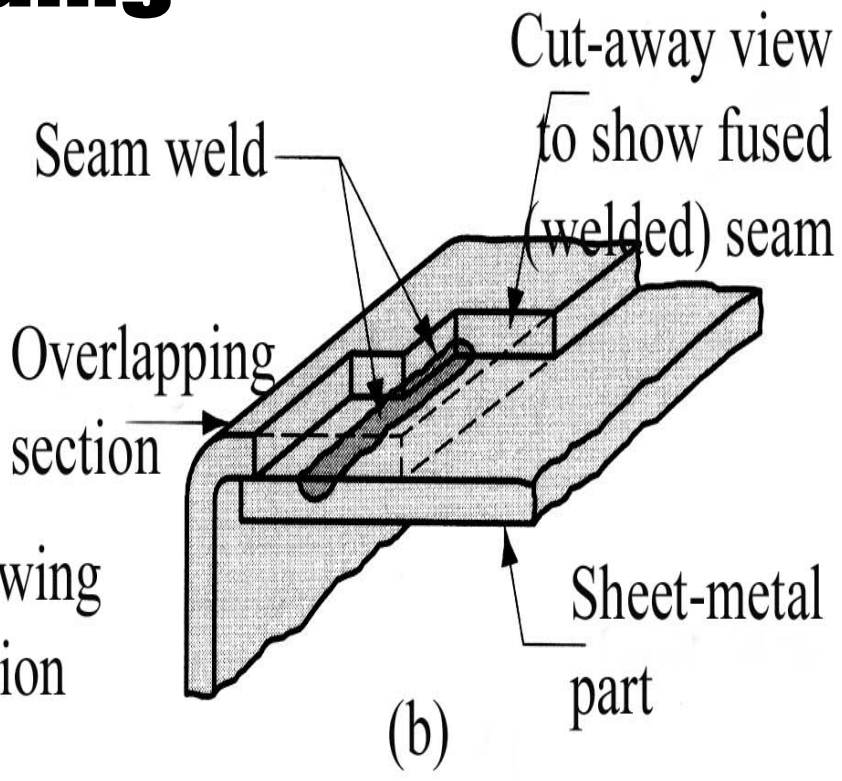

No shielding gas, no filler, mass production…


Conductive materials, hard to weld corner, limit to metal sheets…

Fusion: Resistance welding

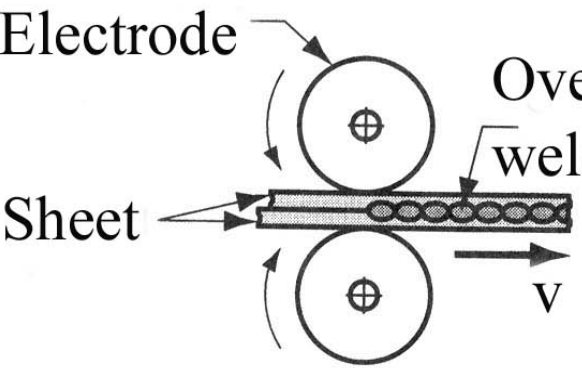


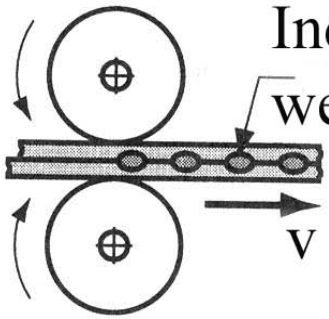
Resistance spot welding

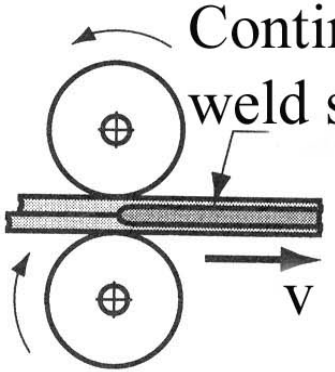


Resistance seam welding

Fusion: Resistance welding







https://www.youtube.com/watch?v=0L7Xk5_s3QQ