transformers:

losses RI^2 ($I \downarrow$), losses $\downarrow$

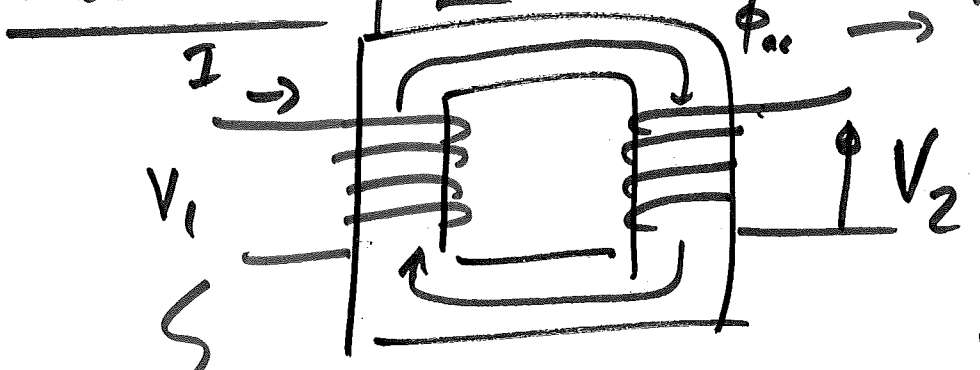
$P \longrightarrow$ far away $\quad P = VI\cos(\theta_V - \theta_I)$

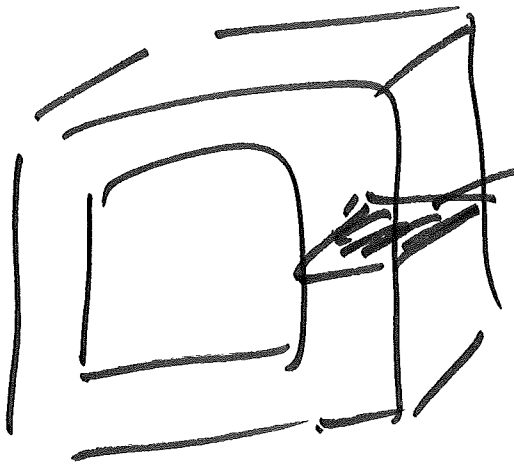
$P = \mathrm{Re}(\bar{V}\bar{I}^*)$

Step up the voltage $V \uparrow$, $I \downarrow$ for the same power transmitted!

Gen, Motors, **transformers.** ✓ OK.

Ideal transformers:

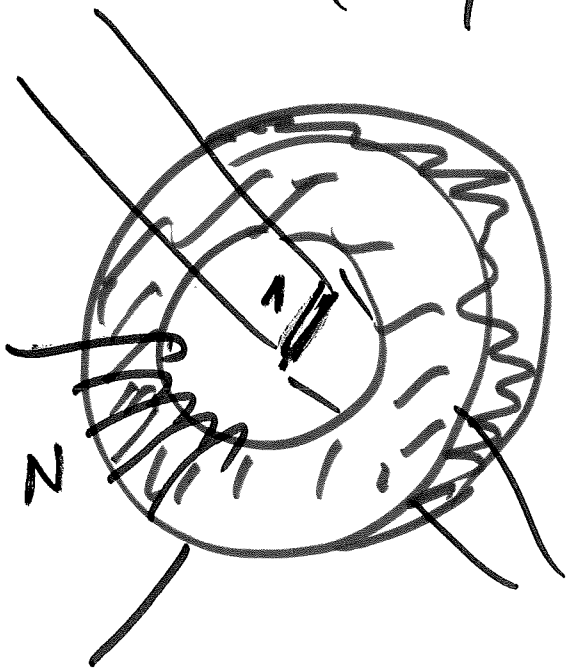


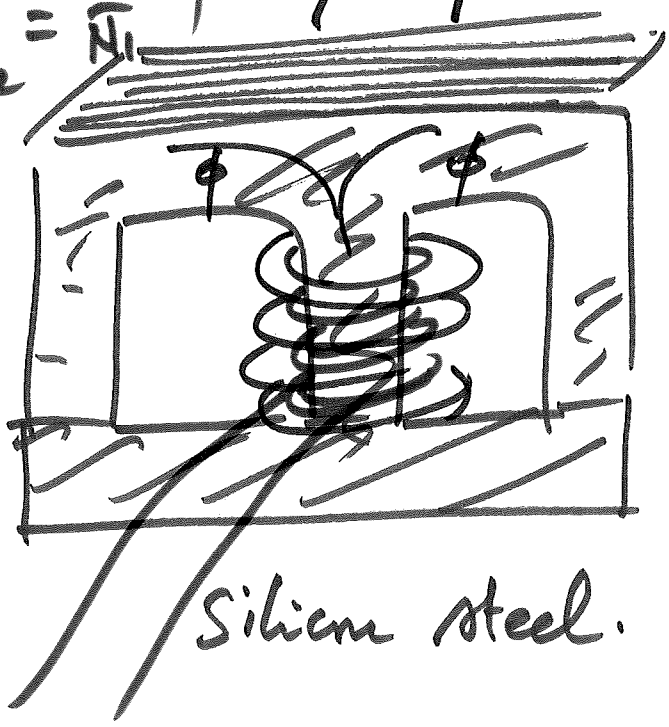


$$N_1 \bar{I}_1 = N_2 \bar{I}_2$$

$$\left(\frac{\bar{V}_1}{\bar{V}_2} = \frac{N_1}{N_2}\right)$$

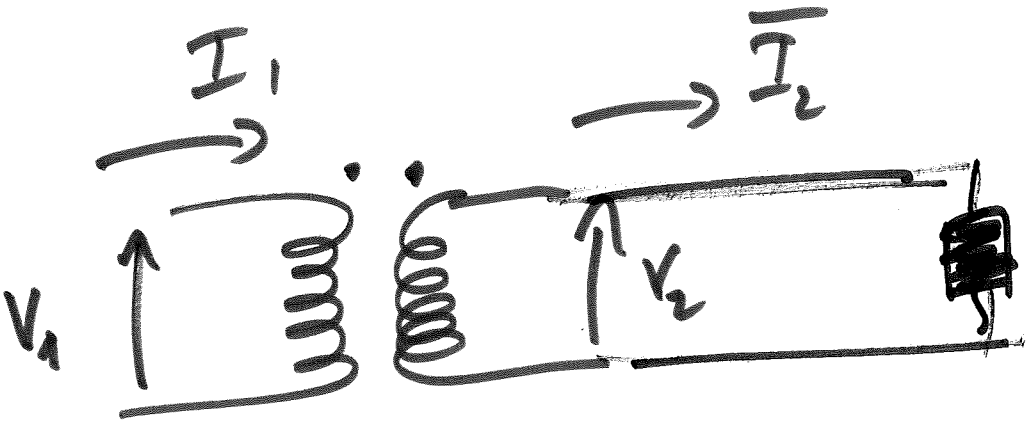
$$\left(\frac{\bar{V}_1}{N_1}\right) = \left(\frac{\bar{V}_2}{N_2}\right) \left(\frac{\bar{I}_1}{\bar{I}_2} = \frac{N_2}{N_1}\right)$$

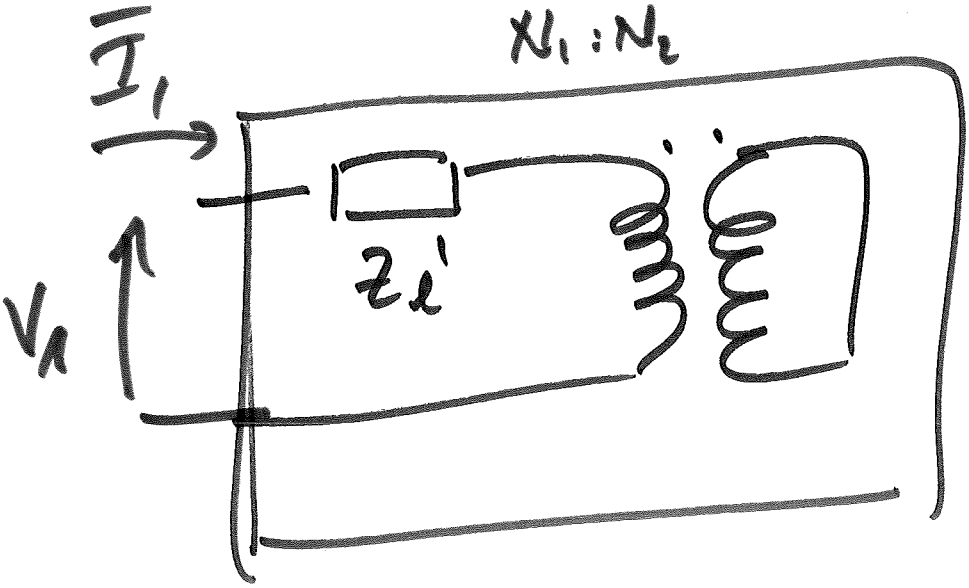




$$S_{in} = V_1 \cdot \bar{I}_1^* = \left(\frac{N_1}{N_2}\right) \bar{V}_2 \left(\frac{N_2}{N_1}\right) \bar{I}_2^*$$

$$= S_{out}$$





$$\left(\frac{\bar{V}_1}{\bar{V}_2} = \frac{N_1}{N_2}\cdot \quad \frac{\bar{I}_1}{\bar{I}_2} = \frac{N_2}{N_1}\right)$$

$$\frac{\bar{V}_1}{\bar{I}_1} = \frac{\left(\frac{N_1}{N_2}\right)\bar{V}_2}{\left(\frac{N_2}{N_1}\right)\bar{I}_2} = \left(\frac{N_1}{N_2}\right)^2 \frac{\bar{V}_2}{\bar{I}_2}$$

Z_ℓ.

$$\frac{\bar{V}_1}{\bar{I}_1} = \left(\frac{N_1}{N_2}\right)^2 Z_\ell = Z_\ell'$$

(Impedance reflection)