

2 port components

$$\frac{e_1}{f_1} \overset{m}{TF} \frac{e_2}{f_2} \quad e_2 = m e_1 \quad m f_2 = f_1$$

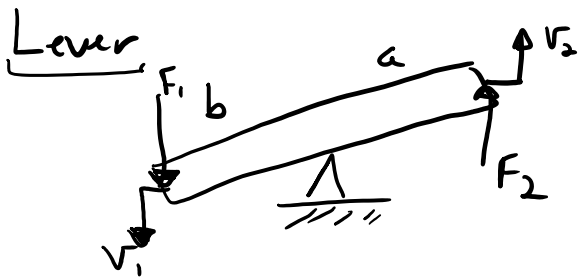
Transformer

$$\frac{e_1}{f_1} \overset{m}{TF} \frac{e_2}{f_2} \quad e_1 = m e_2 \quad m f_1 = f_2$$

effort \propto effort-flow \propto flow

no energy lost conservative!!

Examples

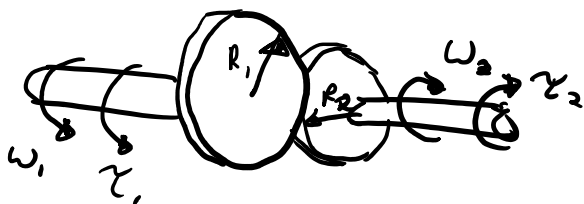


$$F_1 F_2 a \Rightarrow F_1 = \frac{a}{b} F_2$$

$$v_1 a = v_2 b \Rightarrow \frac{a}{b} v_1 = v_2$$

$$\frac{F_1}{v_1} \overset{a/b}{TF} \frac{F_2}{v_2}$$

Gears



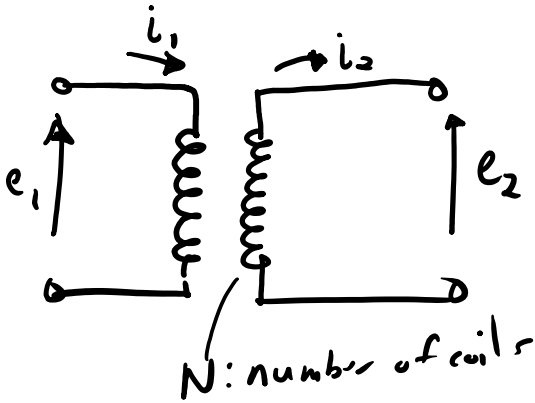
$$R_1 \tau_2 = R_2 \tau_1 \Rightarrow \tau_1 = \frac{R_1}{R_2} \tau_2$$

$$R_1 \omega_1 = R_2 \omega_2 \Rightarrow \frac{R_1}{R_2} \omega_1 = \omega_2$$

$$\tau_1 \overset{R_1/R_2}{TF} \tau_2$$

$$\frac{\tau_1}{\omega_1} \rightarrow TF \frac{\tau_2}{\omega_2}$$

Electrical Transformers

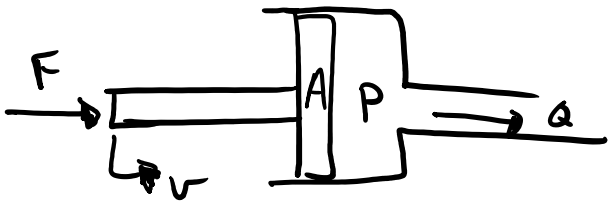


$$\frac{e_1}{i_1} \rightarrow TF \frac{e_2}{i_2}$$

$$e_1 = N e_2$$

$$N i_1 = i_2$$

Hydraulic Piston



$$\frac{F}{r} \rightarrow TF \frac{Q}{q}$$

$A =$

$$F = AP$$

$$Ar = Q$$

2 Port Gyration

$$\frac{e_1}{s_1} \rightarrow TF \frac{e_2}{f_2}$$

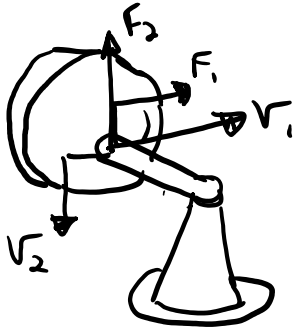
$$e_1 = r f_2$$

$$r f_1 = e_2$$

effort \propto flow

flow \propto effort

Gyroscope



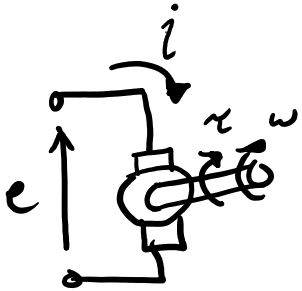
function the angular momentum

$$F_1 = r v_2$$

$$r v_1 = F_2$$

$$\frac{F_1}{v_1} \rightarrow \overset{r}{G} \dot{Y} \frac{F_2}{v_2}$$

DC Motor (wound permanent magnet)

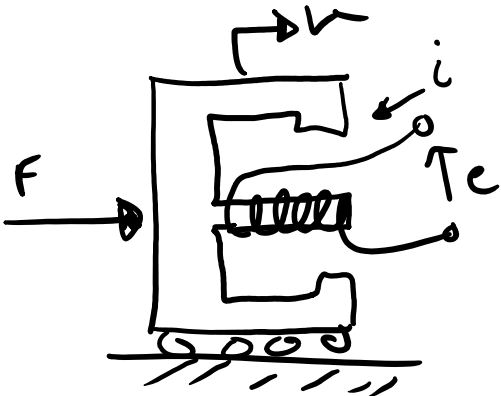


$$e = T \omega$$

$$T i = \tau$$

$$\frac{e}{i} \rightarrow \overset{T}{G} \dot{Y} \frac{\tau}{\omega}$$

Voice Coil (Speaker)



magnetic flux
 Bl ← length of wire

$$\frac{e}{i} \rightarrow \overset{Bl}{G} \dot{Y} \frac{F}{r}$$