Basic Energy elements

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Literature

- R. Isermann, Mechatronic Systems: fundamentals, Springer Verlag, London, 2005.
- www.wikipedia.org/en (pictures)

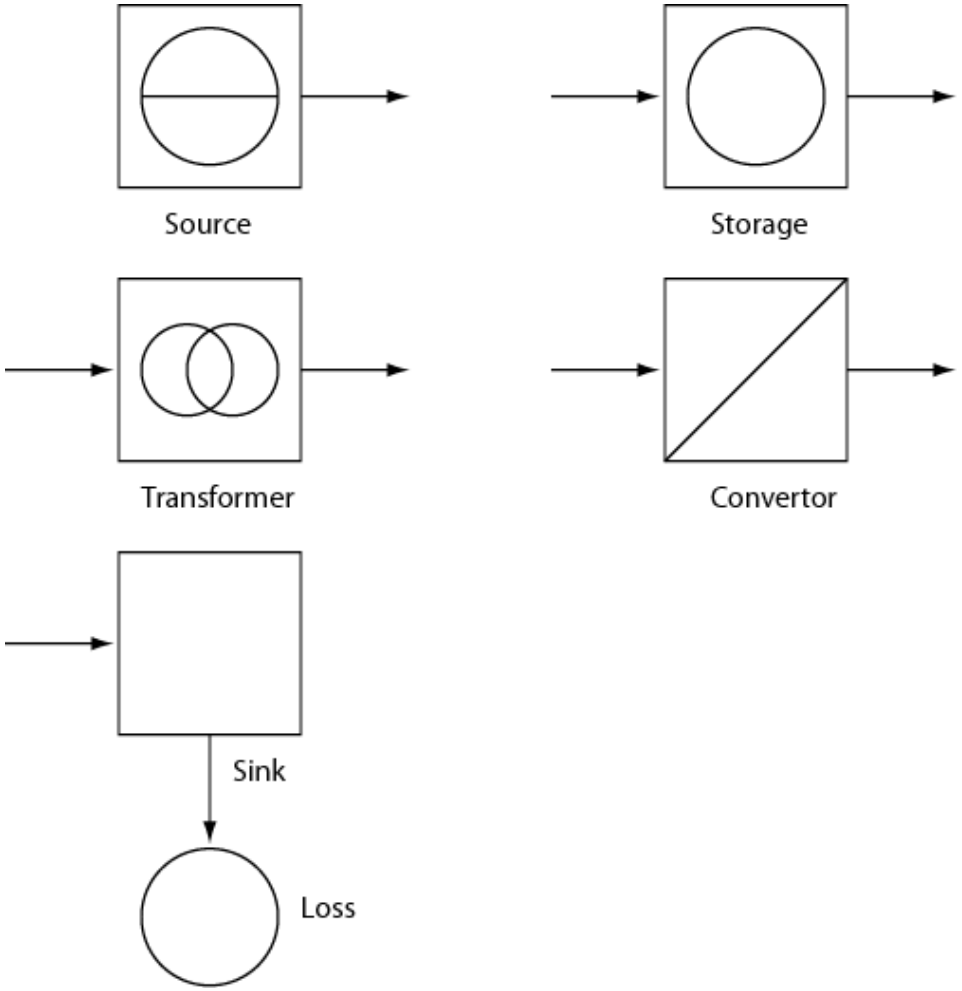
Ideaal basic energy elements

1. Sources
   - Deliver an output quantity from a large supply
2. Storages
   - Take up a quantity and deliver it in the same form
3. Transformers
   - Take up a quantity and deliver it in the same form, without storing it.
4. Converters
   - Take up a quantity in a certain form and deliver it after conversion into another form, without storing it.
5. Sinks
   - Take up an input quantity and consume it.

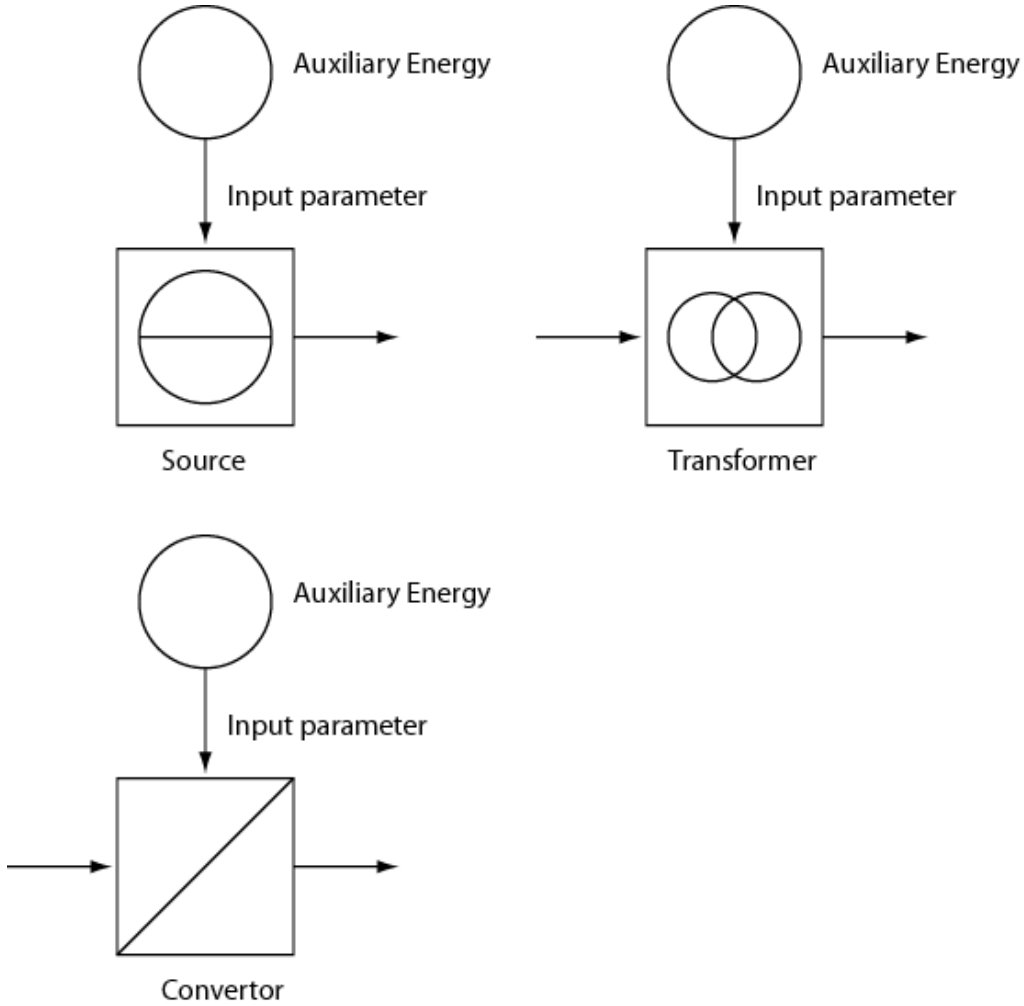
Process elements and controllability

- Passive elements
  - The transferred quantity is not controllable by an additional auxiliary energy.
    - Passive storages(capacitances, …),
    - Passive transformers (fixed gear transmissions, …),
    - passive converters(constant speed fans, …)
- Active elements
  - A quantity is controlled by an actuator.
    - Controllable sources (voltage sources, …)
    - Controllable transformers (electrical amplifier, …)
    - Controllable converters (electromagnets, …)

Ideaal passive energy elements



Ideaal active energy elements



Ideaal sources

1. Potential source
   - The potential supplied by an ideal potential source is independent of the current
2. Current source
   - The current supplied by an ideal current source is independend of the potential

Storages examples:

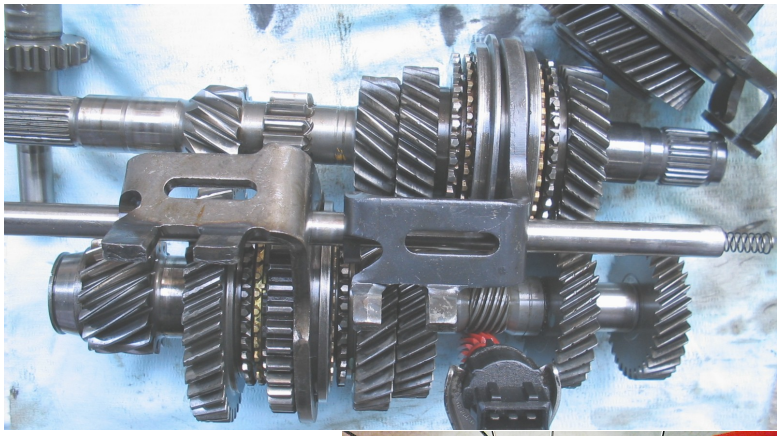
1. Potential storage
    1. Electrical capacitor
    2. Mechanical spring
2. Flow storage
    1. Electrical inductor
    2. Mechanical kinematic energy

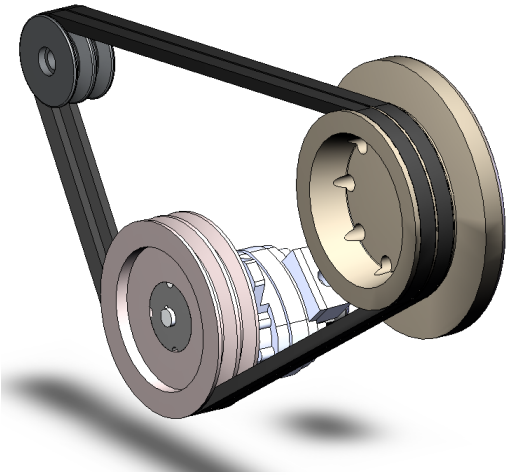
Examples transformers

- Mechanical
  - Transmission (gearbox)
- Electrical
  - Transformer
- Thermal
  - Heat exchanger
- Hydraulic
  - Pressure transmission

Mechanical transformers

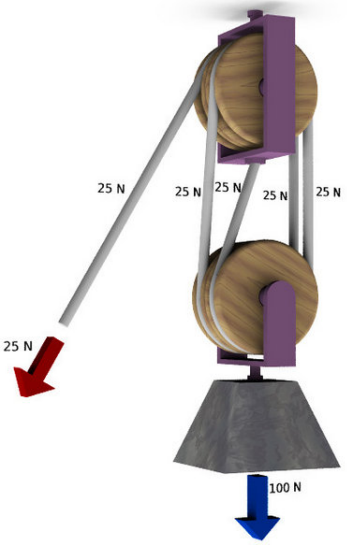
R -> R





R -> … ->R

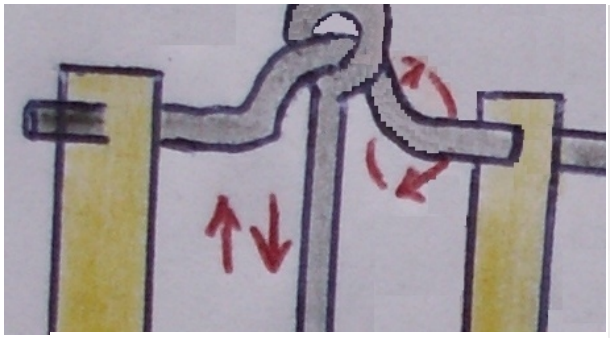
R -> … -> R

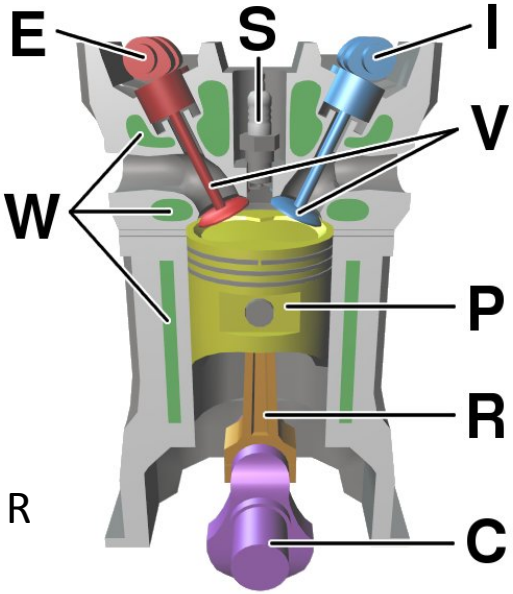


L -> … -> L

Mechanical transformers

L -> R or R -> L

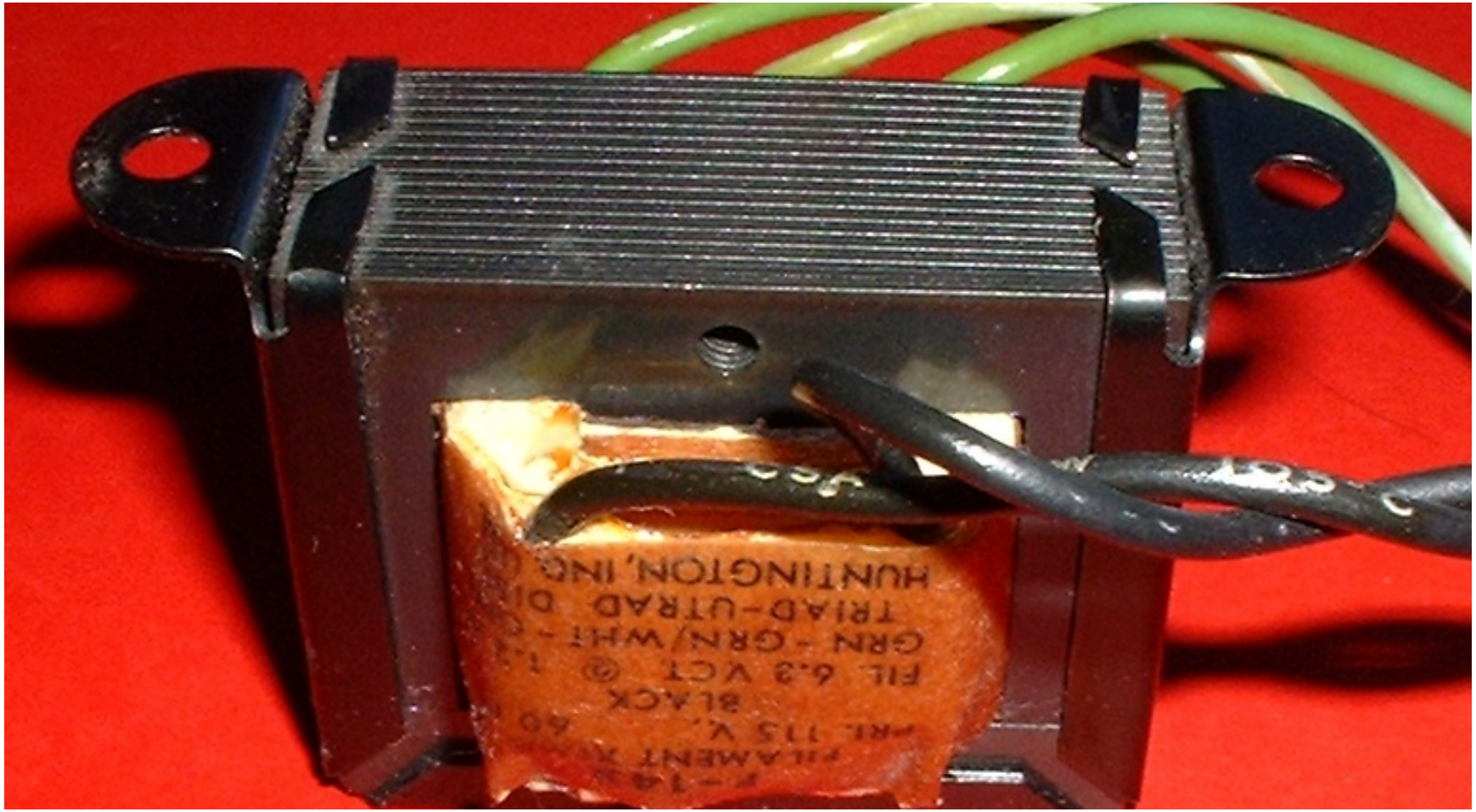




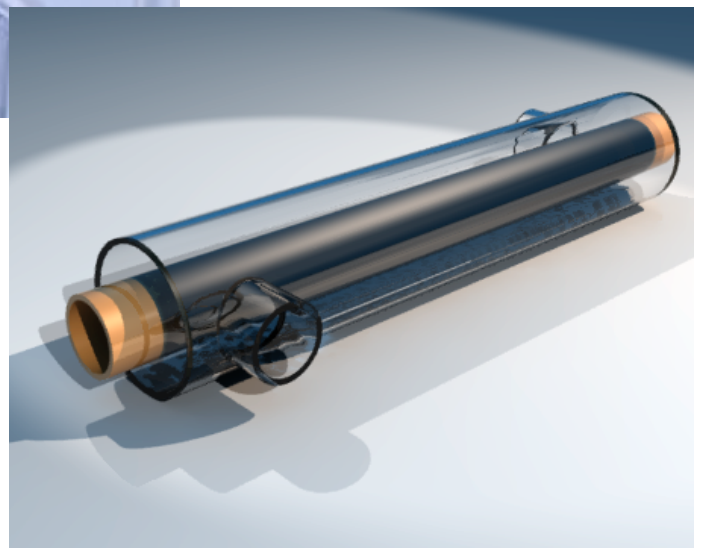
L -> R

R -> L

Electrical transformer



Thermal transformer



Hydraulic transformer

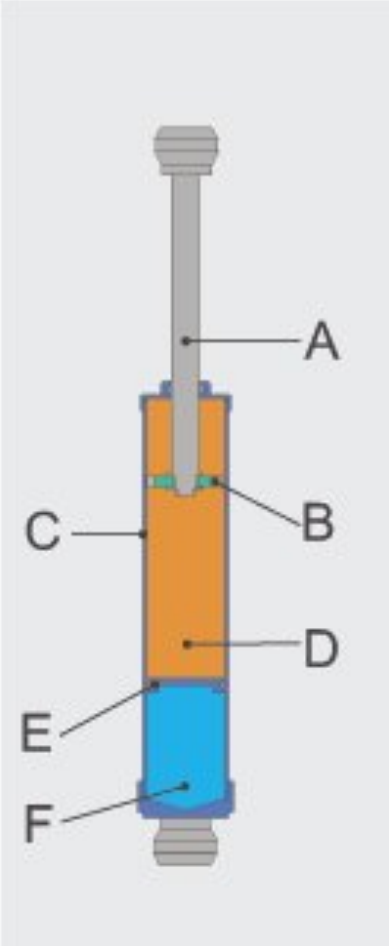
Convertor examples

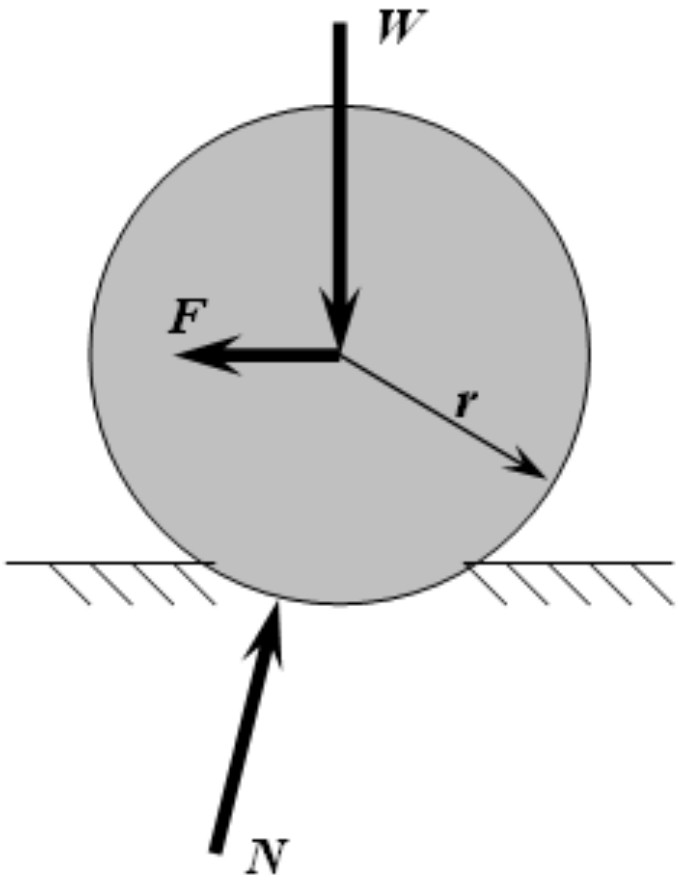
- Electrical → Mechanical
  - Electrical motor
- Mechanical → Electrical
  - Electrical generator
- Mechanical → Hydraulic
  - Pump
- Hydraulic → Mechanical
  - Hydraulic piston
- Mechanical → Pneumatic
  - Compressor

General sinks, dissipative converters

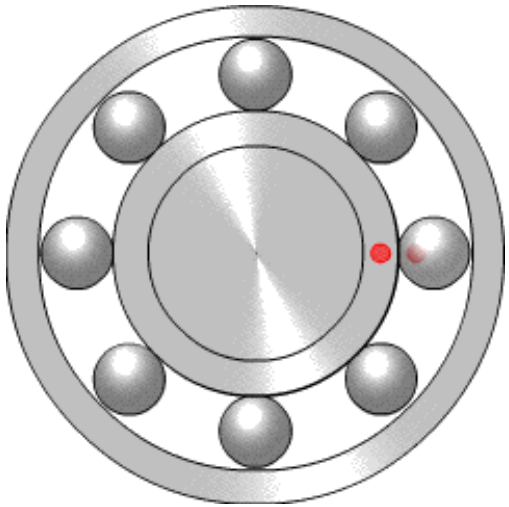
- Examples
  - Mechanical
    - Damper,
    - Friction
  - Electrical: resistance
  - Hydraulic: throttle
  - Thermal: heat conductor

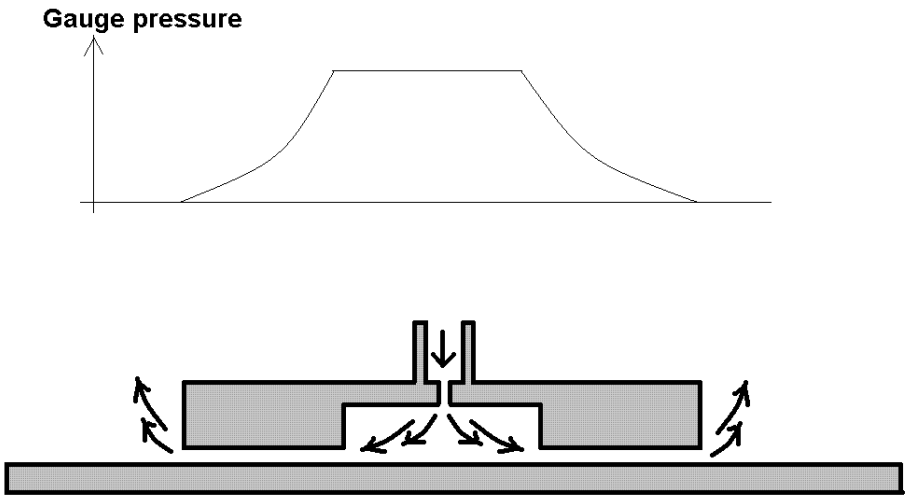
Mechanical sink: Damper or friction





Reducing friction





Actuators

- Actuators usually transform low-powered manipulated variables into process input variables of much higher power level.