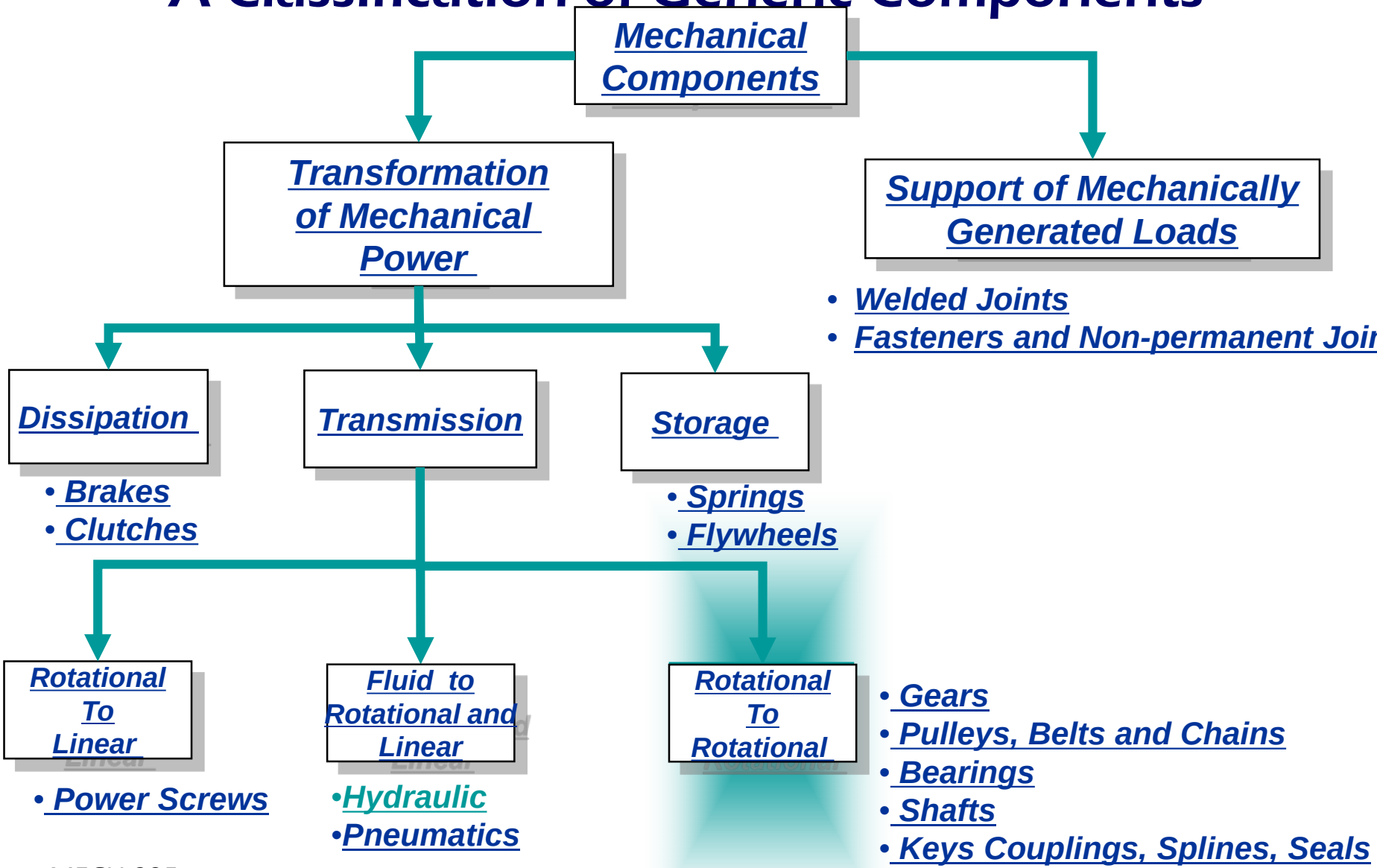
MECH 325
Fluid Power

Learning Objectives

1. To learn specific basic components uses in fluid power
2. To interpret several basic symbols for components and to understand the functions of the available fluid power components by the symbols.
3. To organize some basic components to create a circuit
4. To practice reading simple circuits

A Classification of Generic Components



Fluid Power

ADVANTAGES

- ***Easy speed control***
- ***Easy direction control***
- ***Adaptable circuit***
- ***Power transmission***
- ***Can handle overloads and shocks***
- ***Easily automated***

DISADVANTAGES

- ***High maintenance***
- ***High skill required.***
- ***Must be kept clean***
- ***Expensive***
- ***Energy inefficient (especially pneumatics)***

Characteristics

PNEUMATICS

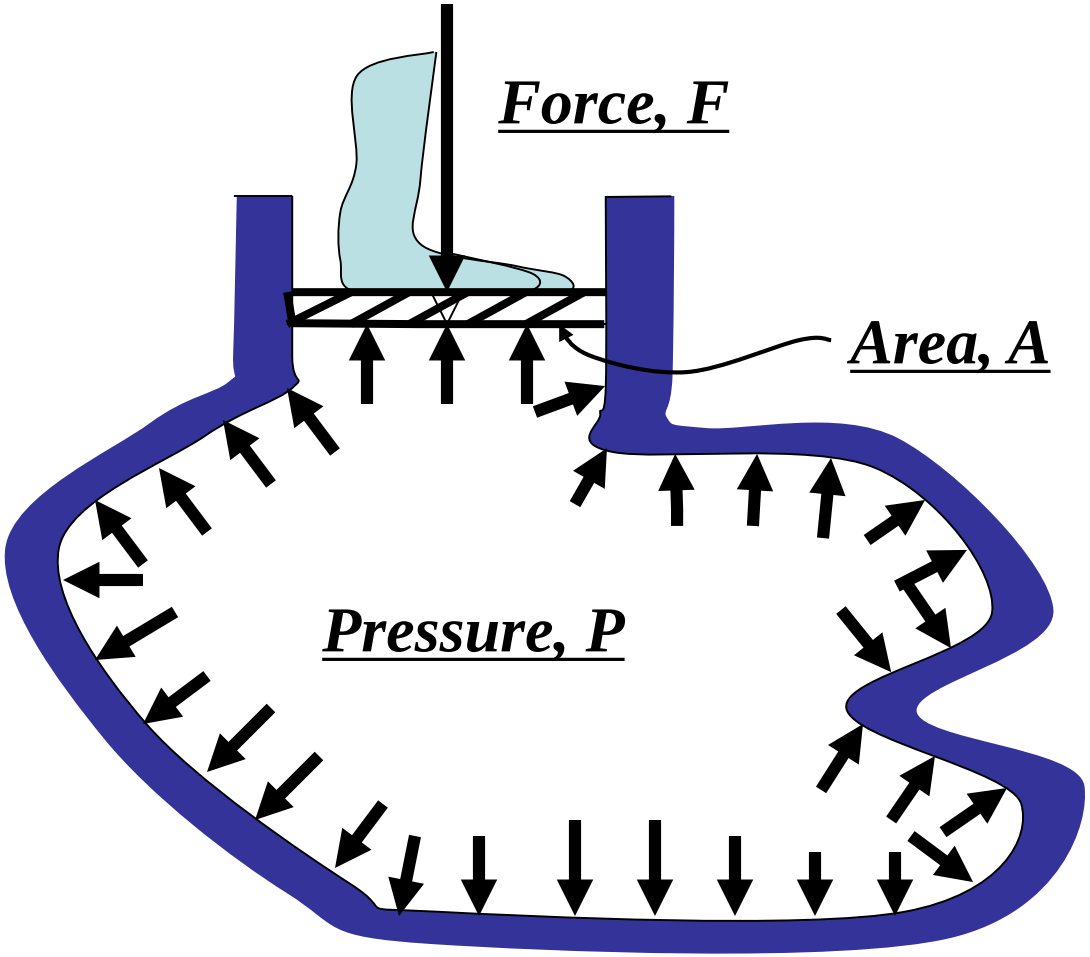
- Compressible fluid
- Low pressure (~100psi)
- Less expensive
- Less maintenance
- Less control
- Better in dirty environment
- High speed

HYDRAULICS

- Incompressible fluid.
- High pressure (~1,000 to 10,000 psi)
- High loads and power in compact devices
- More expensive
- High maintenance
- Easily controlled
- Need clean internal environment

We are going to concentrate mostly on hydraulics in this module.

Fluid pressure

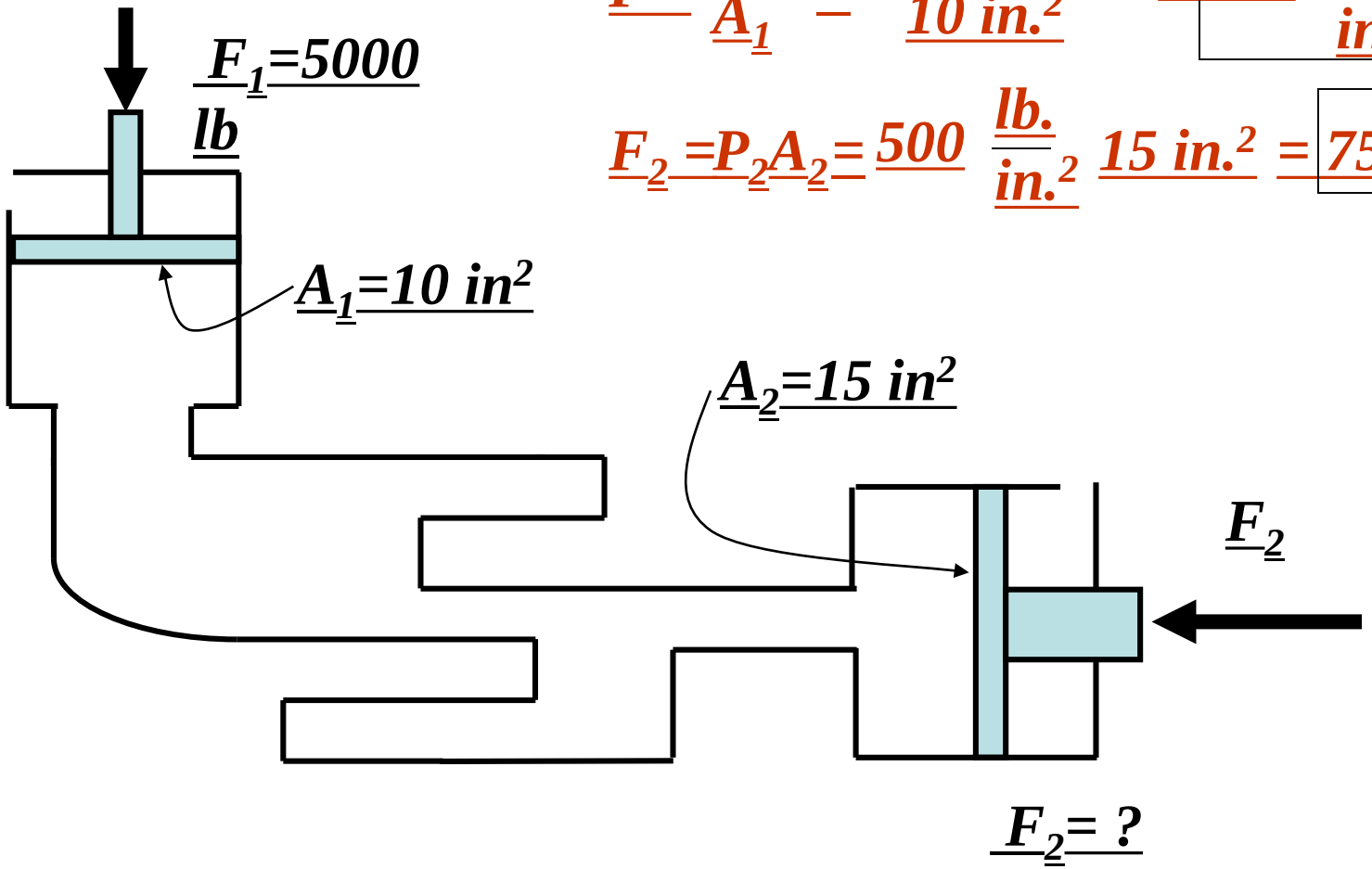


$$P = \frac{F}{A}$$

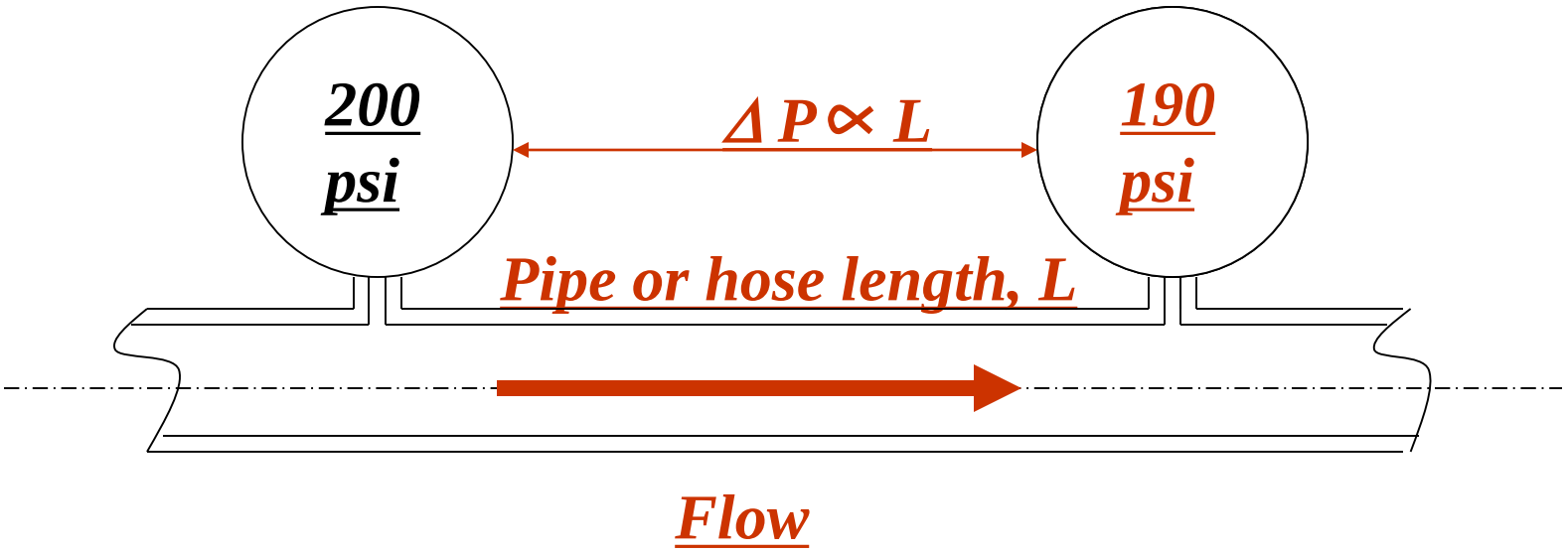
Fluid pressure and reaction

$$P = \frac{F_1}{A_1} = \frac{5000\ \text{lb.}}{10\ \text{in.}^2} = 500\ \frac{\text{lb.}}{\text{in.}^2}$$

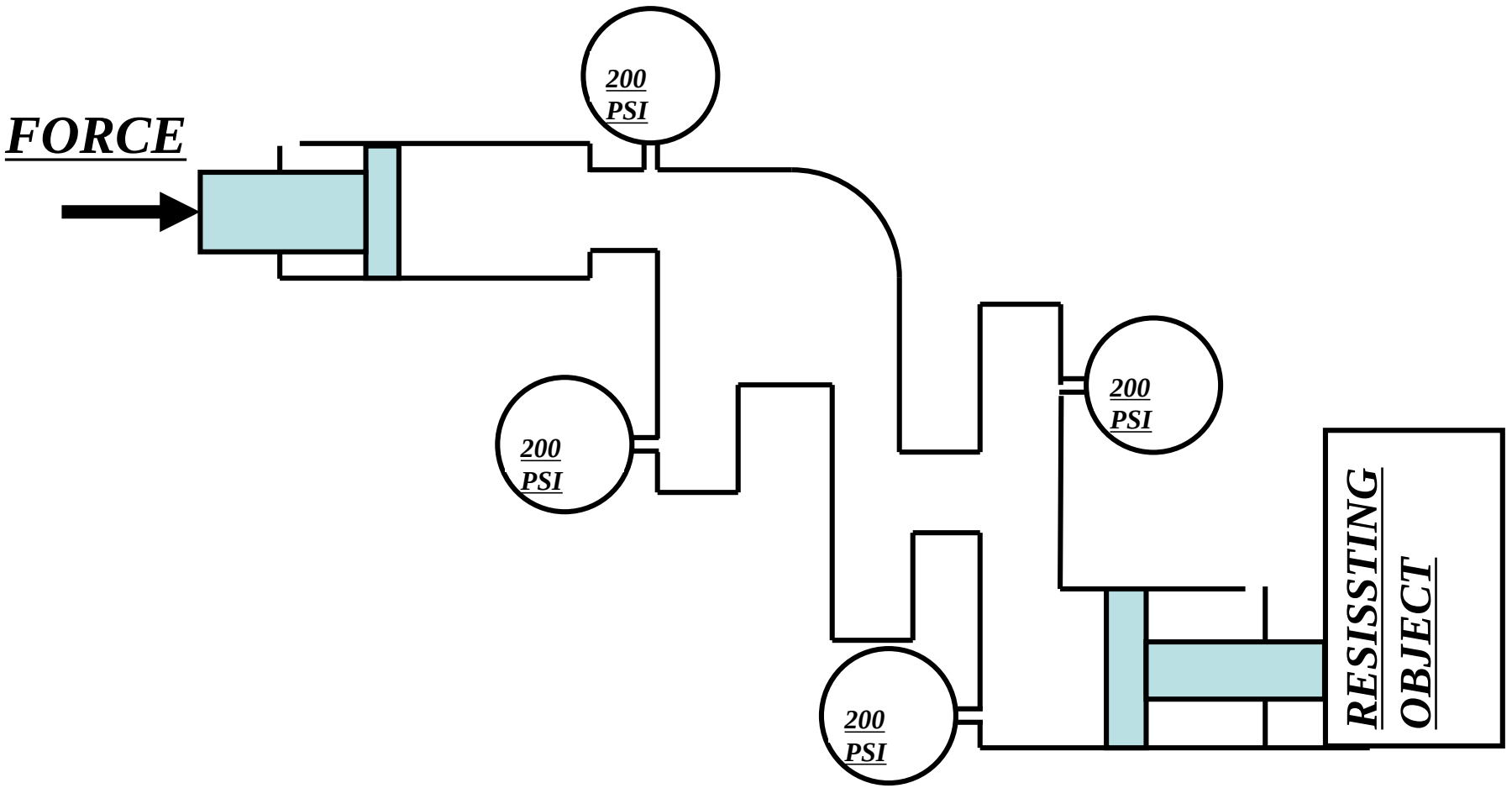
$$F_2 = P_2 A_2 = 500\ \frac{\text{lb.}}{\text{in.}^2}\ 15\ \text{in.}^2 = 7500\ \text{lb.}$$



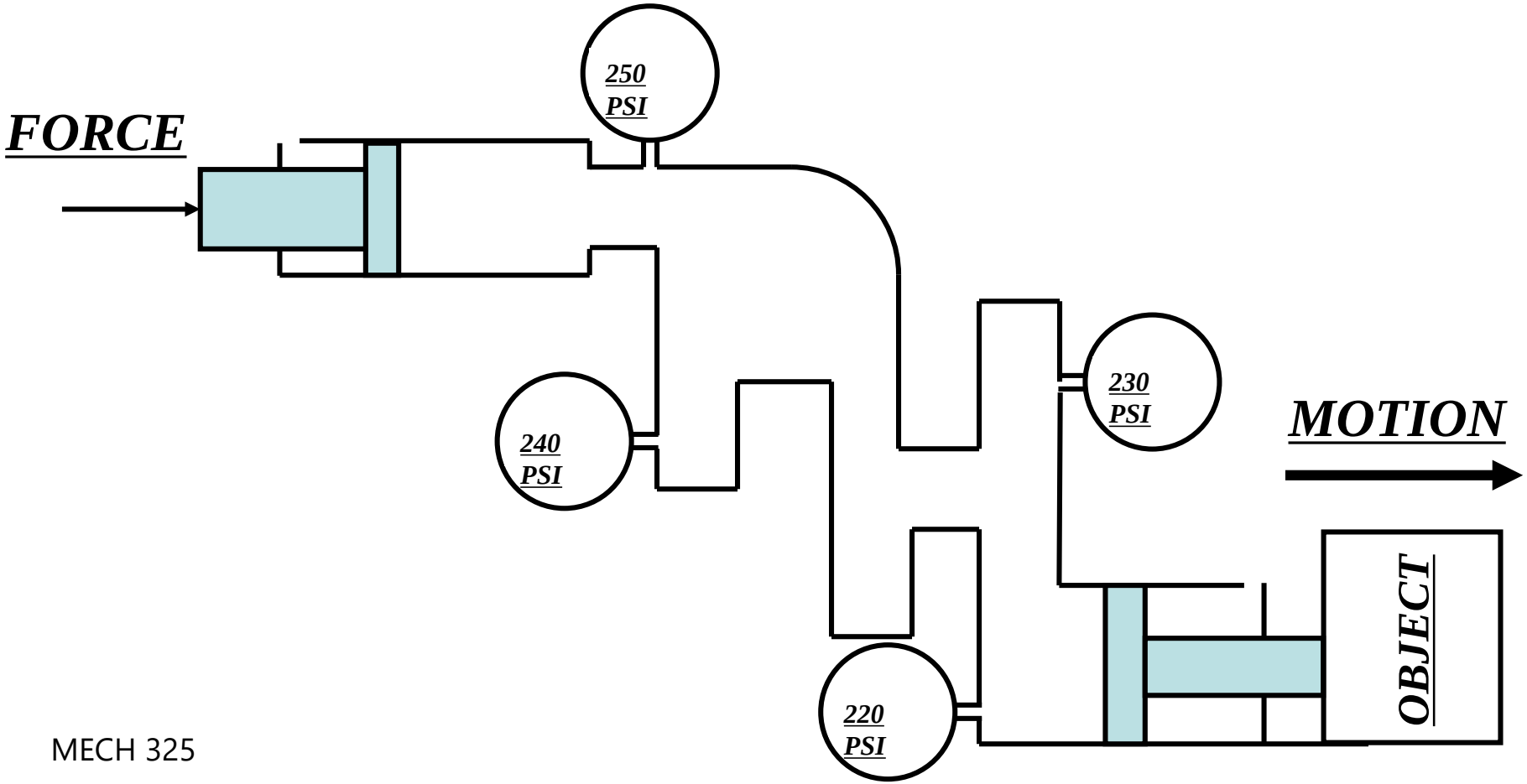
Pressure losses due to flow



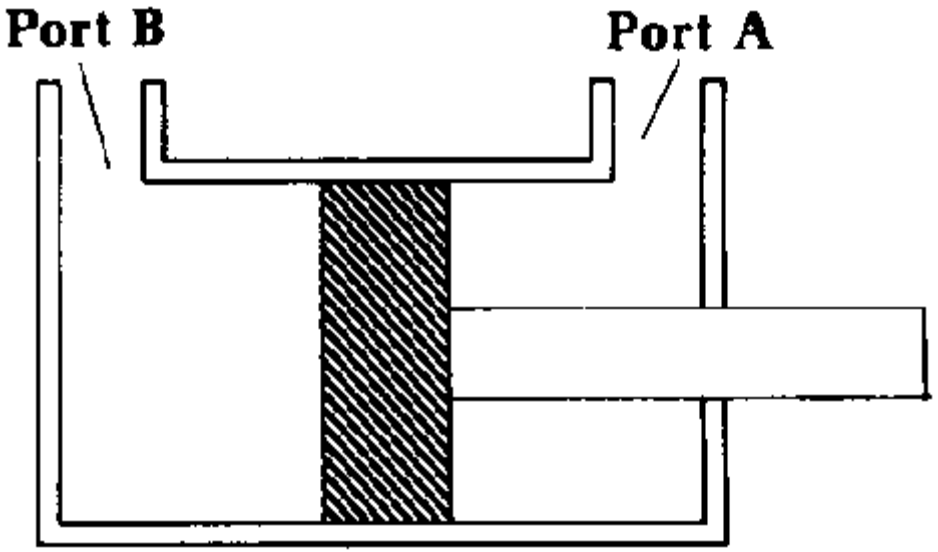
System with no flow



- ***The most common cause of pressure losses in pipes and hoses is friction.***
-

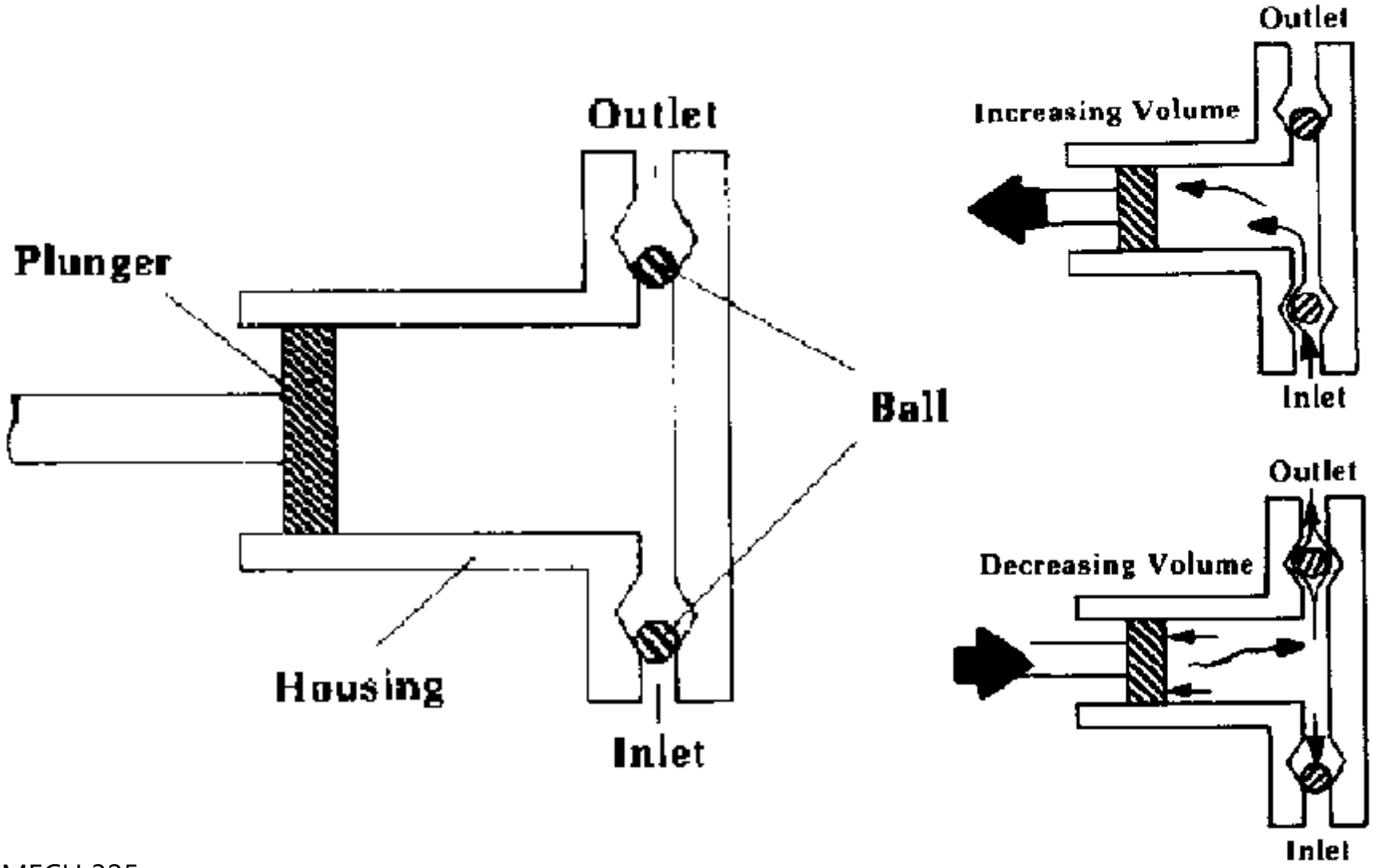


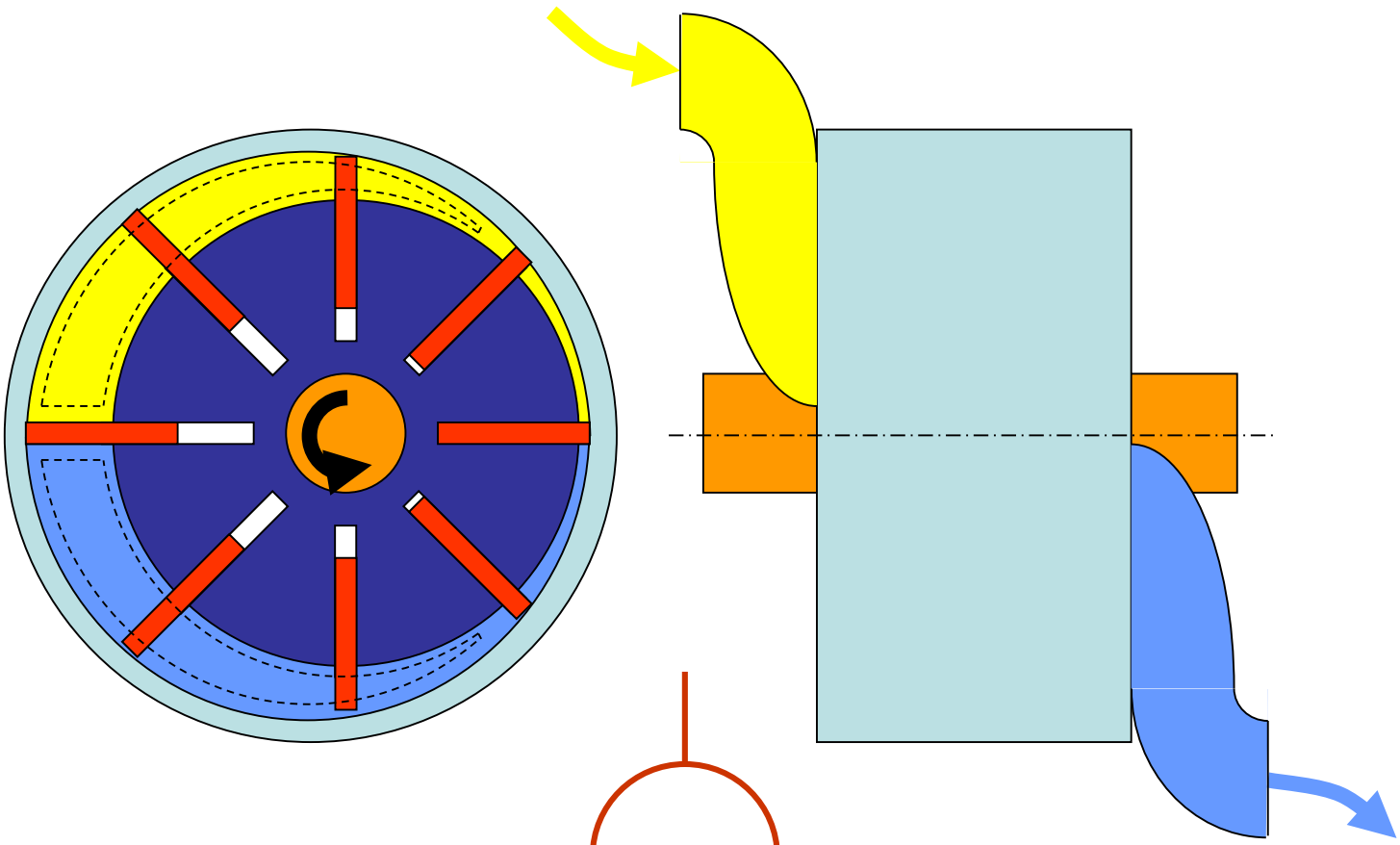
Double acting cylinder



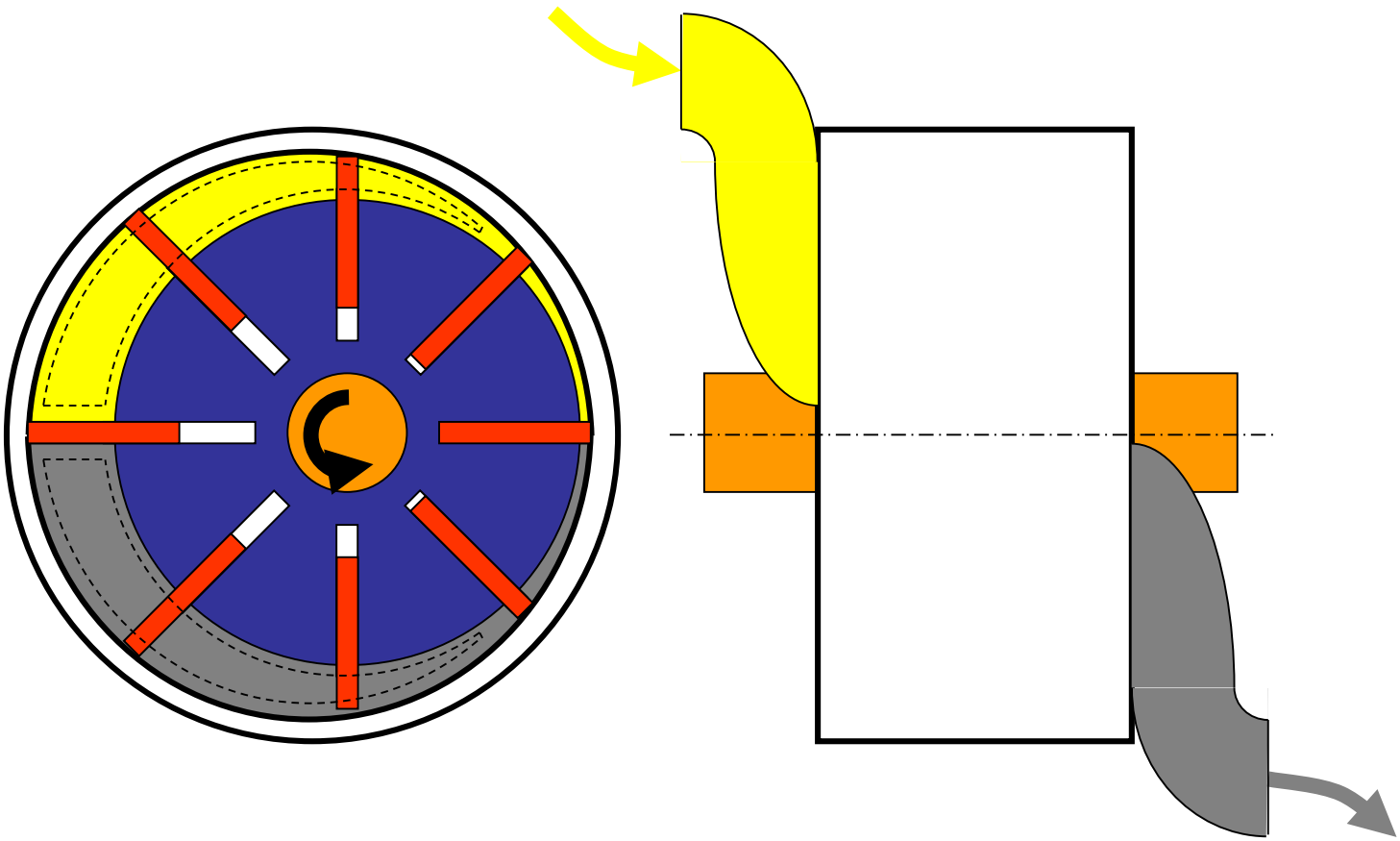
Symbol

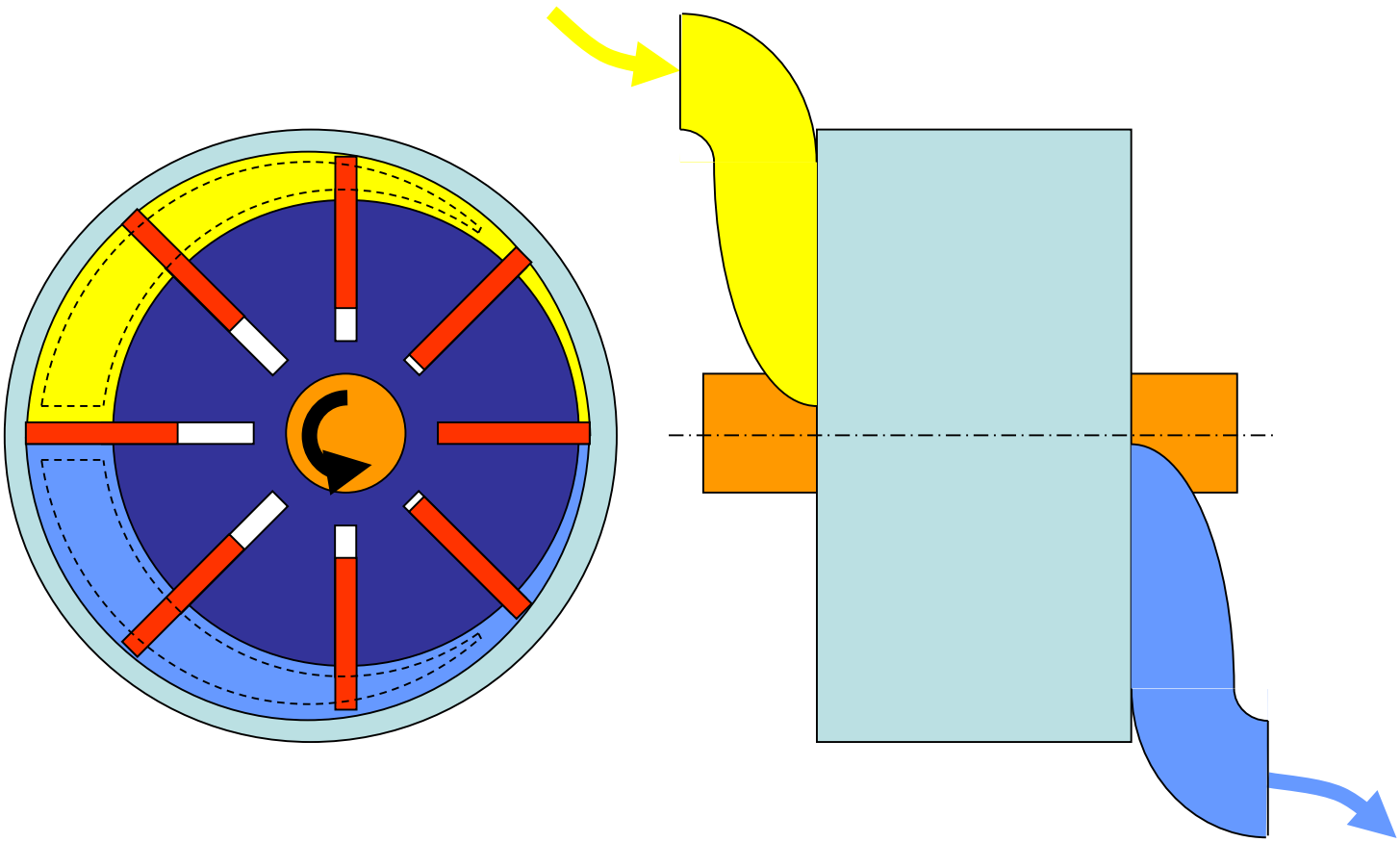
Positive displacement reciprocating pump

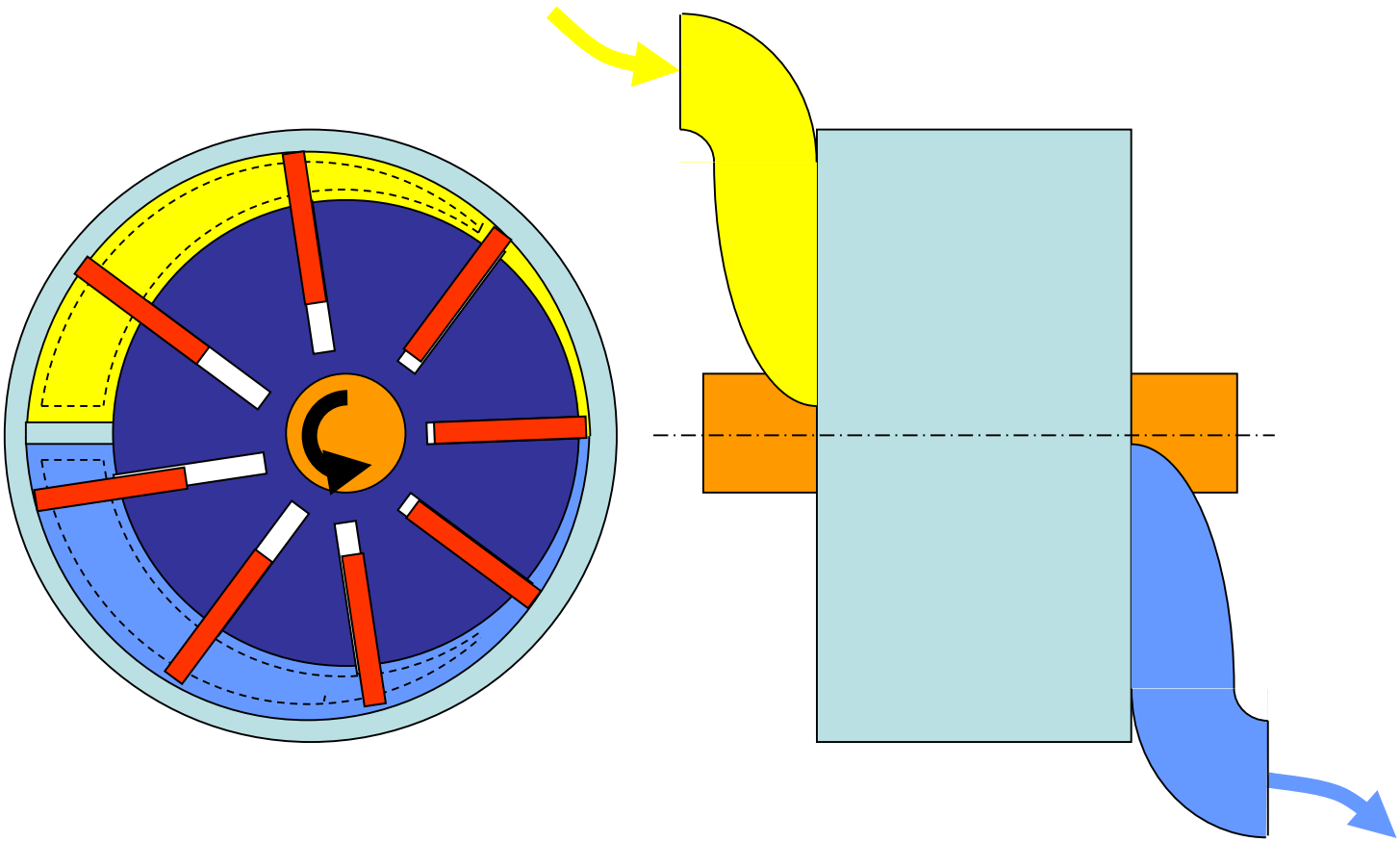


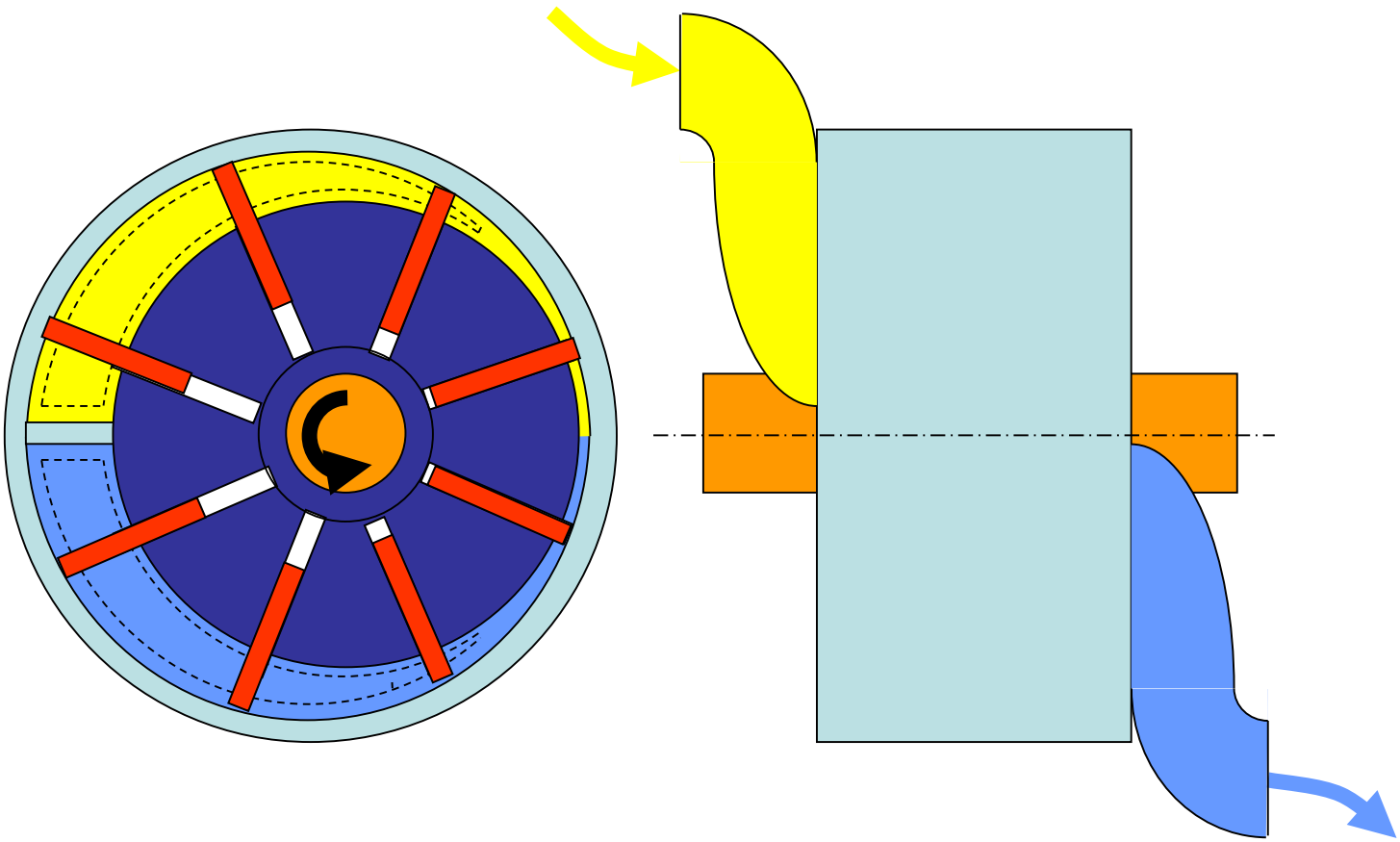


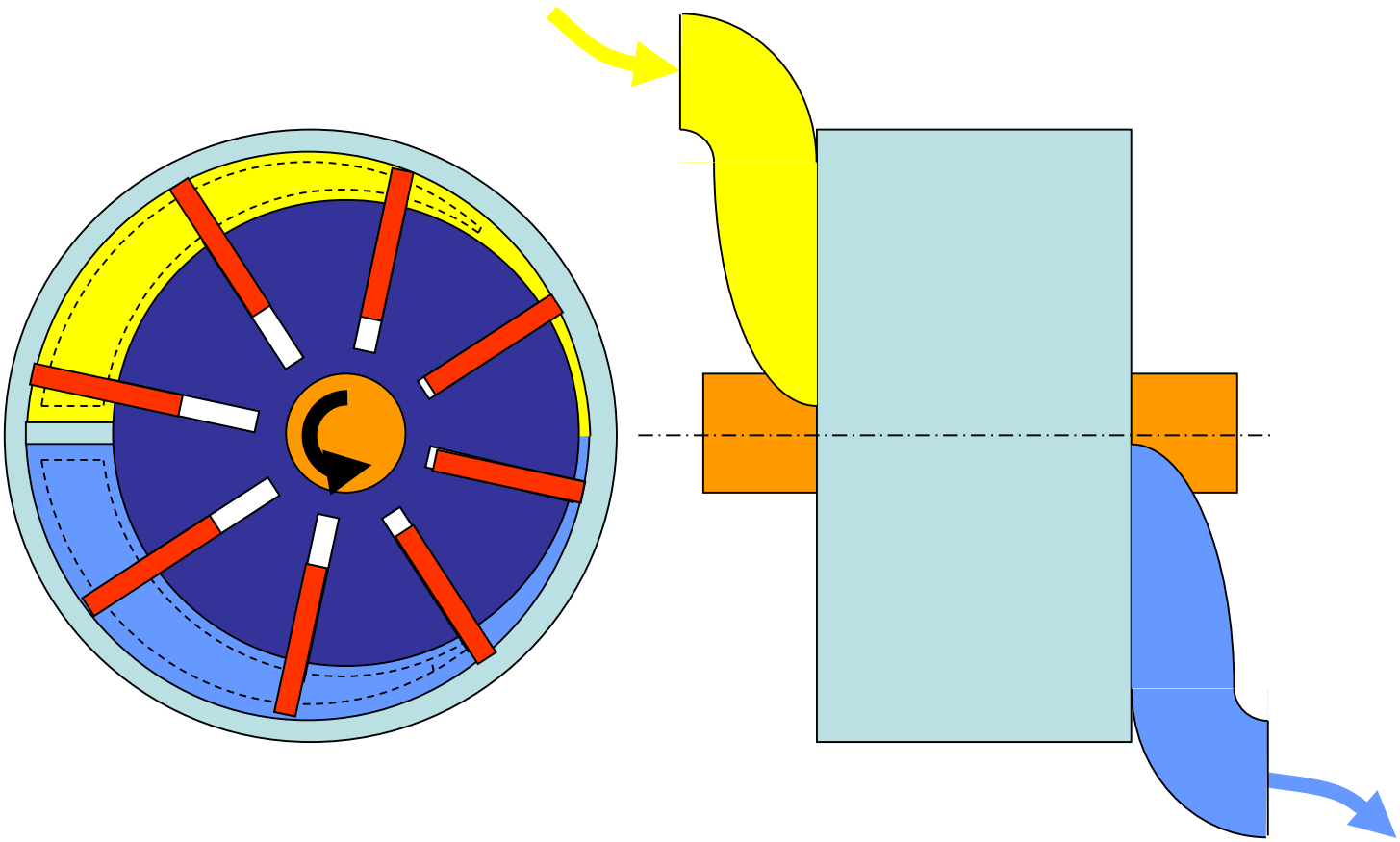
Symbol

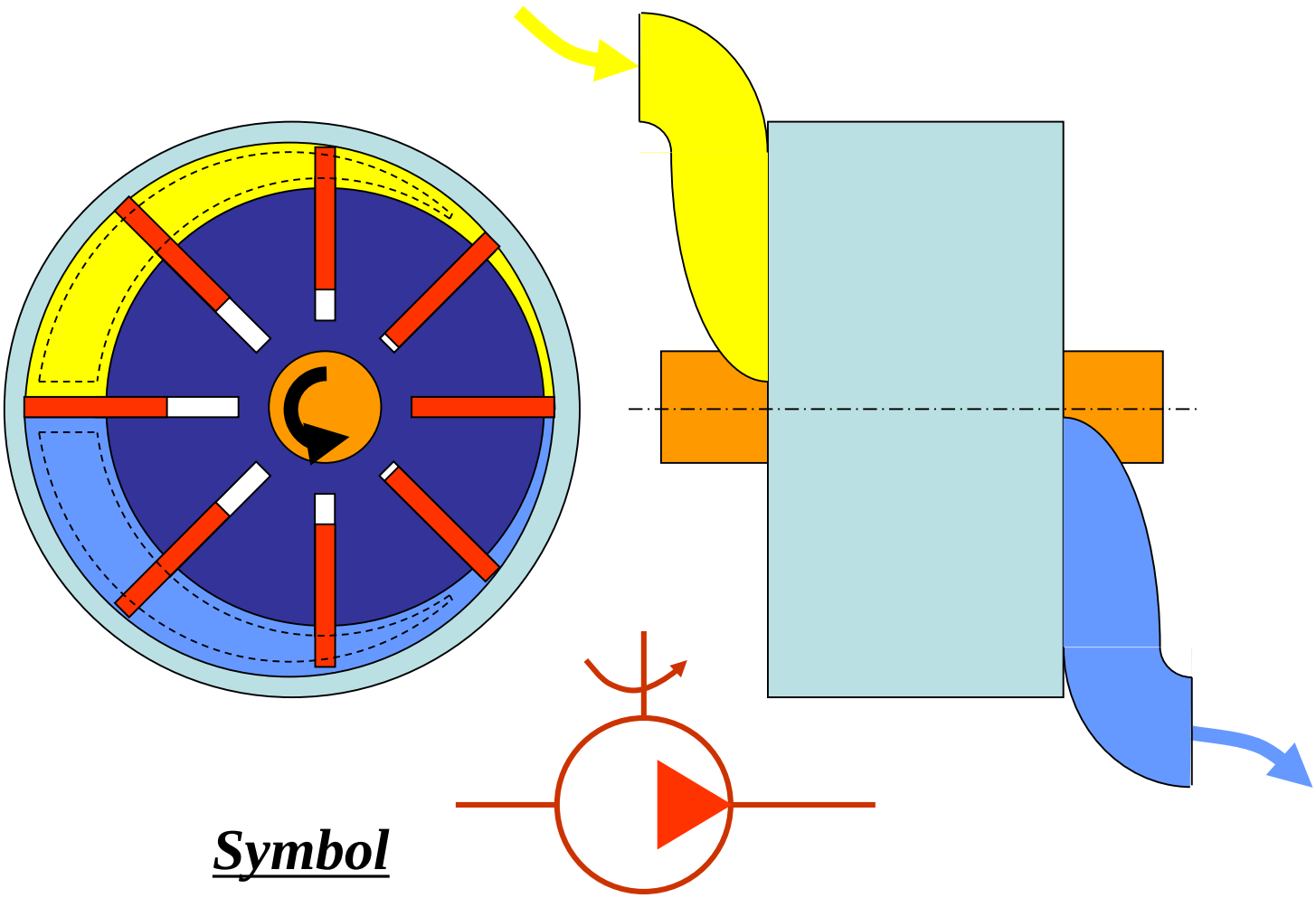






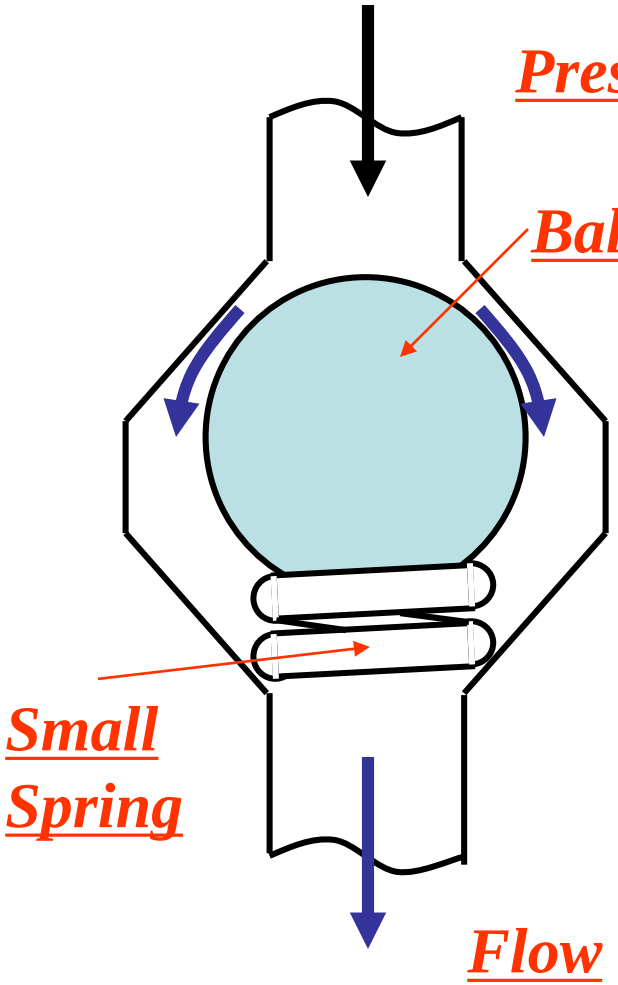






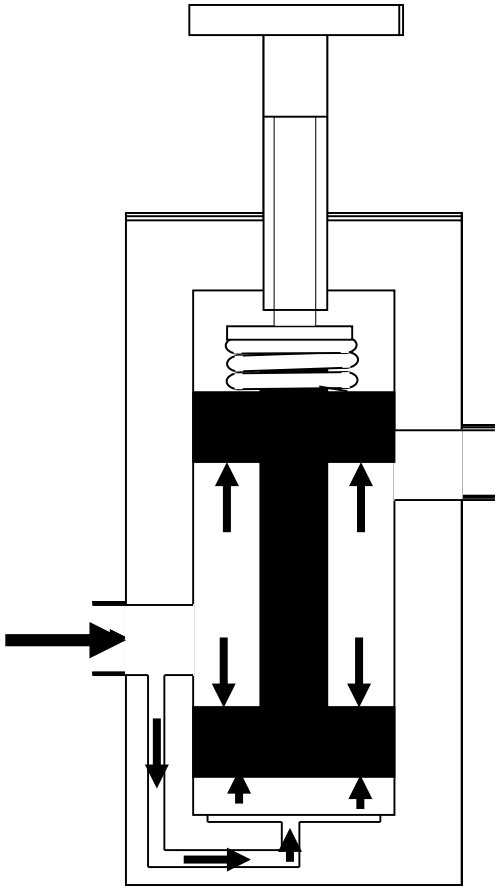
Symbol

Check Valve



Symbol

Pressure control valves

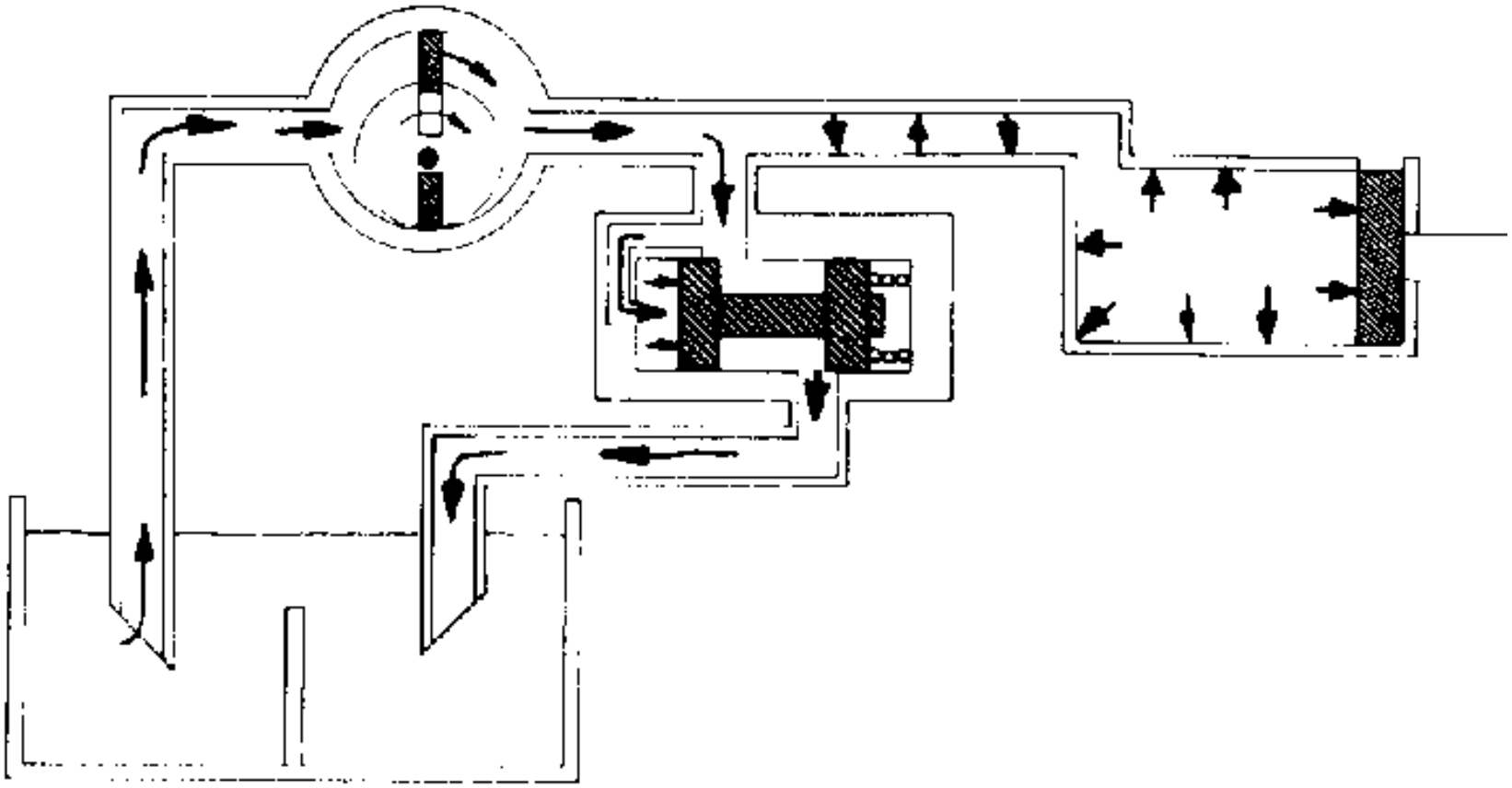


Secondary Port

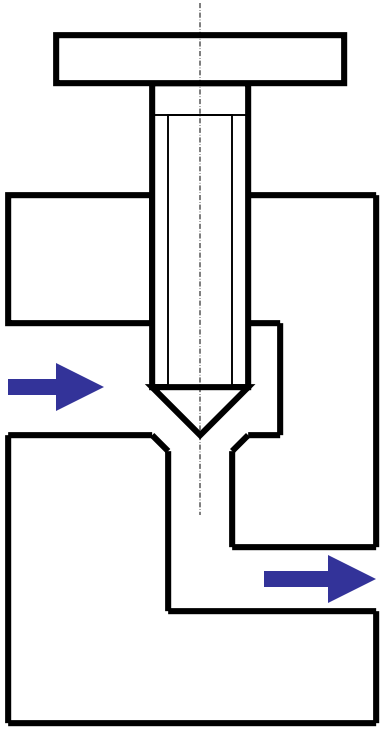
Primary Port

Symbol

Pressure control as a relief valve

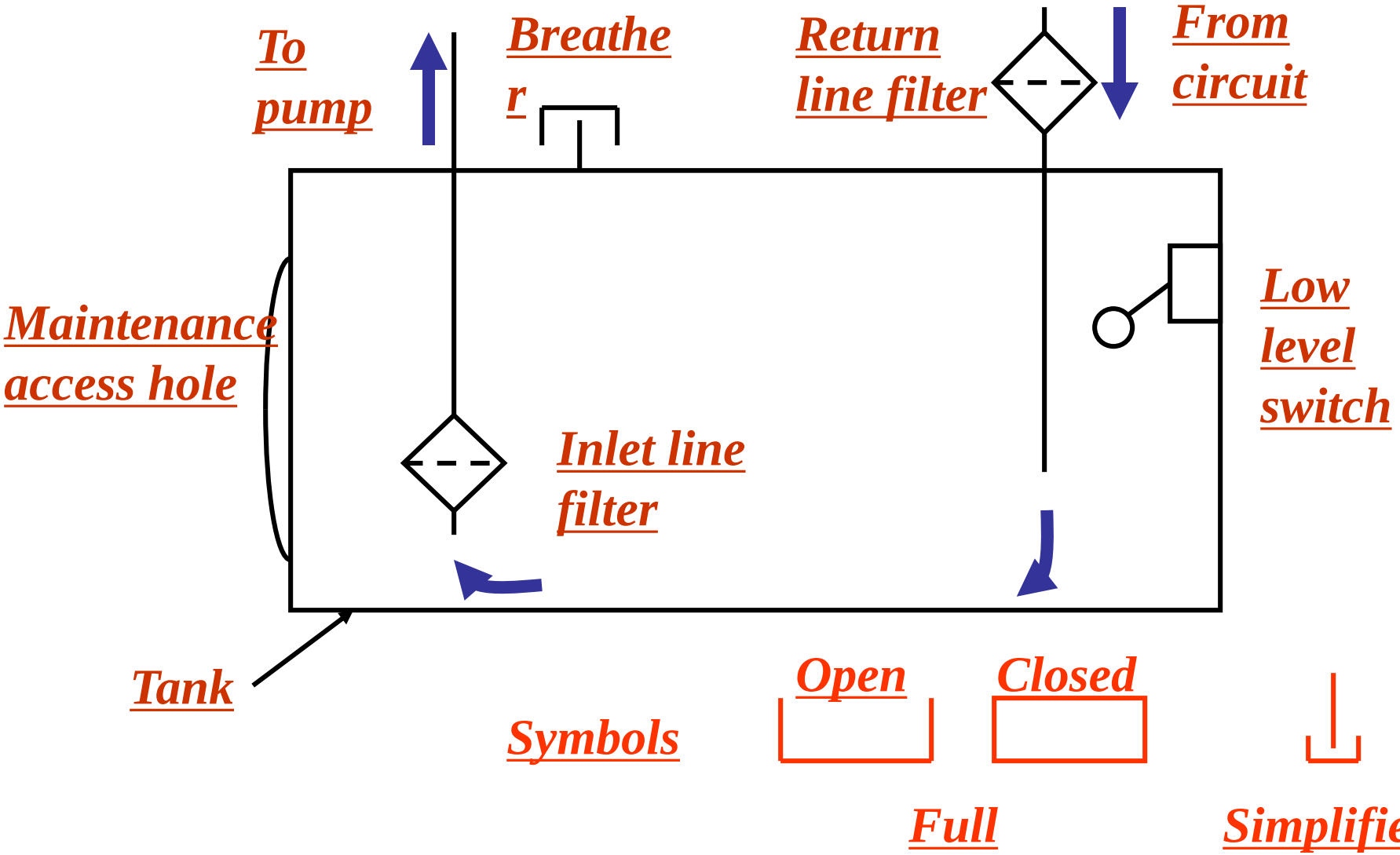


Flow Control Valve

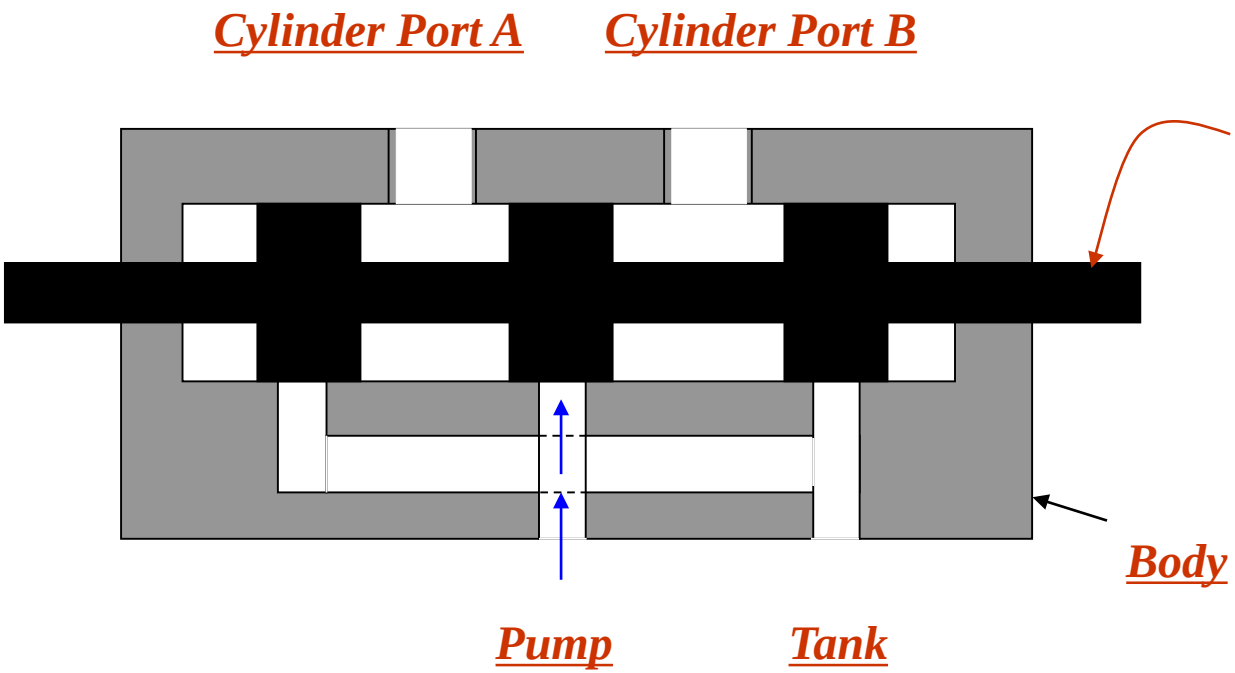


Symbol

Reservoir (Tank)

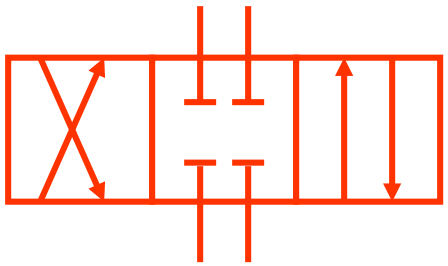


Directional control valves

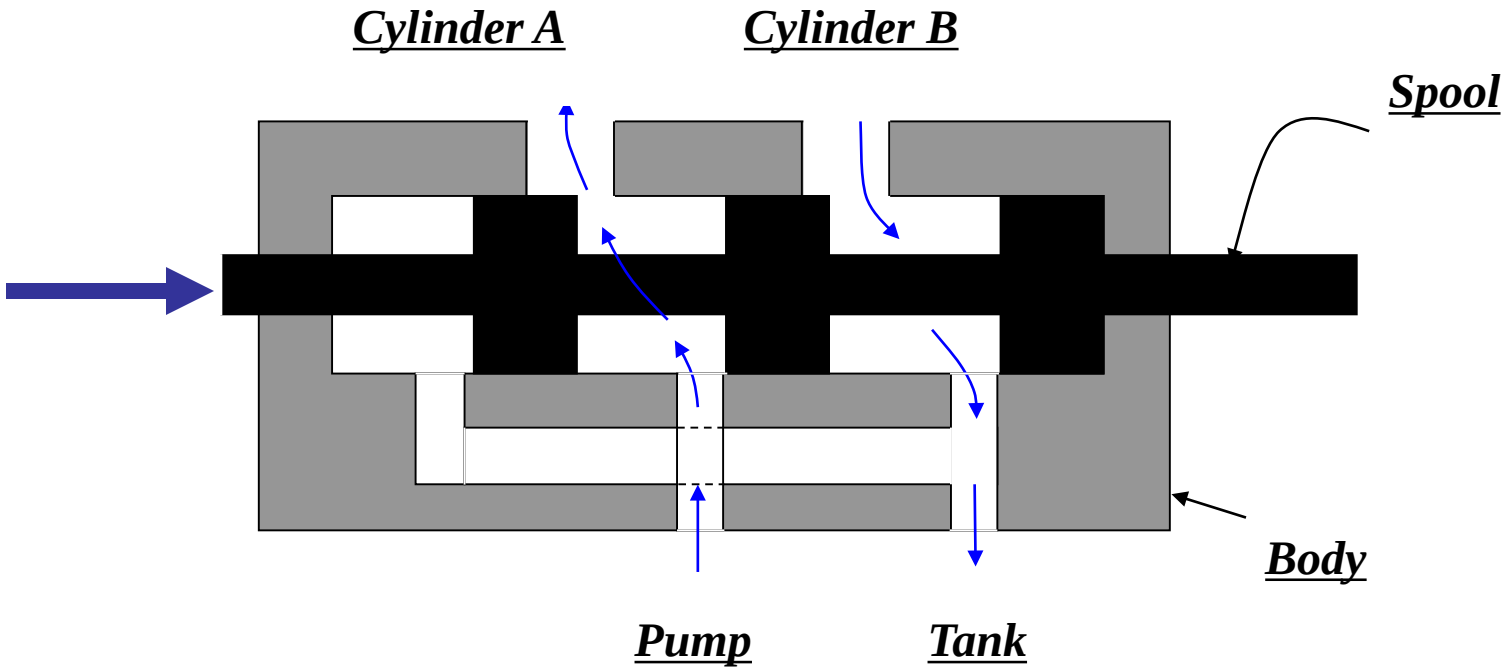


By convention symbols are drawn with the system in the "down" or "retracted" mode.

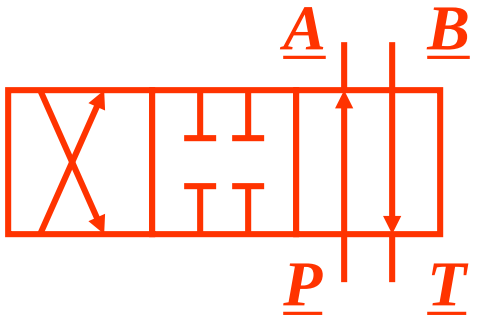
Symbol



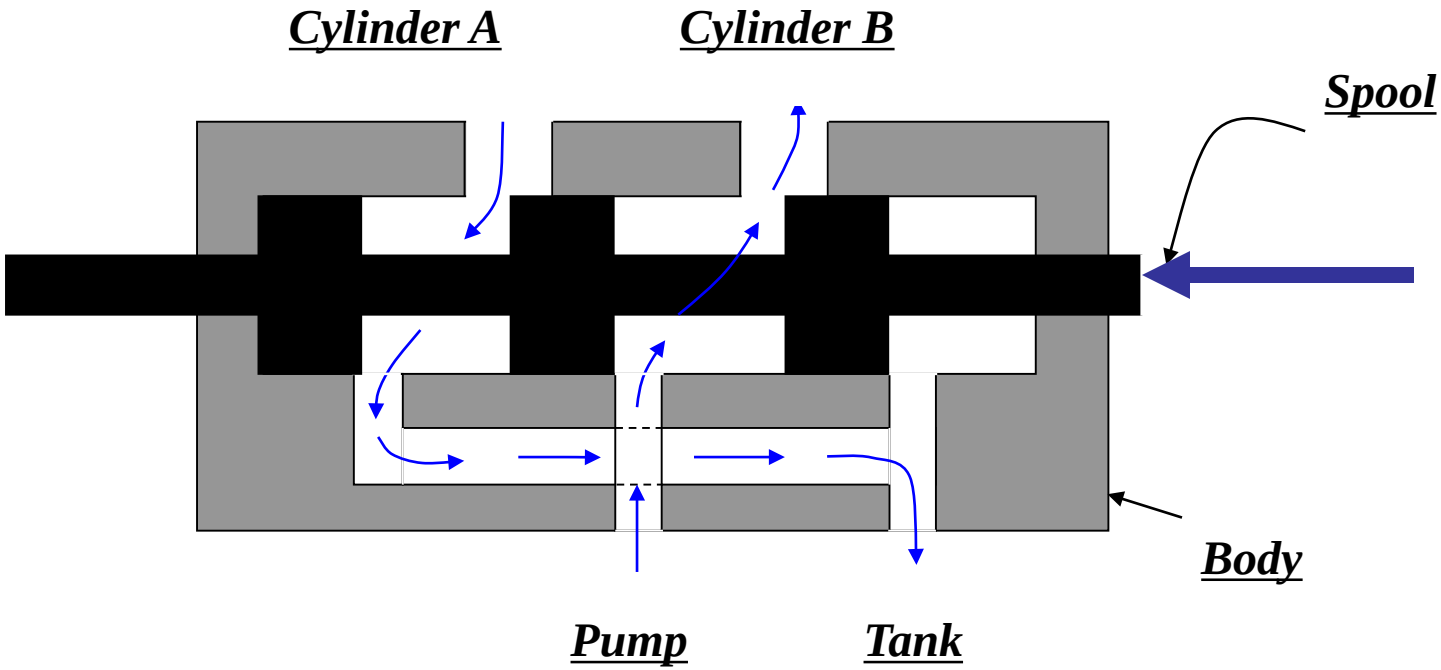
Directional control valves

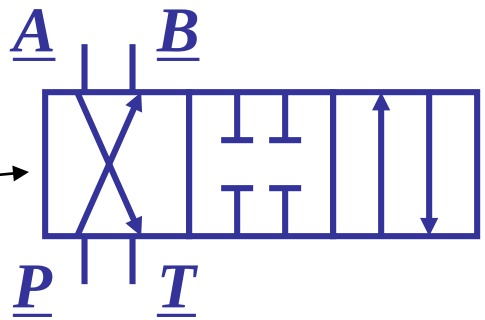


Think of the symbol this way, but do not draw it like this.



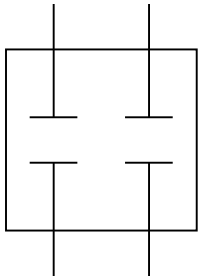
Directional control valves



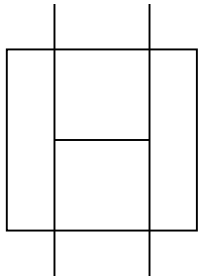


Think of the symbol this way, but do not draw it like this.

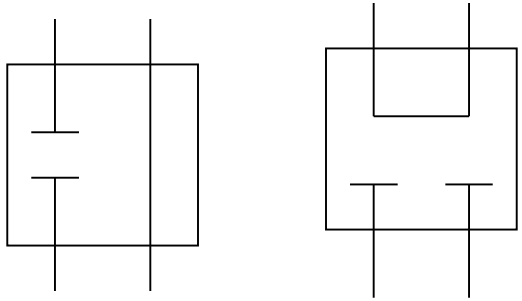
Common valve centre positions



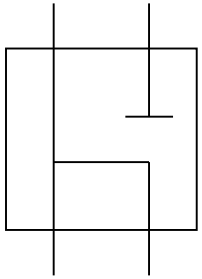
All ports plugged



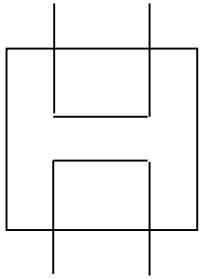
All ports connected



2 ports plugged
2 ports connected



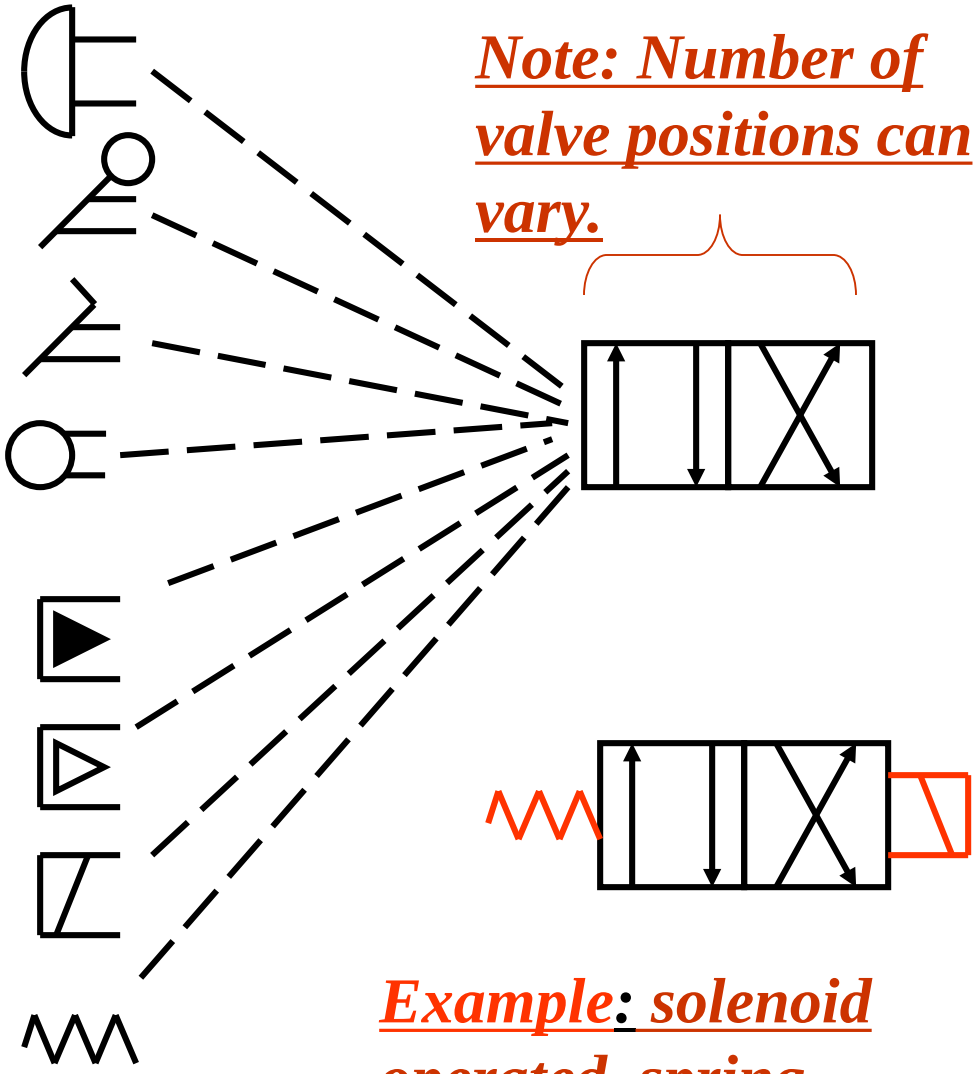
1 port plugged
3 ports connected



2 plus 2 connected

Valve Actuators

- Push button
- Hand lever
- Foot pedal
- Mechanically actuated symbol
- Hydraulic pilot
- Air pilot
- Solenoid
- Spring return

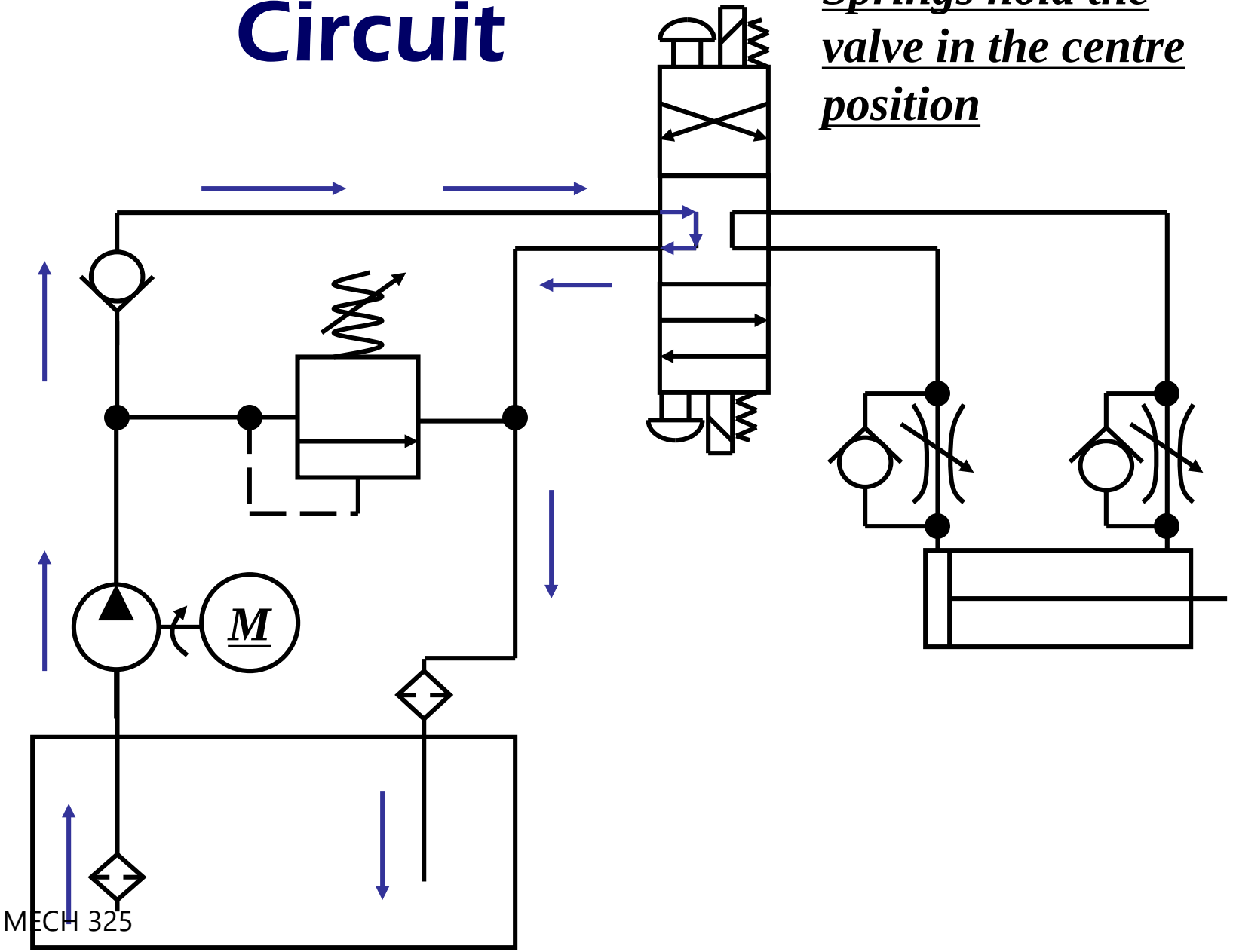


Note: Number of valve positions can vary.

Example: solenoid operated, spring return

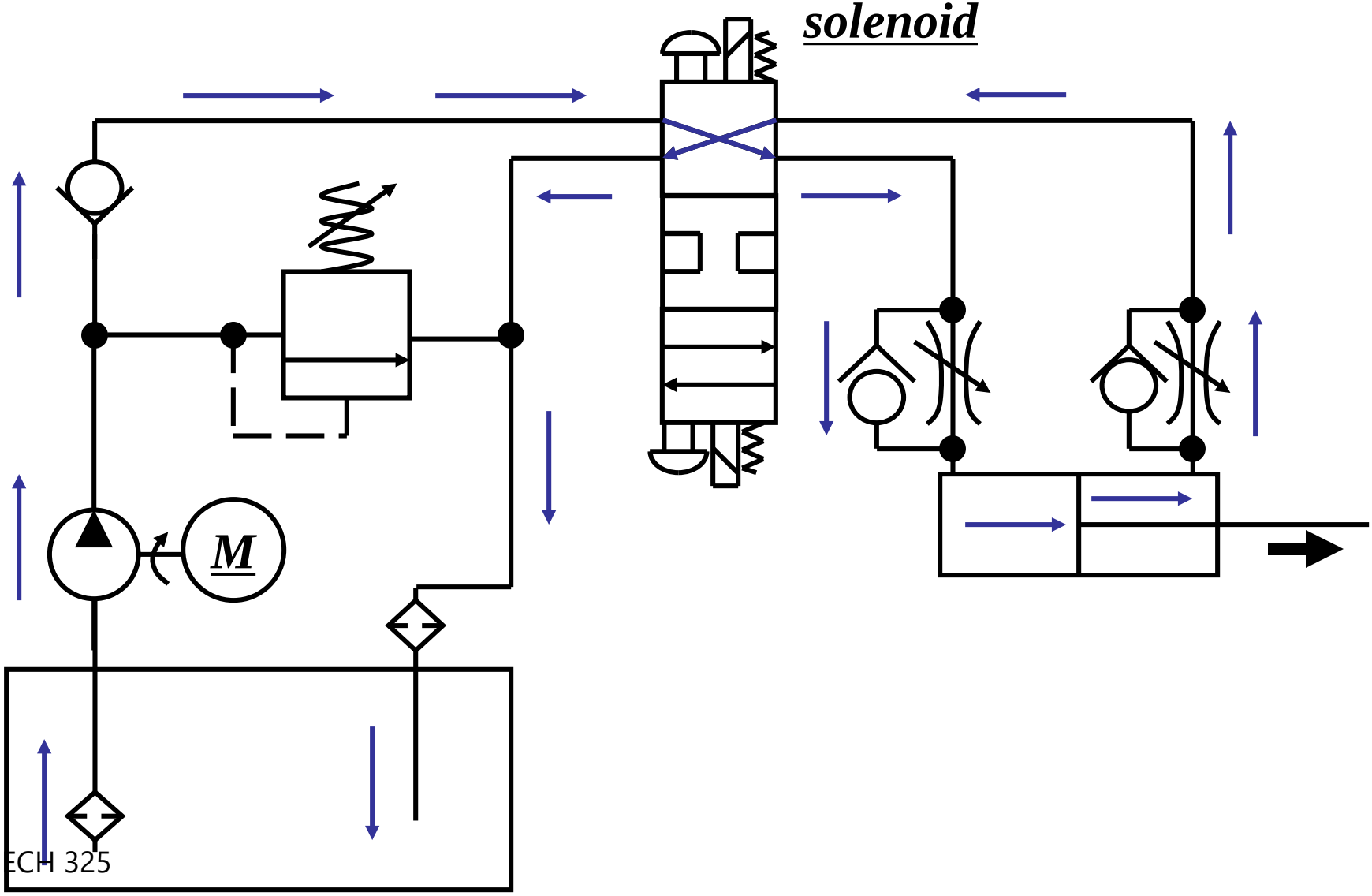
Simple Circuit

Springs hold the valve in the centre position

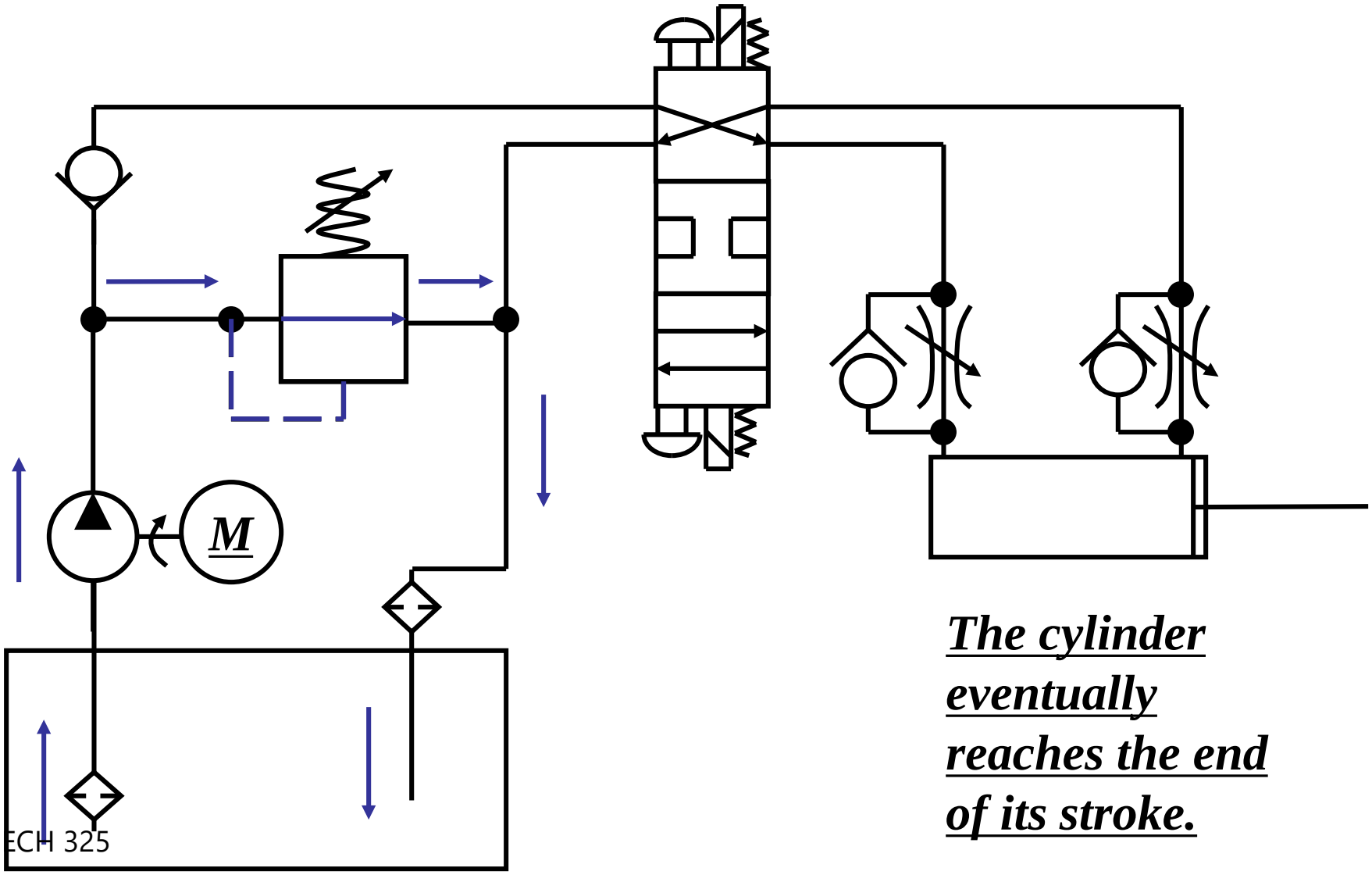


Simple Circuit

Valve pushed to this position by hand or solenoid

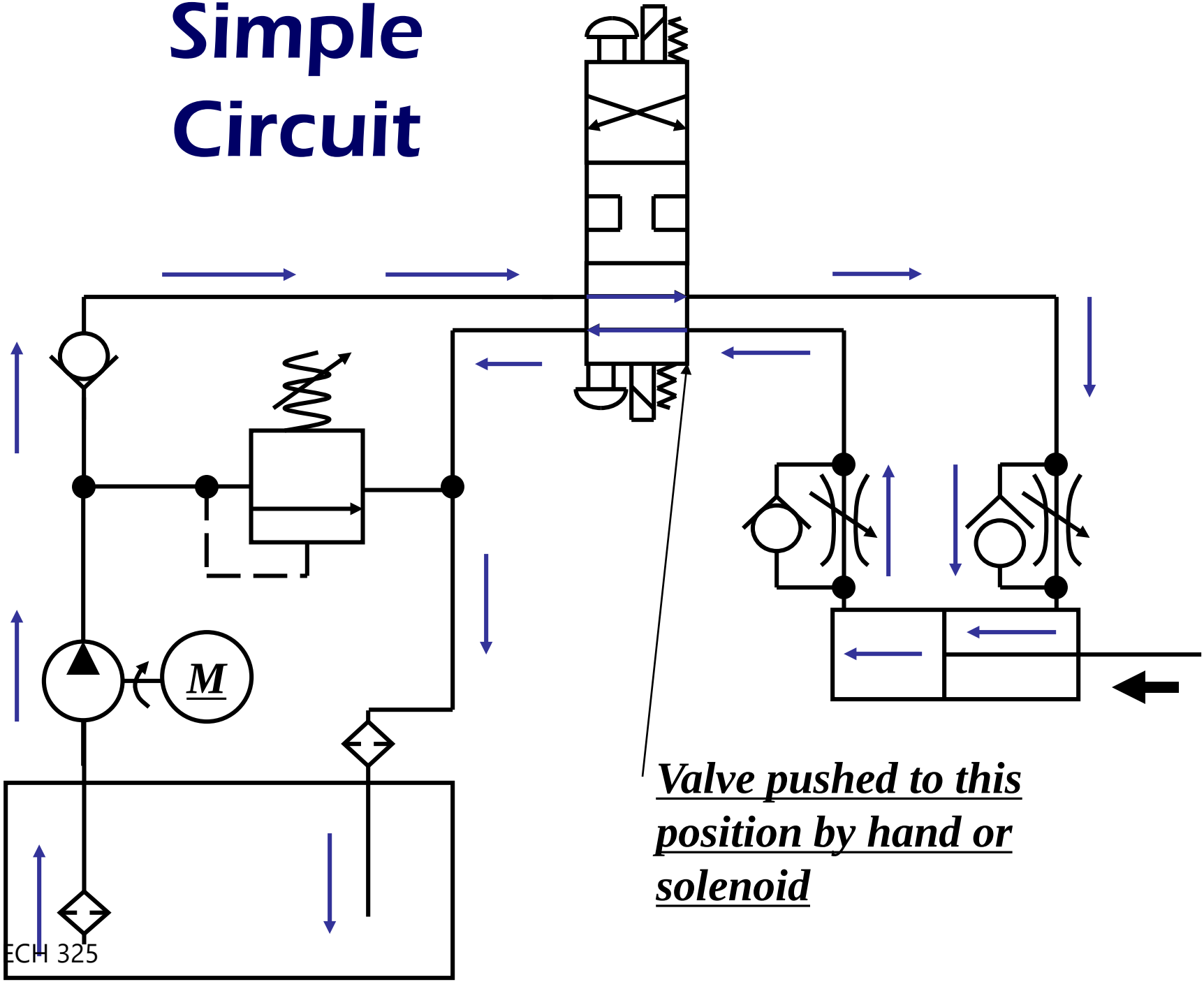


Simple Circuit



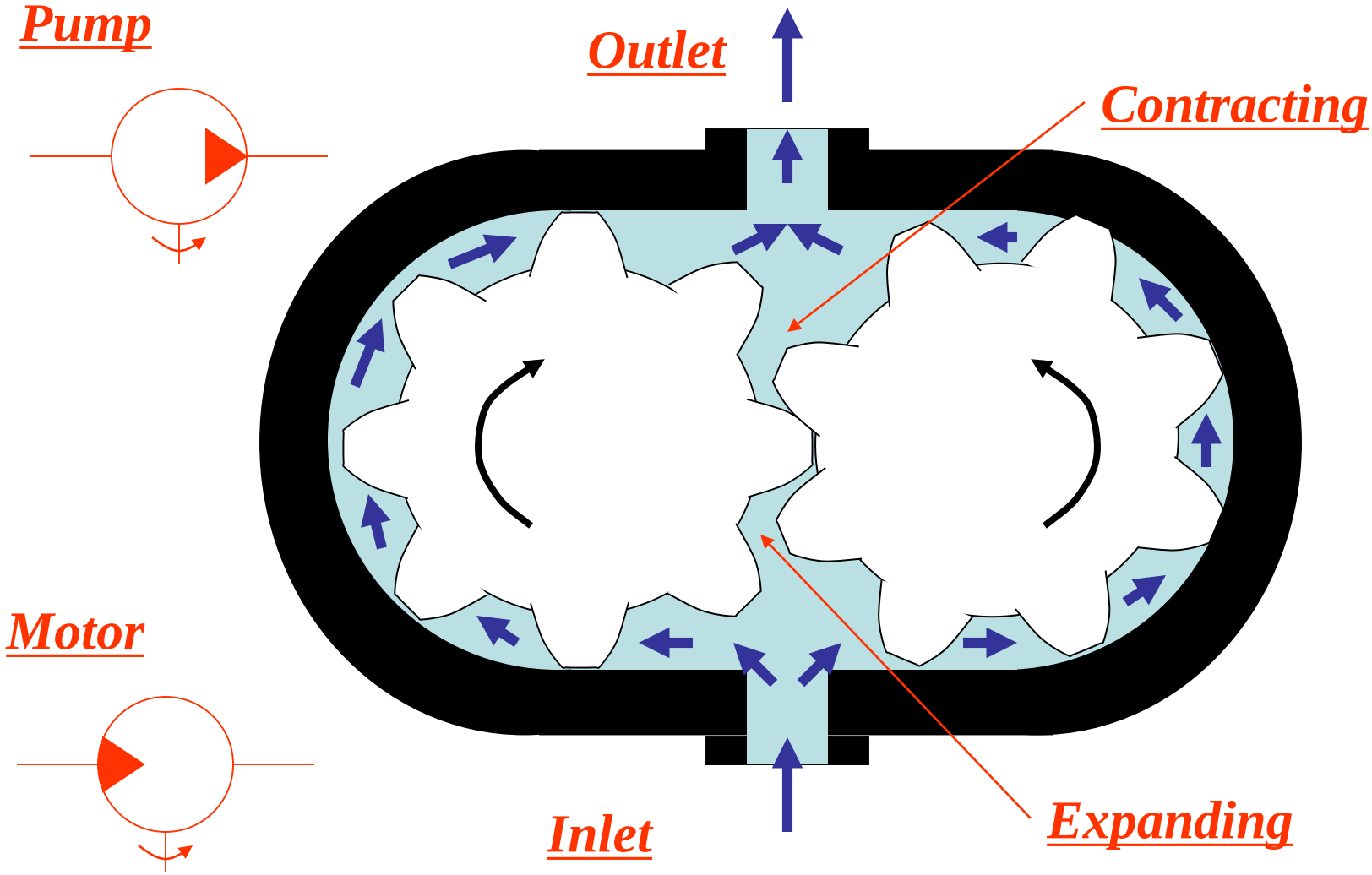
The cylinder eventually reaches the end of its stroke.

Simple Circuit

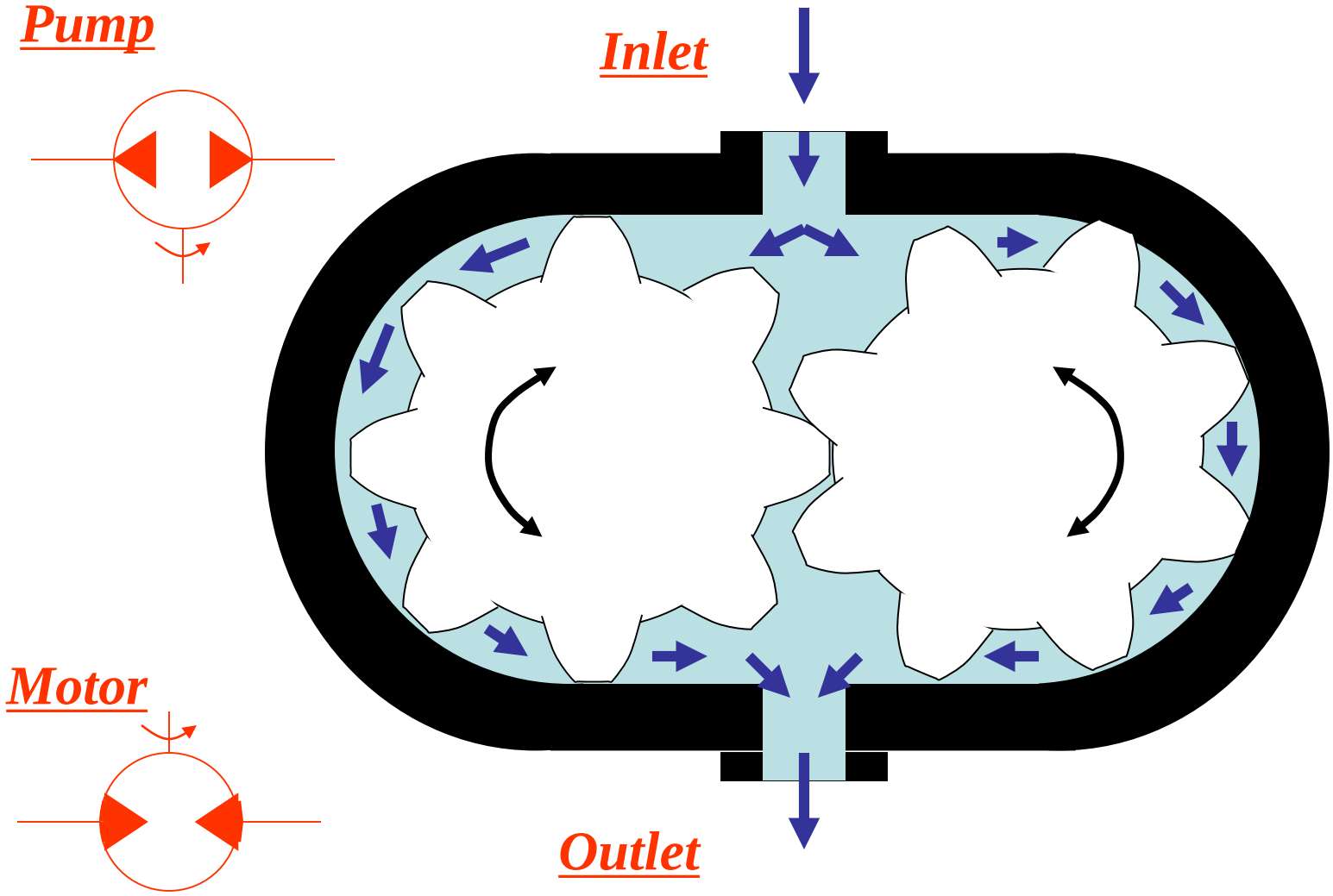


Valve pushed to this position by hand or solenoid

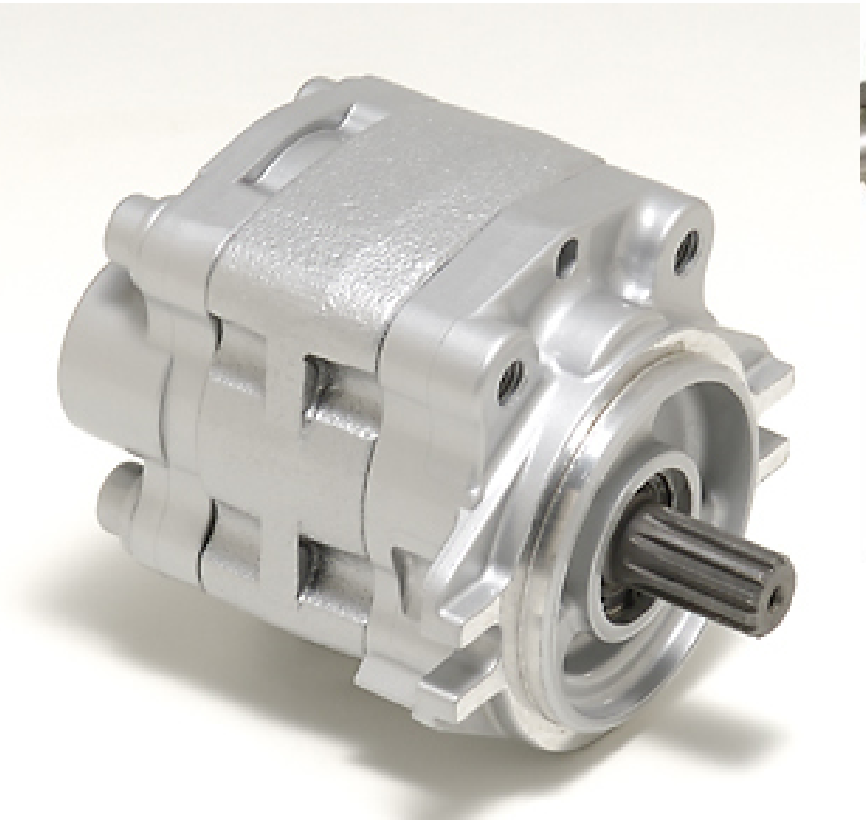
Gear pumps and motors

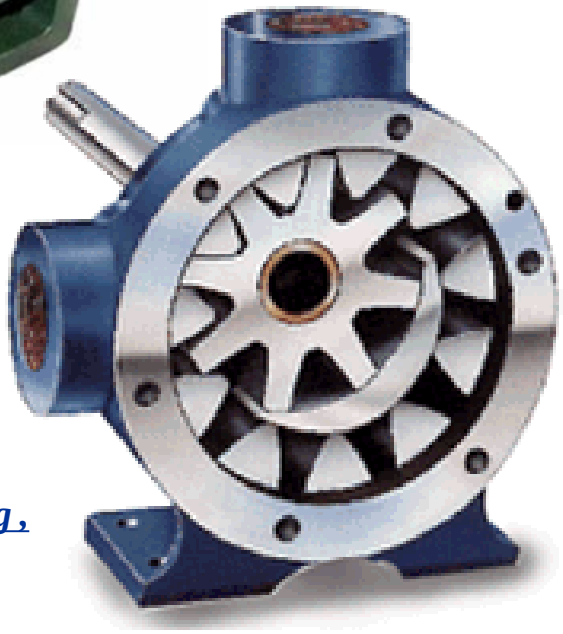


Bi-directional motors and pumps



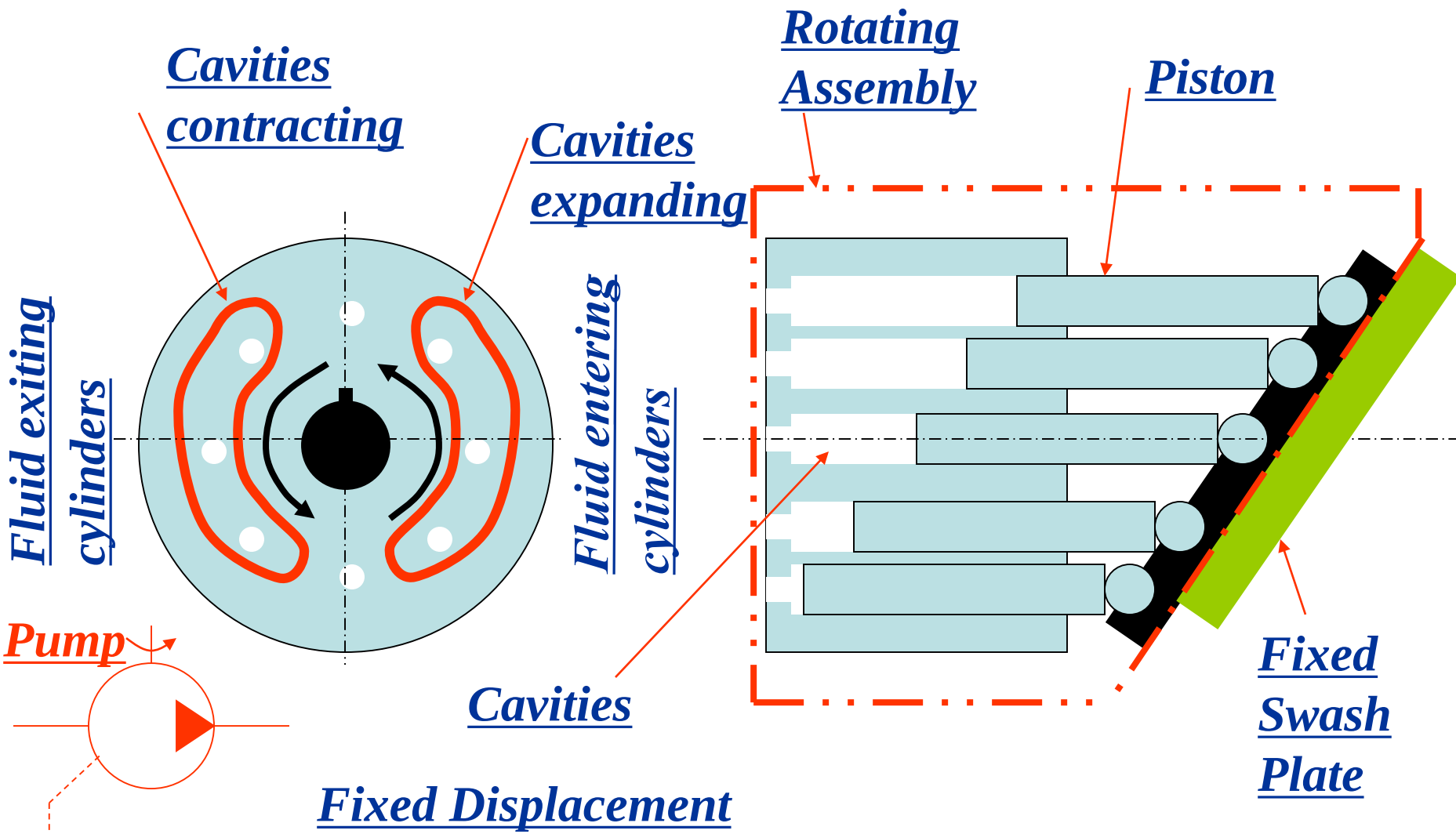
Examples of Gear Pump





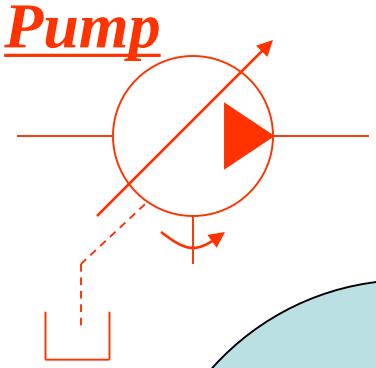
Sources: http://www.kybfluidpower.com/KFS_Gear_Pump.jpg ,
http://www.pumpschool.com/images/genpur.gif ,
http://www.sandybrae.com/training/gp.jpg

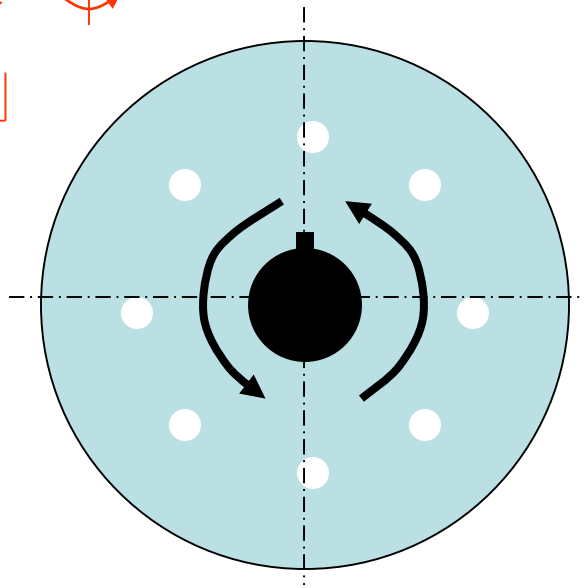
Axial piston pumps and motors

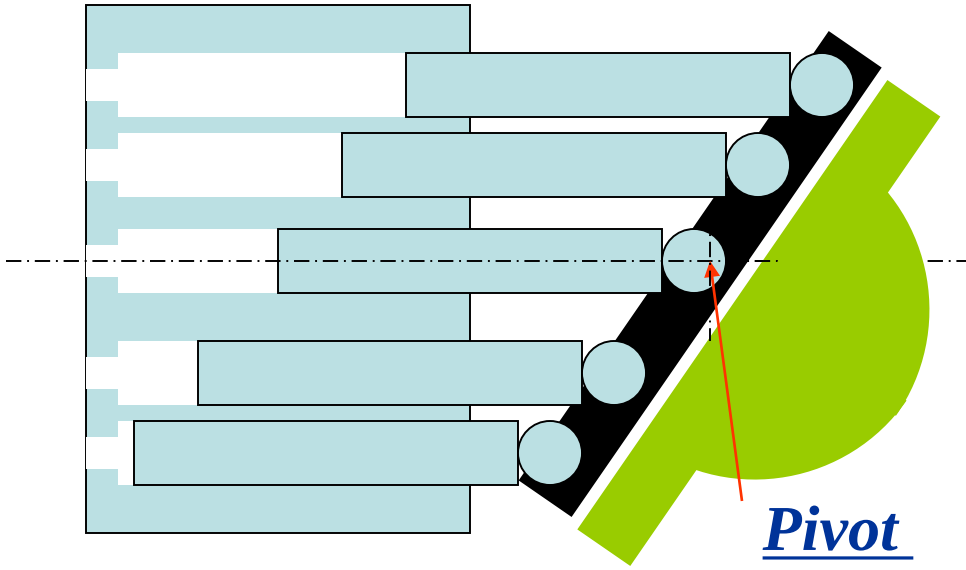


Axial piston pumps and motors

Pump



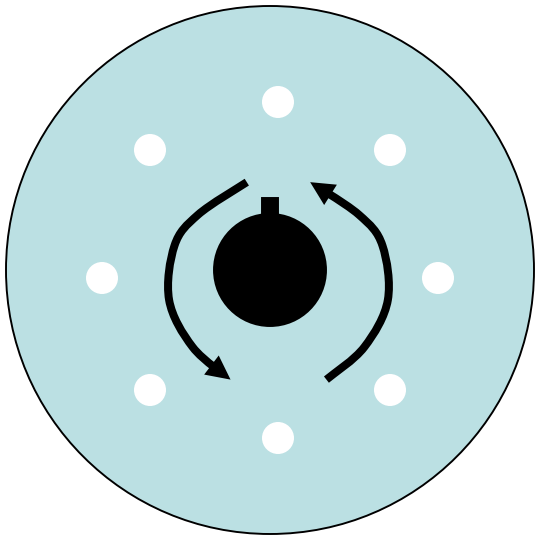


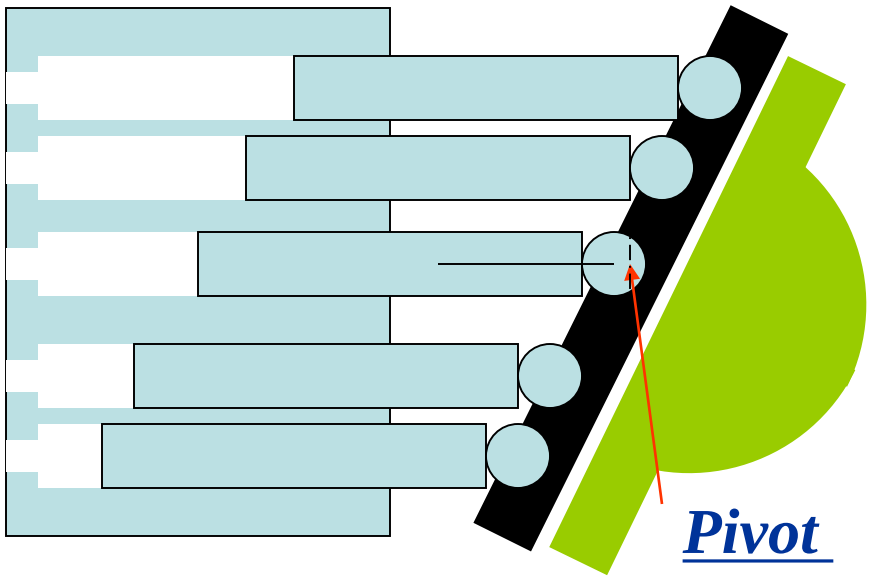


Variable Displacement

Fully stroked – maximum flow rate

Axial piston pumps and motors

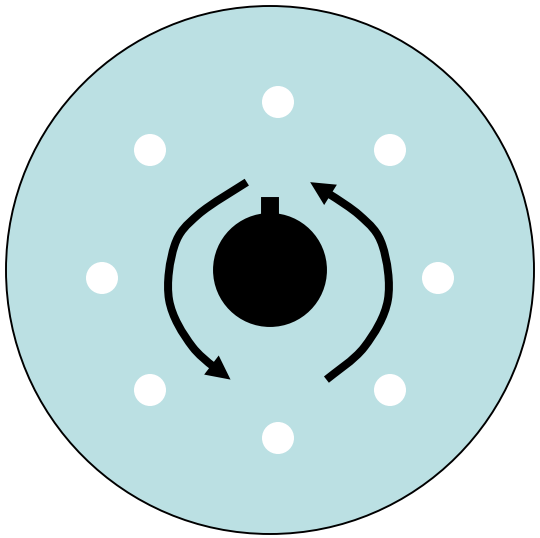


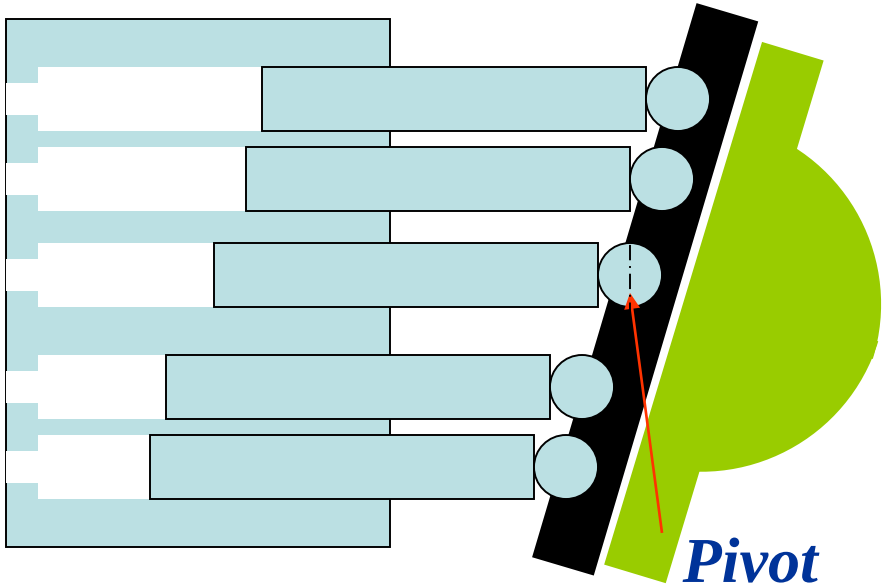


Variable Displacement

Three quarter flow rate

Axial piston pumps and motors





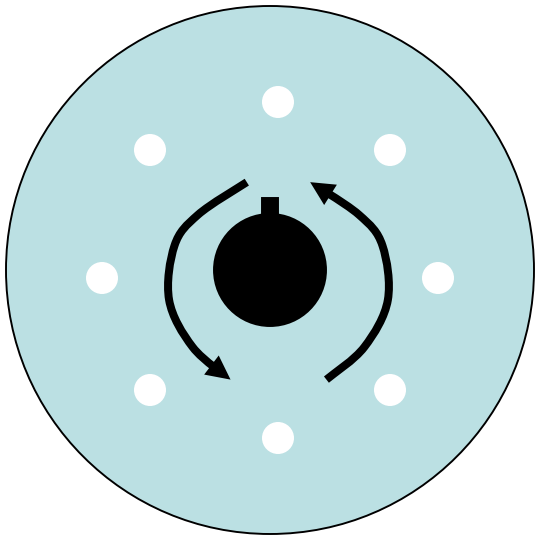
Variable Displacement

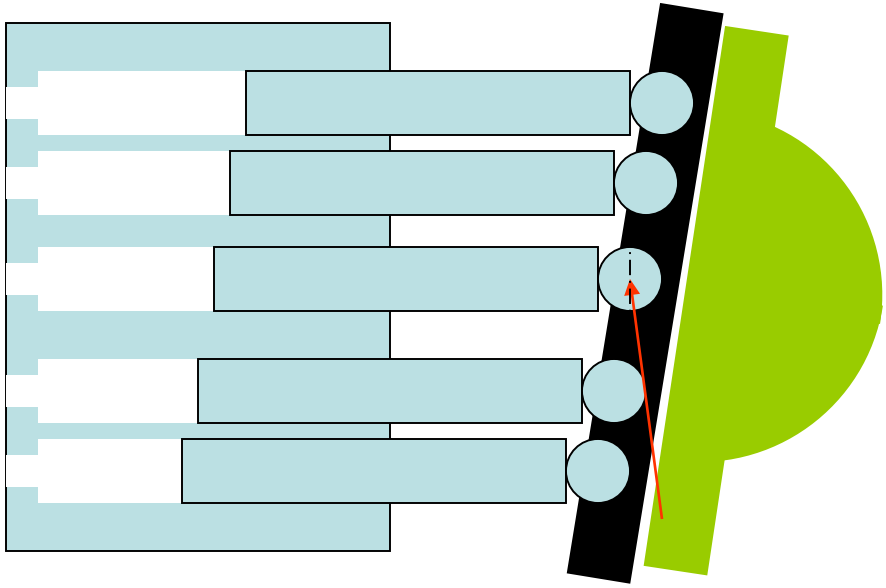
Half flow rate

Tilting Swash Plate

Pivot point

Axial piston pumps and motors





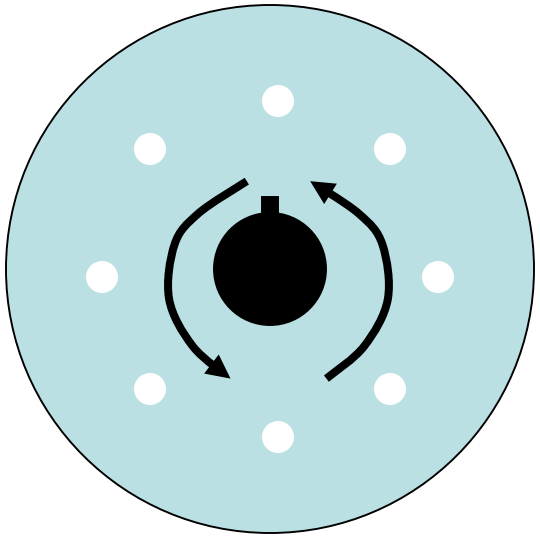
Variable Displacement

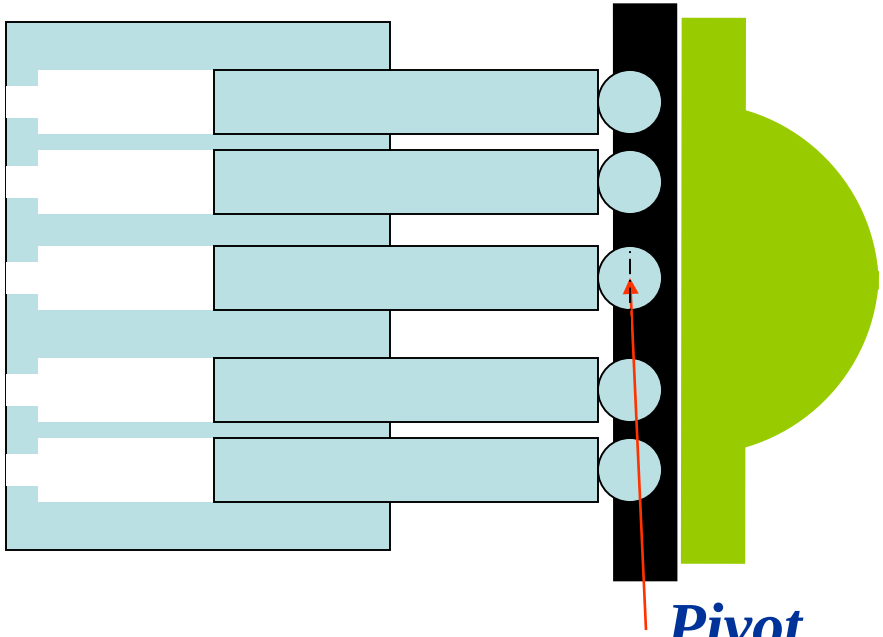
Small flow rate

Tilting Swash Plate

Pivot point

Axial piston pumps and motors





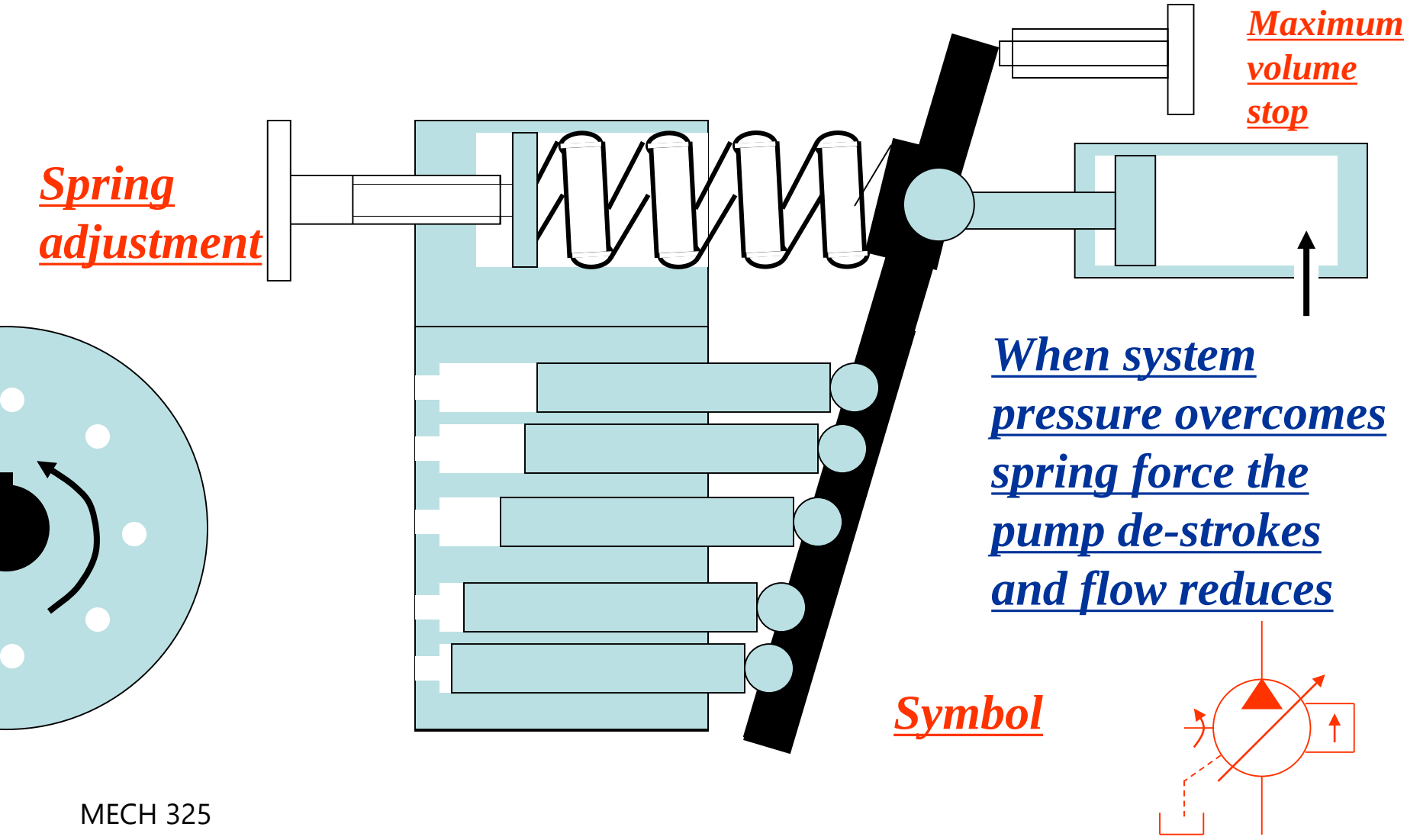
Variable Displacement

Totally de-stroked – no flow but pressure maintained

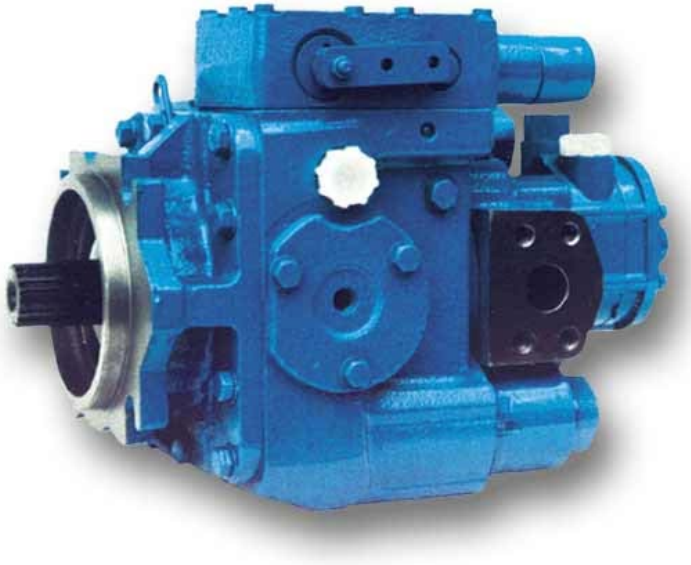
Tilting Swash Plate

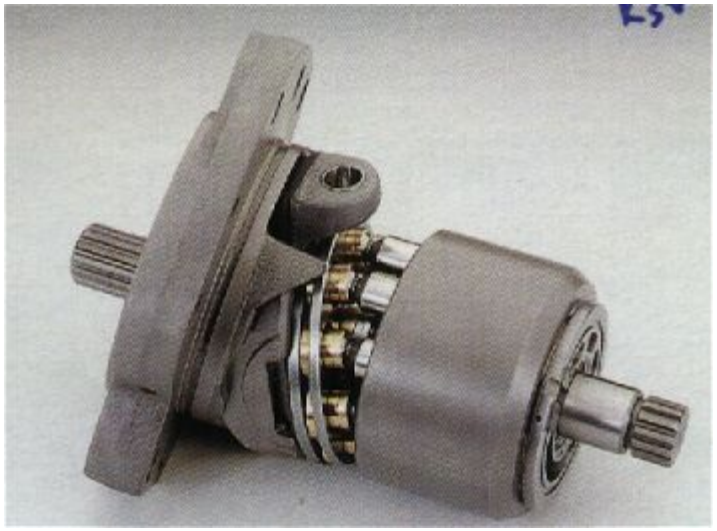
Pivot point

Axial Piston Pumps $^{c}/_{w}$ Variable Displacement, Maximum Flow Stop and Pressure Compensation



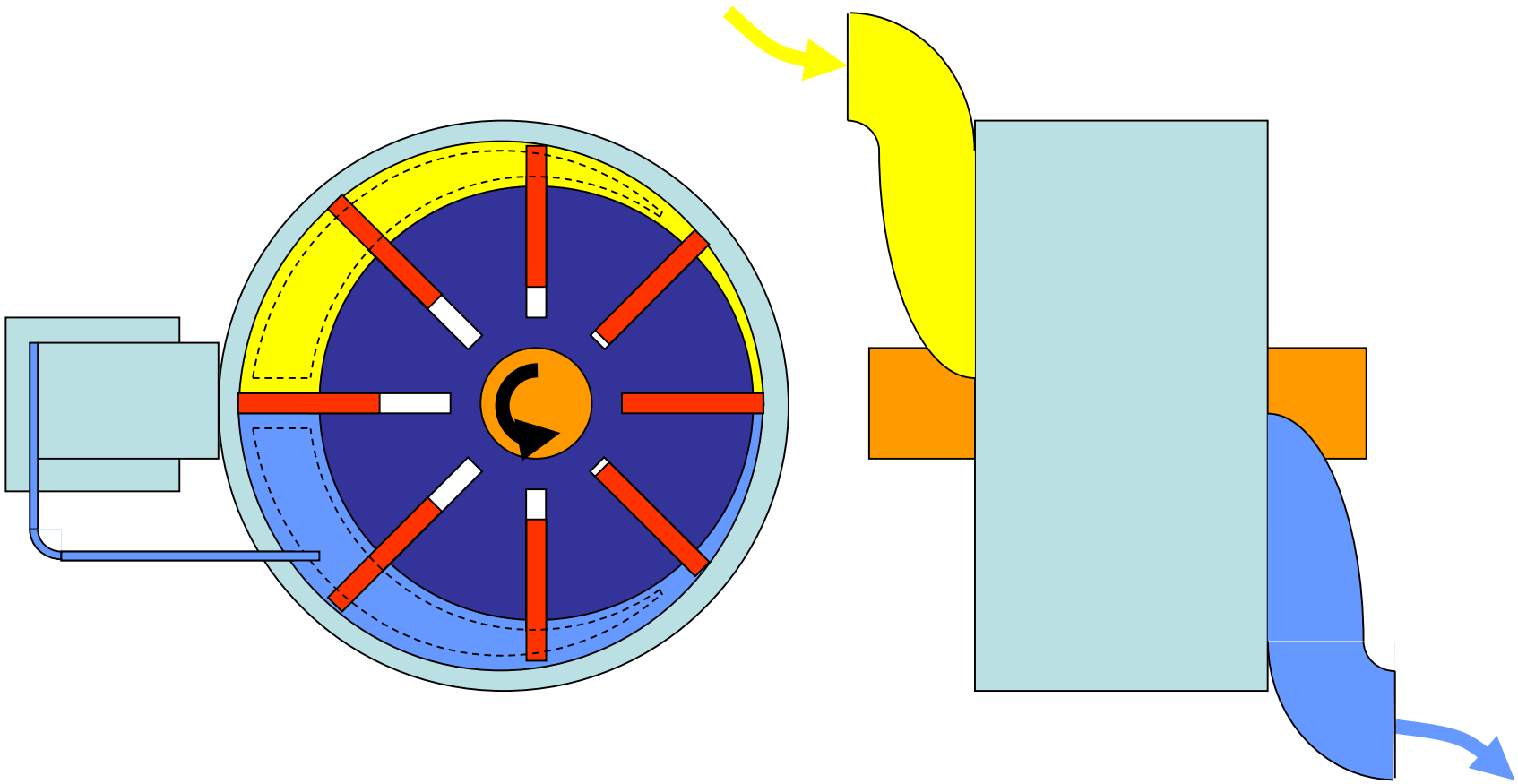
Examples of Axial Piston Pumps



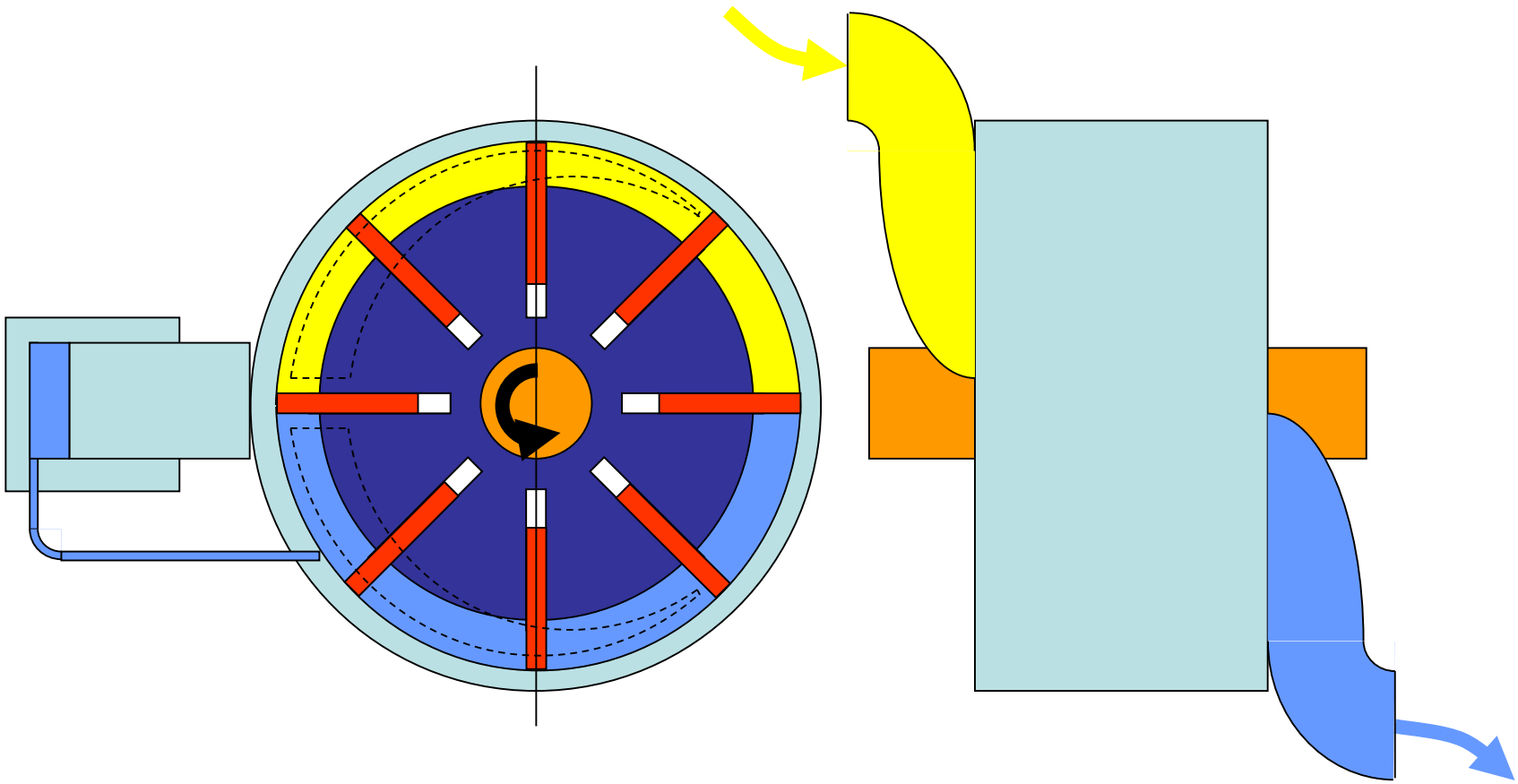


Sources: http://www.alibaba.com/catalog/10851228/Axial_Piston_Pump_20_Series.html , http://paul128.co.kr/paul/heavyequip/pump-kawasaki-k3.htm,

Vane Pump -Variable Displacement Pressure compensating

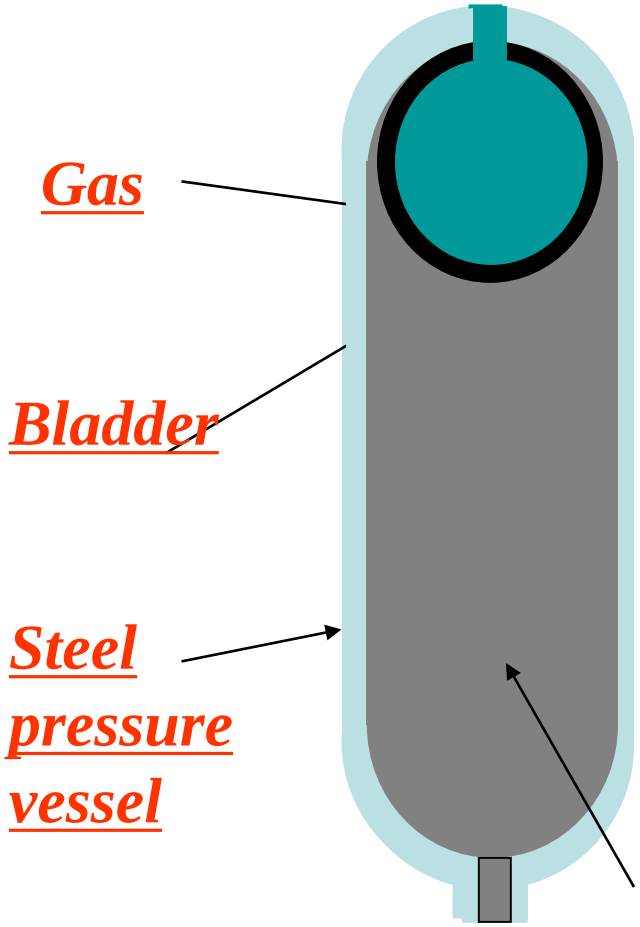


Vane Pump -Variable Displacement Pressure compensating

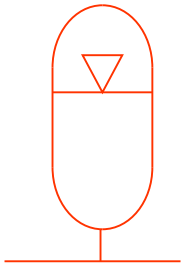


Accumulators

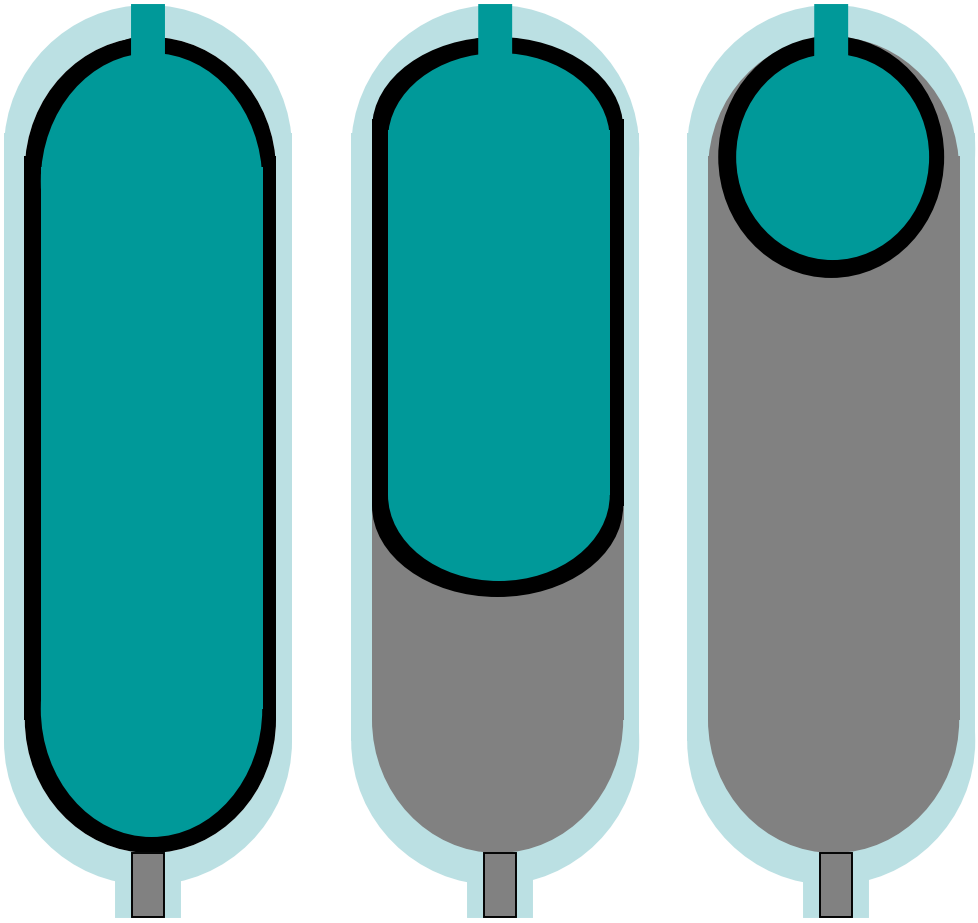
Accumulators can be used to store energy when full pump flow is not needed or for shock absorption or pulsation damping



Symbol for gas filled accumulator

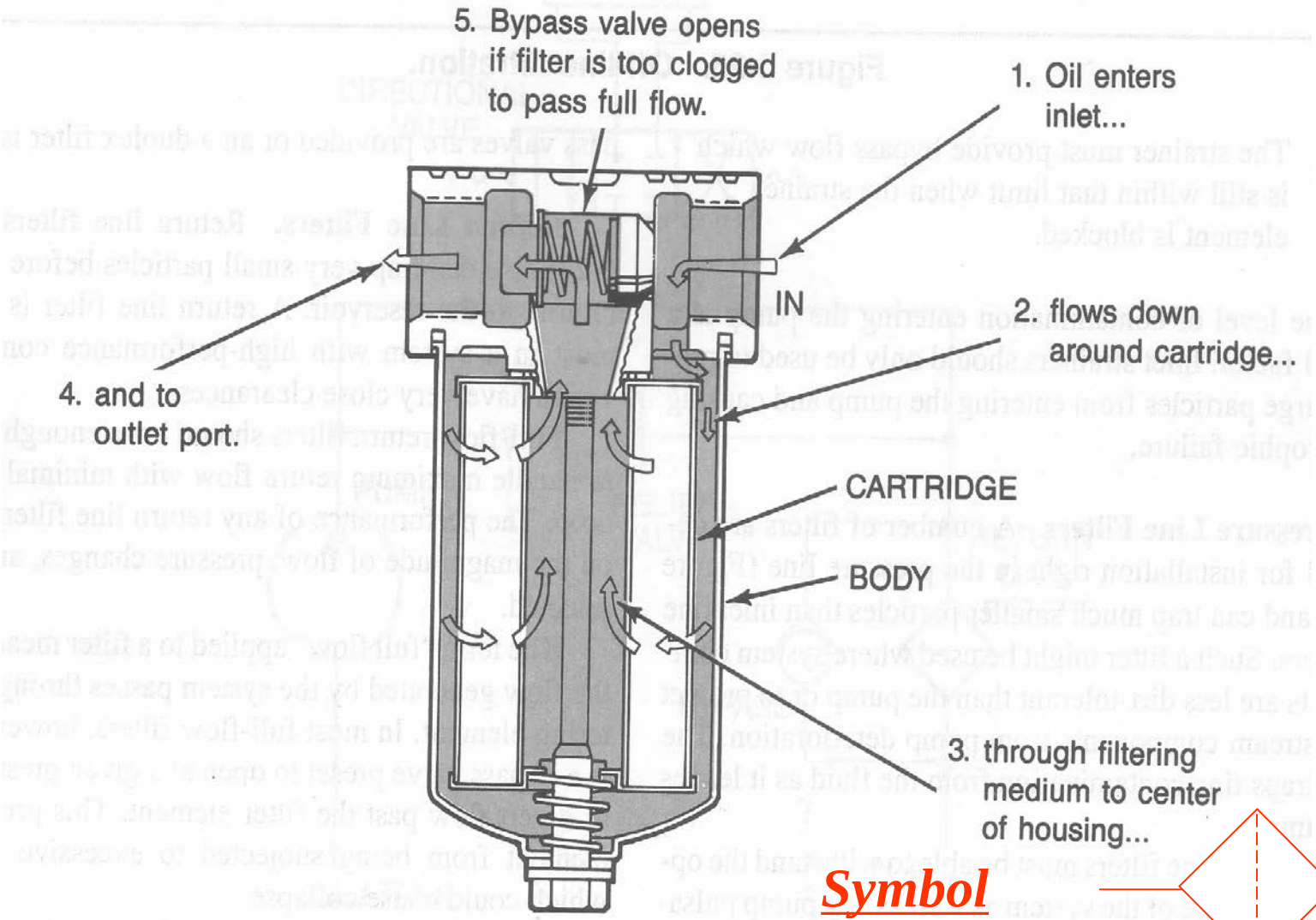


Accumulators

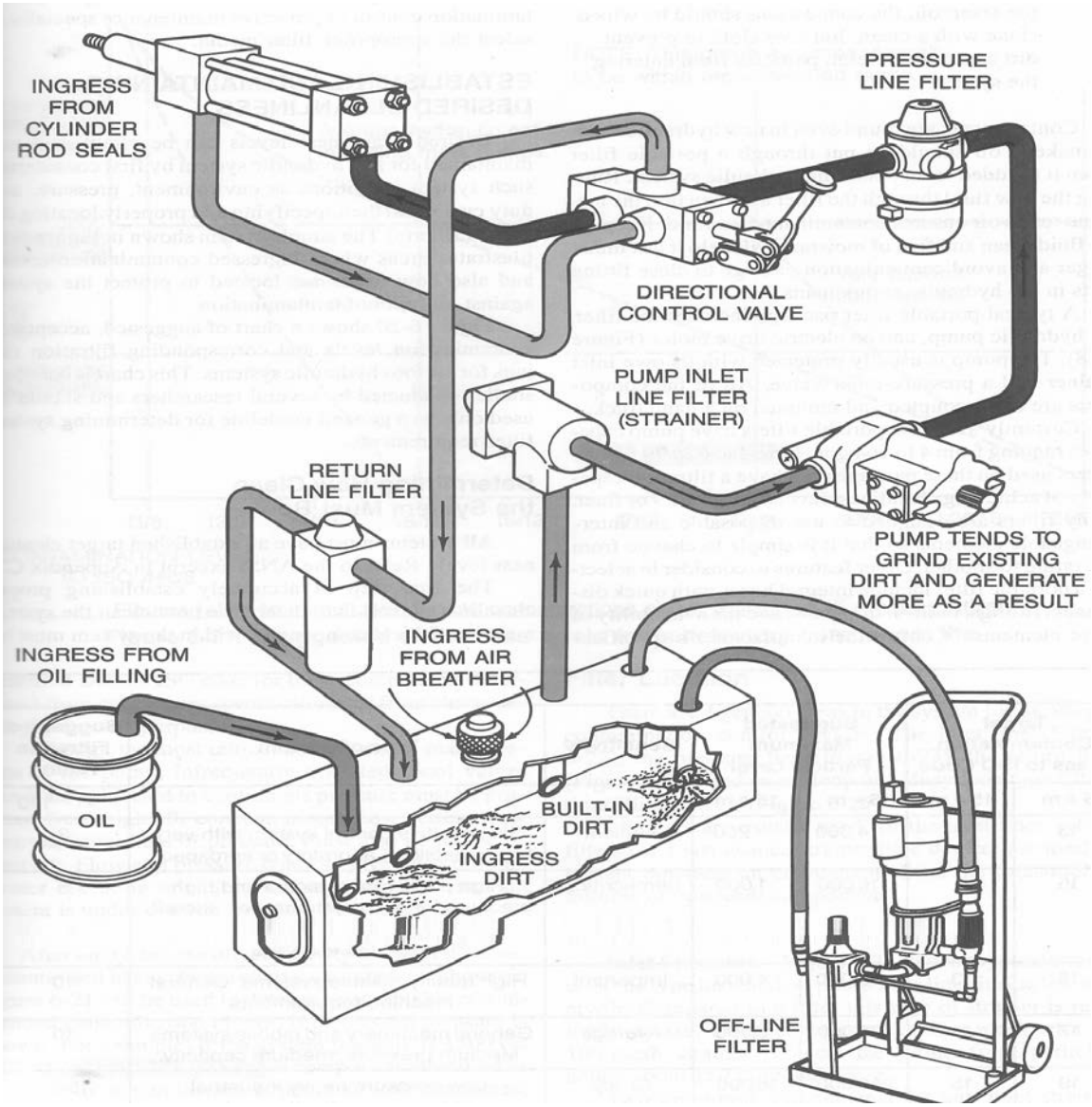


Fluid @ ***Low pressure*** ***Medium pressure*** ***High pressure***

Oil Filters


5. Bypass valve opens if filter is too clogged to pass full flow.
1. Oil enters inlet...
IN
2. flows down around cartridge...
4. and to outlet port.
CARTRIDGE
BODY
3. through filtering medium to center of housing...
Symbol

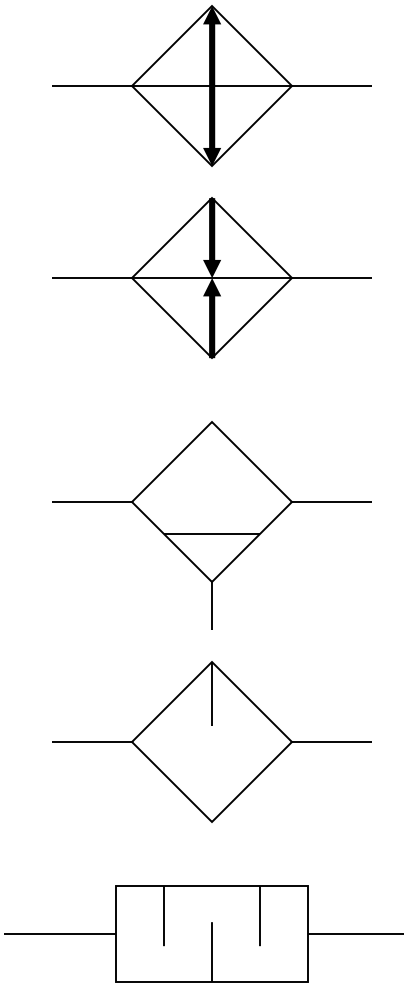
Filters in system



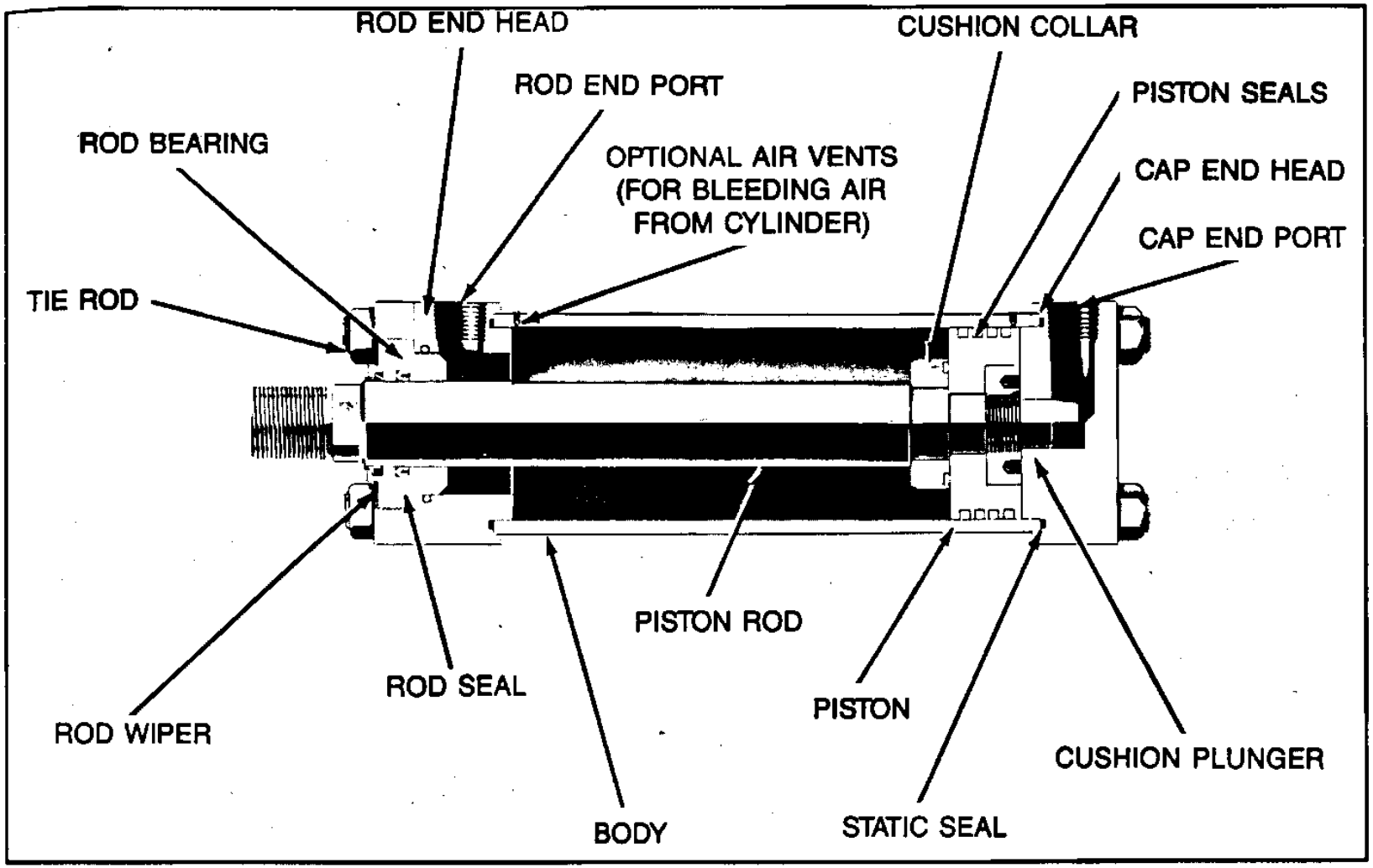
Other fluid conditioners

- Hydraulic
  - ***Cooler***
  - ***Heater***
- Pneumatic
  - ***Separator***
  - ***Lubricator***
  - ***Muffler***

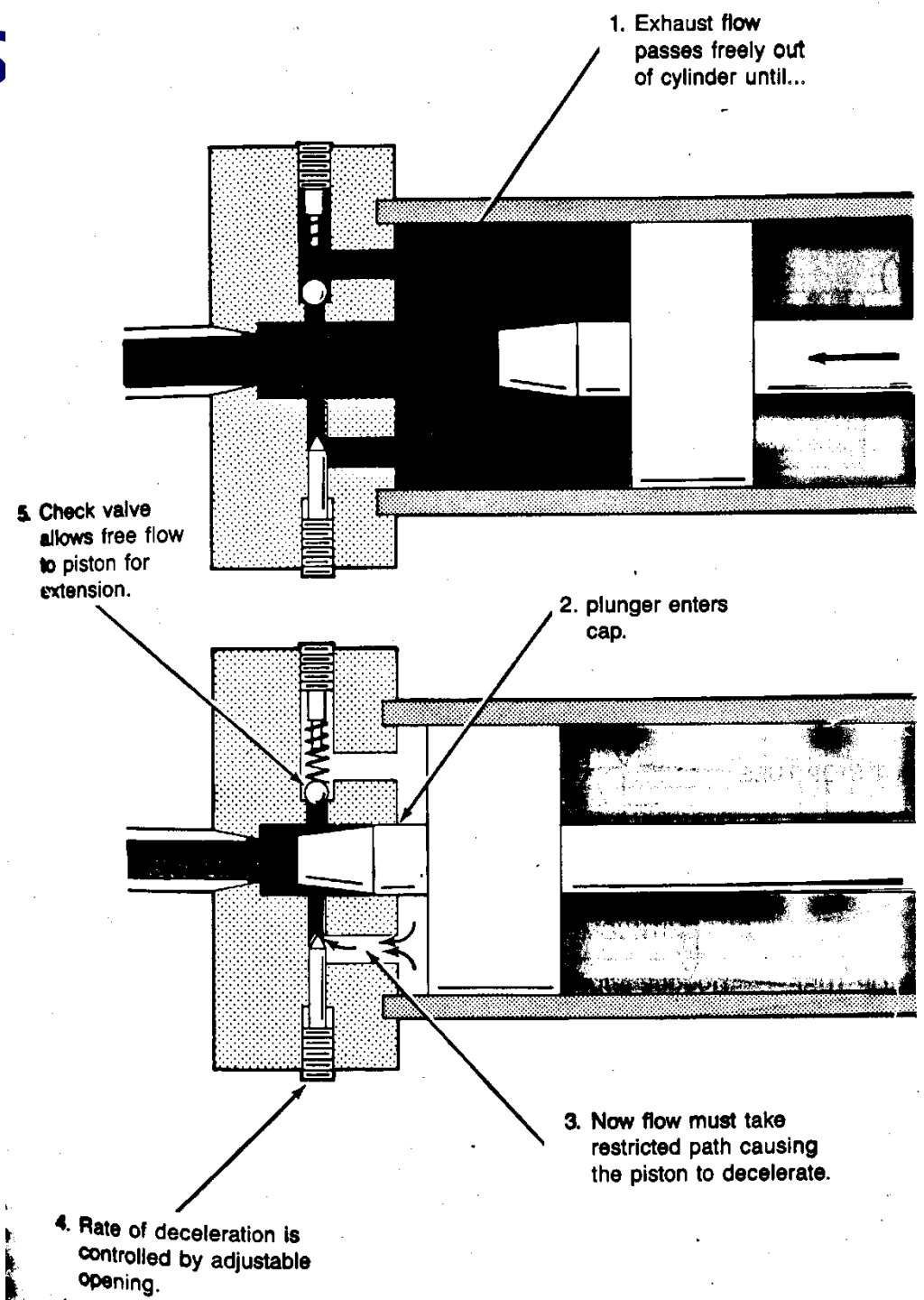
- Symbols



Cushioned Cylinders



Cushions cont.



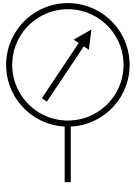
Other devices

- Symbols

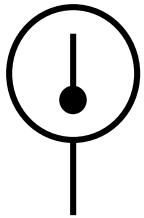
- ***Pipe***

- ***Hose***

- ***Pressure gauge***



- ***Thermometer***



- ***Electrical pressure switch***