PNEUMATIC & HYDRAULIC systems

Midterm exam review

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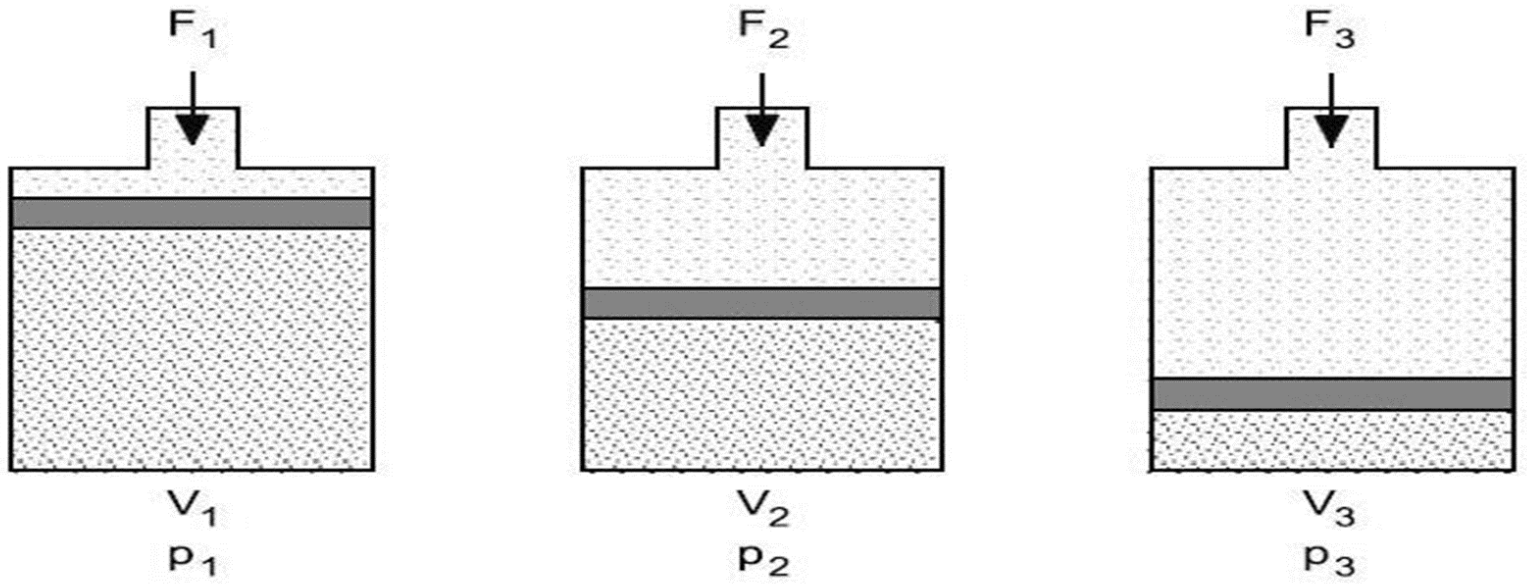
What we studies so fare

- Introduction to fluid power
- Characteristics of air
- Air preparation
- Compressor types
- AIR GENERATION, TREATMENT & DISTREBUTION.
- PNEUMATIC ACTUATORS
- Input, Control and Processing elements
- Pneumatic sensors and transducers
- Pneumatic system design and development part

Characteristics of air

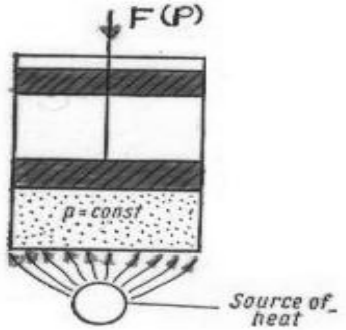
Boyle-Mariotte's Law



The pressure of a gas tends to increase as the volume of the container decreases.

$$p_1 \bullet V_1 = p_2 \bullet V_2 = p_3 \bullet V_3 = \text{Constant}$$

Gay-Lussac law



$$\frac{V_1}{V_2} = \frac{T_1}{T_2} \qquad V_1 = \text{Volume at } T_1,\ V_2 = \text{Volume at } T_2$$

or

$$\frac{V}{T} = \text{Constant}$$

The volume change ΔV is:

$$\Delta V = V_2 - V_1 = V_1 \bullet \frac{T_2 - T_1}{T_1}$$

The following applies for V_2:

$$V_2 = V_1 + \Delta V = V_1 + \frac{V_1}{T_1}(T_2 - T_1)$$

The pressure of a given mass of gas varies directly with the absolute temperature of the gas, when the volume is kept constant

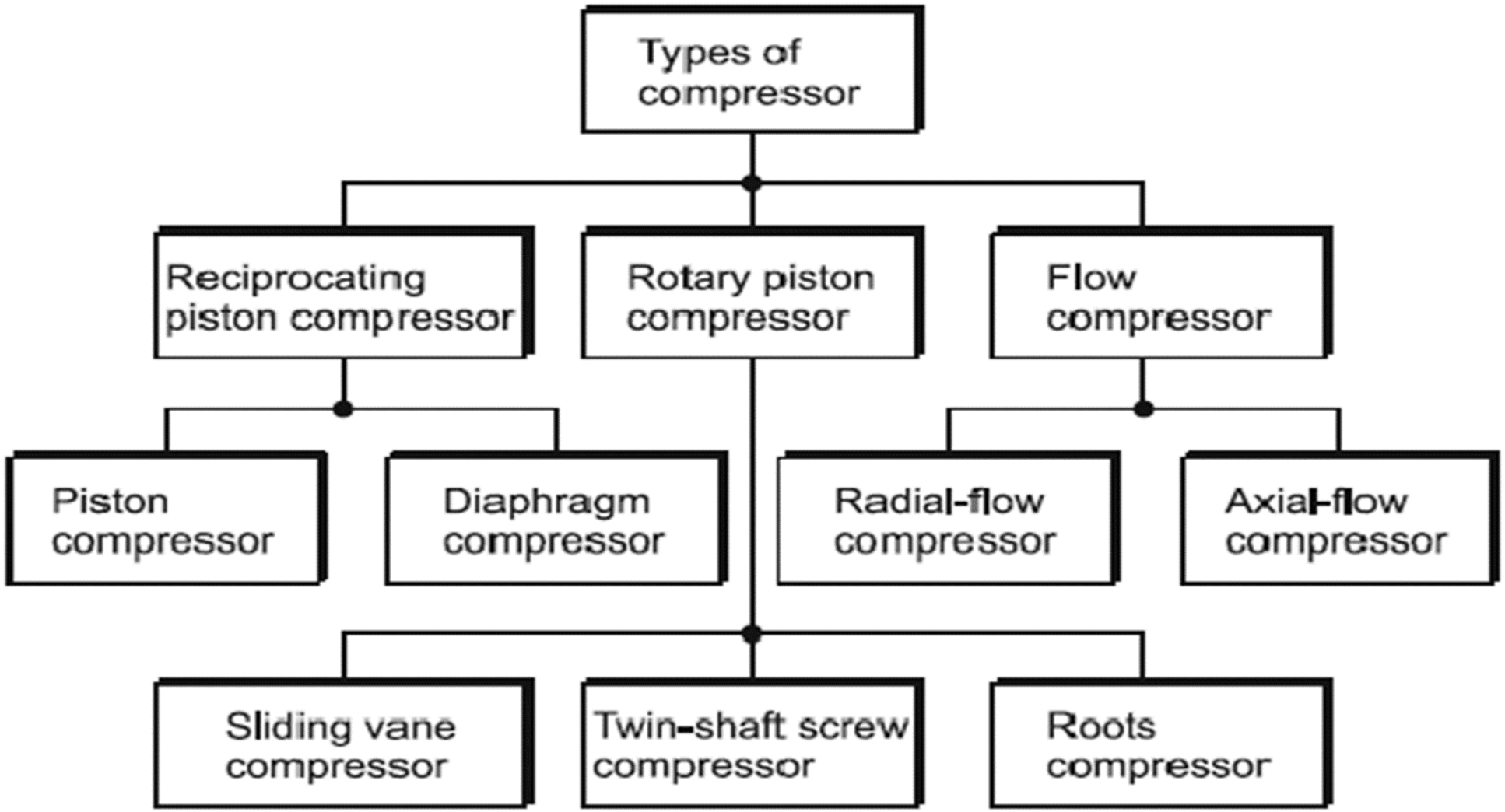
General gas equation

$$\frac{p_1 \bullet V_1}{T_1} = \frac{p_2 \bullet V_2}{T_2} = \text{Constant}$$

This general gas equation results in the previously mentioned laws, if one of the three factors p, V or T is kept constant in each case.

- Pressure p constant : isobar changes
- Volume V constant : isochore changes
- Temperature T constant : isothermal changes

Compressor types



Valve description

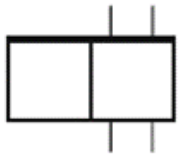
Valve switching positions
are represented as squares

The number of squares shows how many
switching positions the valve has

Lines indicate flow paths,
arrows shows the direction of flow

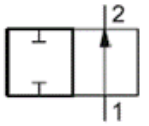
Shut off positions are identified in the boxes
by lines drawn at right angles

The connections (inlet and outlet ports) are shown
by lines on the outside of the box

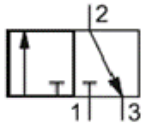


Number of ports
Number of positions

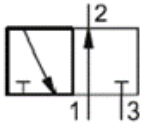
2/2 – Way directional control valve, normally open



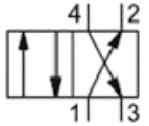
3/2 – Way directional control valve, normally closed



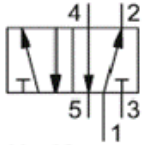
3/2 – Way directional control valve, normally open



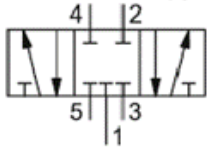
4/2 – Way directional control valve
Flow from 1 → 2 and from 4 → 3



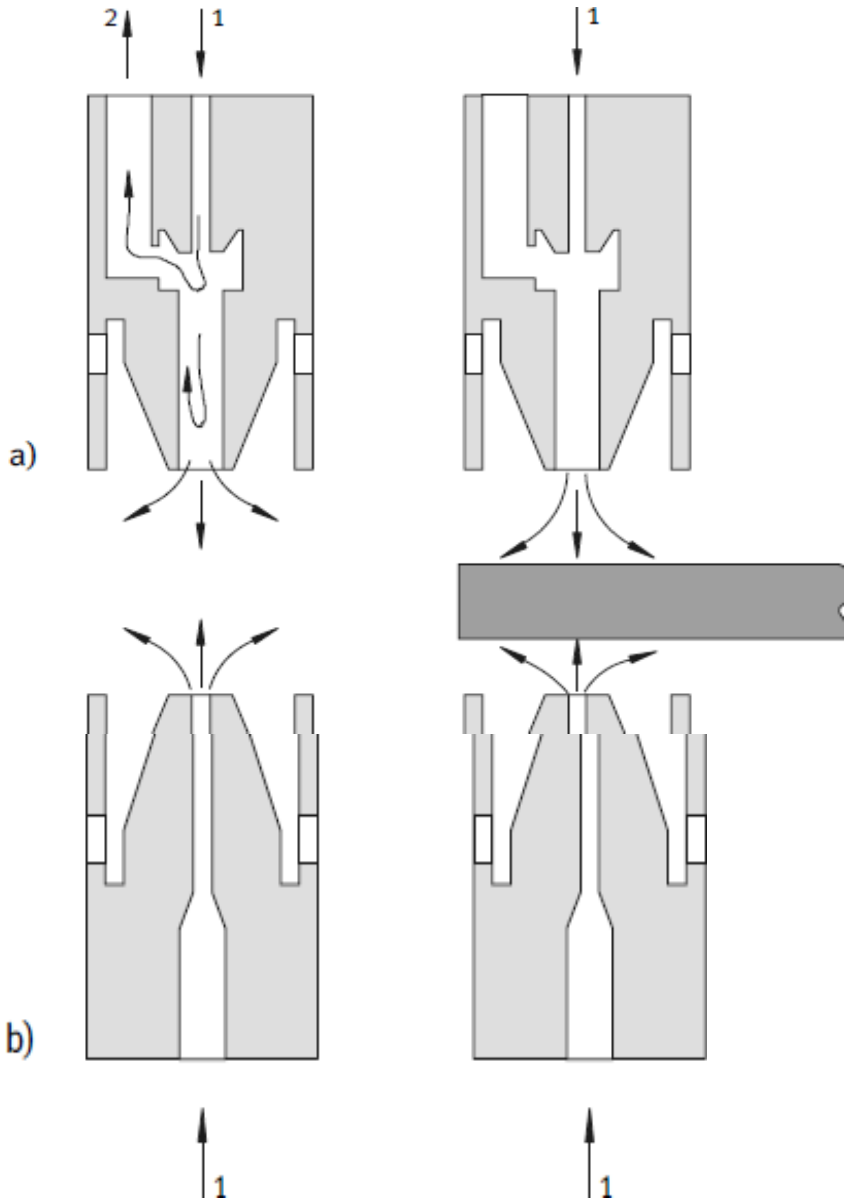
5/2 – Way directional control valve
Flow from 1 → 2 and von 4 → 5



5/3 – Way directional control valve
Mid position closed



Air Barrier Sensor

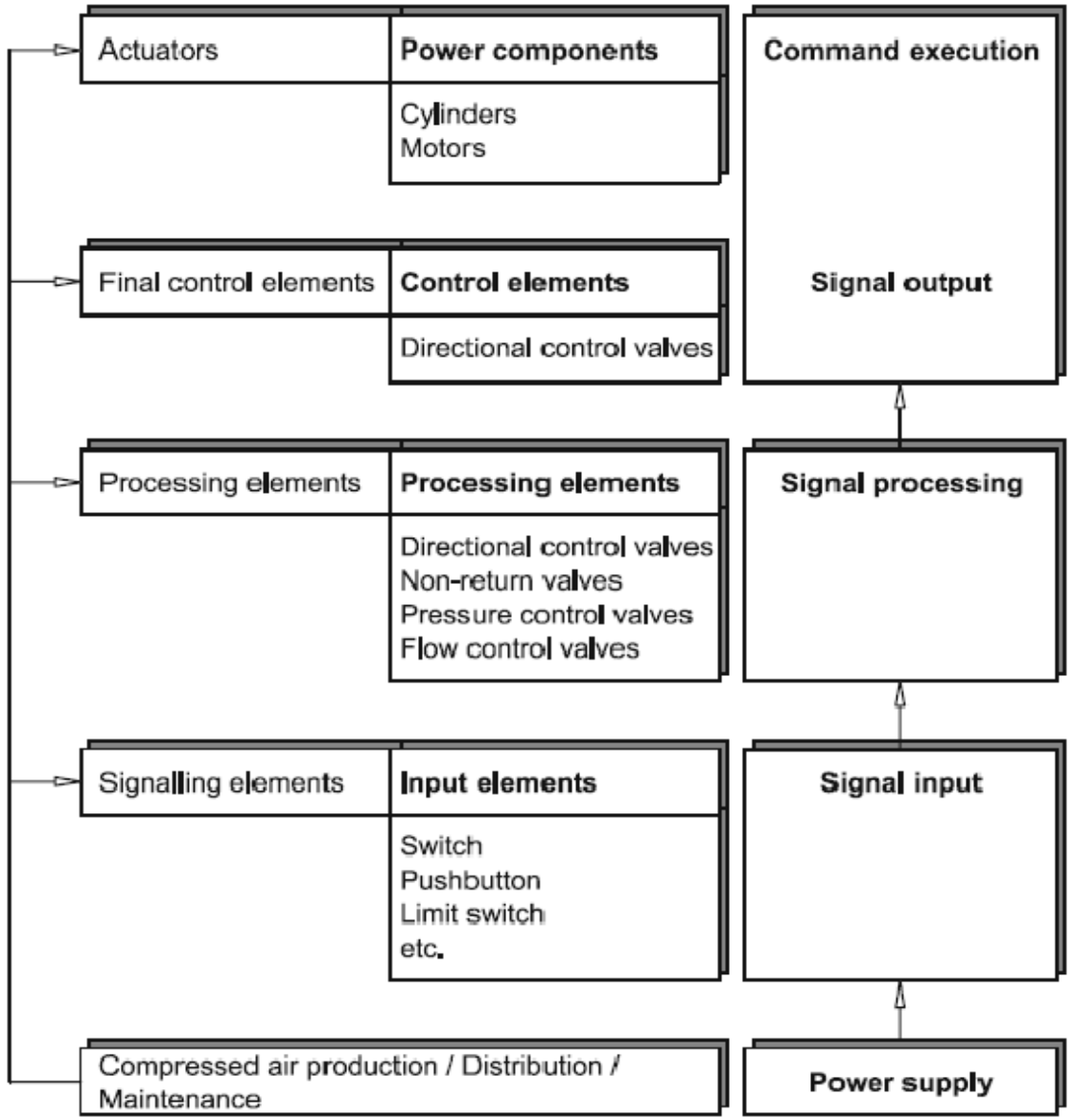


Supply pressure (1) Output pressure (signal pressure) (2)

a) Receiver nozzle

b) Emitter nozzle

Design of the circuit diagram



Control System Development

•The development of the control system solution requires that the problem is defined clearly.

•There are many ways of representing the problem in a descriptive or graphical form.

The methods of representing the control problem include:

- Positional sketch
- Motion diagram:
  -Displacement-Step Diagram.
  -Displacement-Time Diagram.
- Control chart
- Function diagram
- Function chart
- Circuit diagram

Development of Pneumatic circuits

- **- Development of single actuator circuits:**
  - Direct control of a pneumatic cylinders.
  - Indirect control of a pneumatic cylinders.
  - Logic functions: AND, OR, …
  - Memory circuit and speed control of a cylinder.
  - The quick exhaust valve.
  - Pressure dependent control.
  - The time delay valve.
- **- Development of multiple actuator circuits**

Example 1: Direct control of single acting cylinder