

# Chapter 5:

General information on  
**pneumatic & hydraulic** circuits

# Comparison: Hydraulic - Pneumatic

## Pneumatic

Compressed

## Hydraulic

Oil

The organs of the circuits

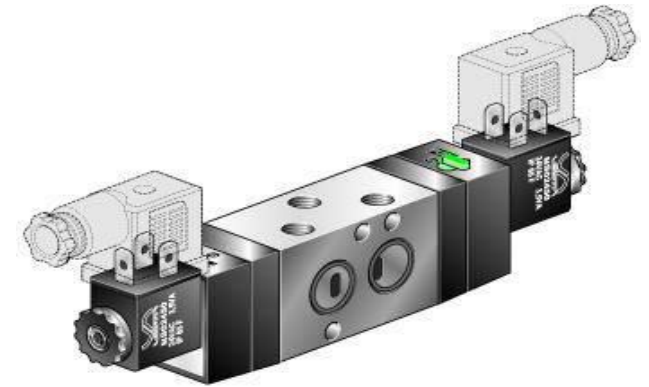
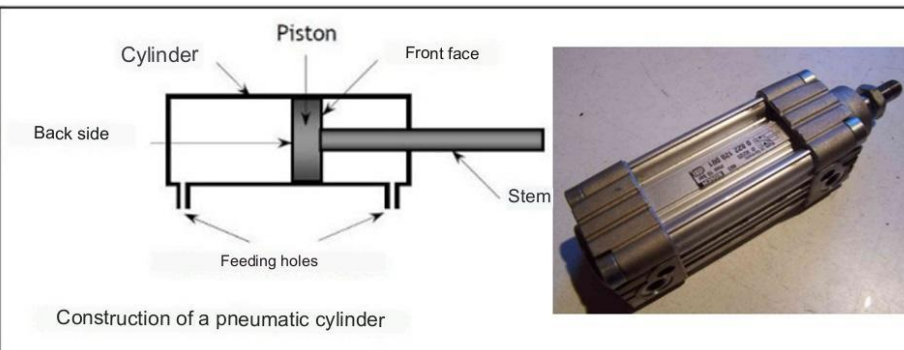
Single and double acting

Distributors

Pressure limitation and regulation

Compressors

Pumps



## Comparison: Hydraulic - Pneumatic

| criteria                              | Hydraulic   | Pneumatic   |
|---------------------------------------|---|---|
| cost                                  | Requires a hydraulic unit                         | centralized compressed air production and easier fluid transport. |
| Admissible power                      | $p = 300 \text{ bar}$ , $F > 500 \text{ daN}$     | $p = 10 \text{ bar}$ , $F < 500 \text{ daN}$                      |
| Responses (Speed)                     | Stronger viscosity, therefore more <<< slower >>> | Speed, speed $3 \text{ m/s}$<br>$30 \text{ m/s}^2$                |
| Flexibility and precision of movement | Regular feed rate (incompressible oil)            | Oleo-pneumatic unit, proportional pneumatic                       |
| Cleanliness<br>Hygiene                | Oil leaks, steam emanation                        | no annoying pneumatic leaks                                       |

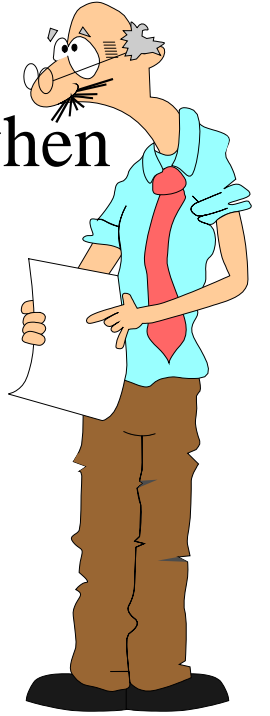
Pneumatic

# 1/ Introduction

Compressed air :

In addition, the main characteristics that must be considered when choosing air as a fluid for the transmission of energy :

- \* low cost ;
- \* a simple and easy supply ;
- \* zero toxicity;
- \* must not generate pollution during use;
- \* **must be compressible for energy storage;**
- \* low viscosity to reduce friction losses during transport.



## 2/ Advantage & Disadvantages

It is true that the use of pneumatics in industry provides many advantages:

- \* air is a free fluid and is available in large quantities;
- \* it is possible to store compressed air in tanks that can be easily moved ;
- \* the compressed air , if it is not lubricated, can be evacuated directly to the open air without any harmful consequences for the environment;
- \* since air is not an explosive gas, no safety device is required ;

## 2/ Advantage & Disadvantages

- air is a fluid which can move at high speed, which makes it possible to obtain very high response times from the actuators ;
  - air is virtually unaffected by temperature variations ;
- \* it is possible to adequately control the force developed by the actuators.

## 2/ Advantage & **Disadvantages**

On the other hand, pneumatic energy does not only have positive aspects. The following list presents the few **disadvantages** related to the use of pneumatics as work energy:

- the compressed air exhaust is very noisy but this aspect is generally well controlled ;
- \* if the compressed air is to be lubricated, it is expected that the exhaust of the air to the atmosphere will cause an excessively high oil concentration in the ambient air.

## 2/ Advantage & Disadvantages

- \* air compression is expensive
- \* it is difficult to obtain constant travel speeds for pneumatic actuators ;

### Mariotte's laws:

Among the laws that govern the behavior of gases, we find Mariotte's law which states that when the temperature is kept constant, the volume of a gas is inversely proportional to its absolute pressure. From this law, follows the following equation:

$$P_1V_1 = P_2V_2$$

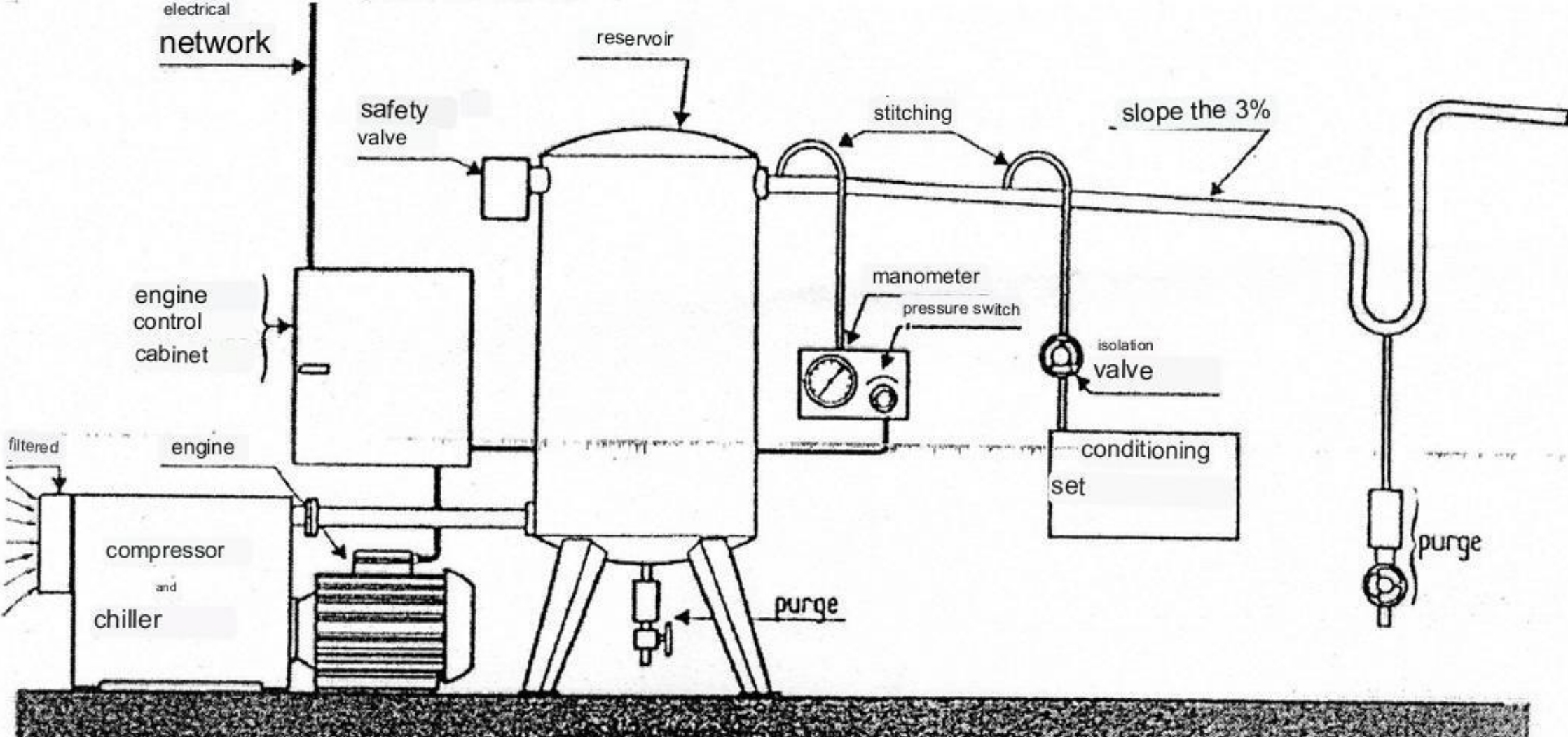
### Gay Lussac's law:

This law concerns the expansion of gases under the effect of heat. Thus, this law stipulates that at constant pressure, the volume of an ideal gas is proportional to its absolute temperature (in degrees Kelvin). Moreover, Gay Lussac's law is realized using the following equation:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

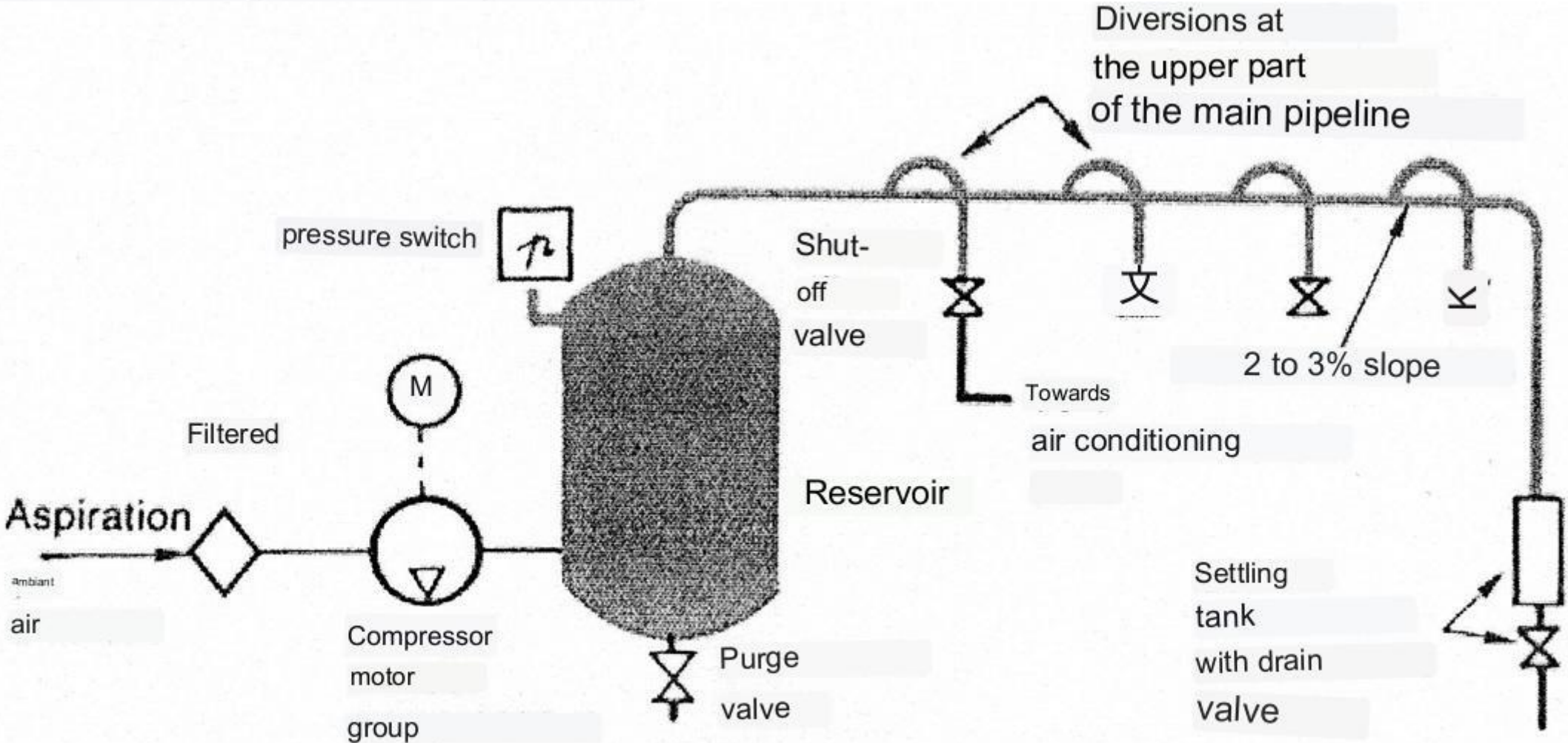
$$T_{kelvin} = T_{celsius} + 273$$

-Pneumatic installation:

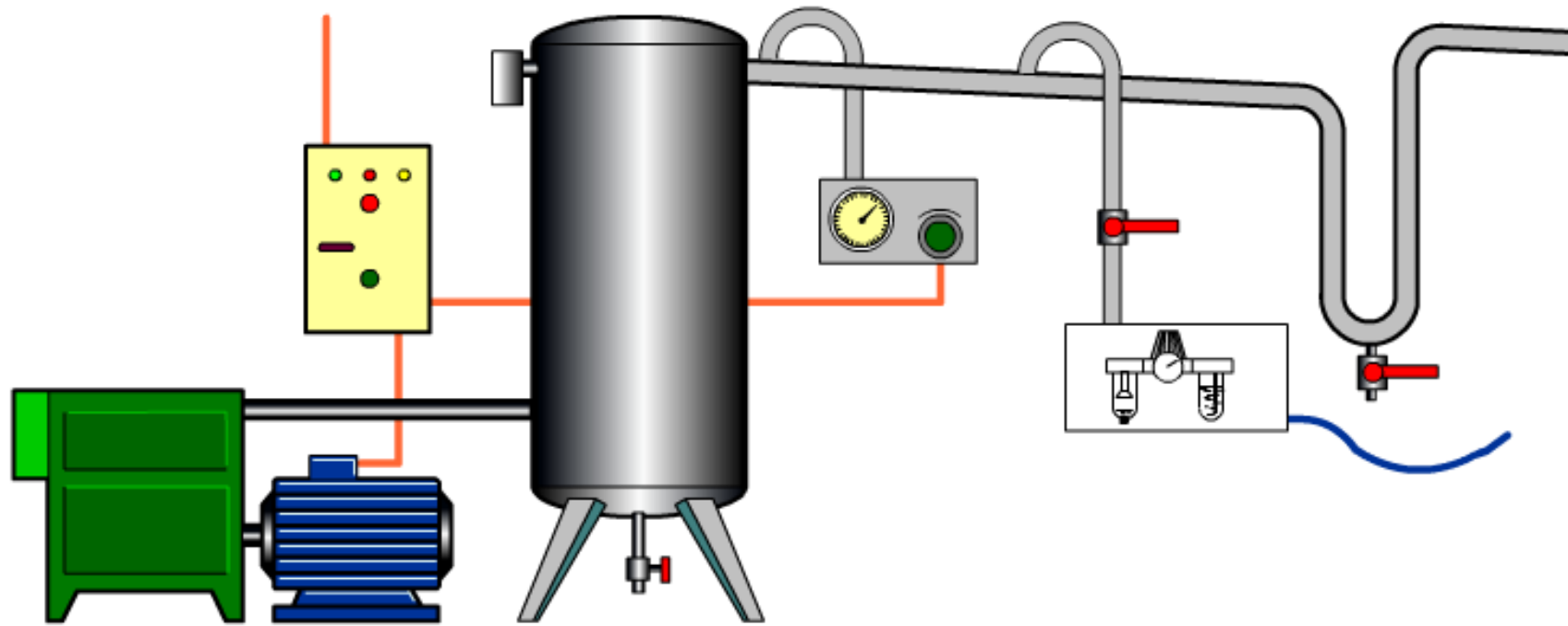


**Air distribution**

-Pneumatic installation:



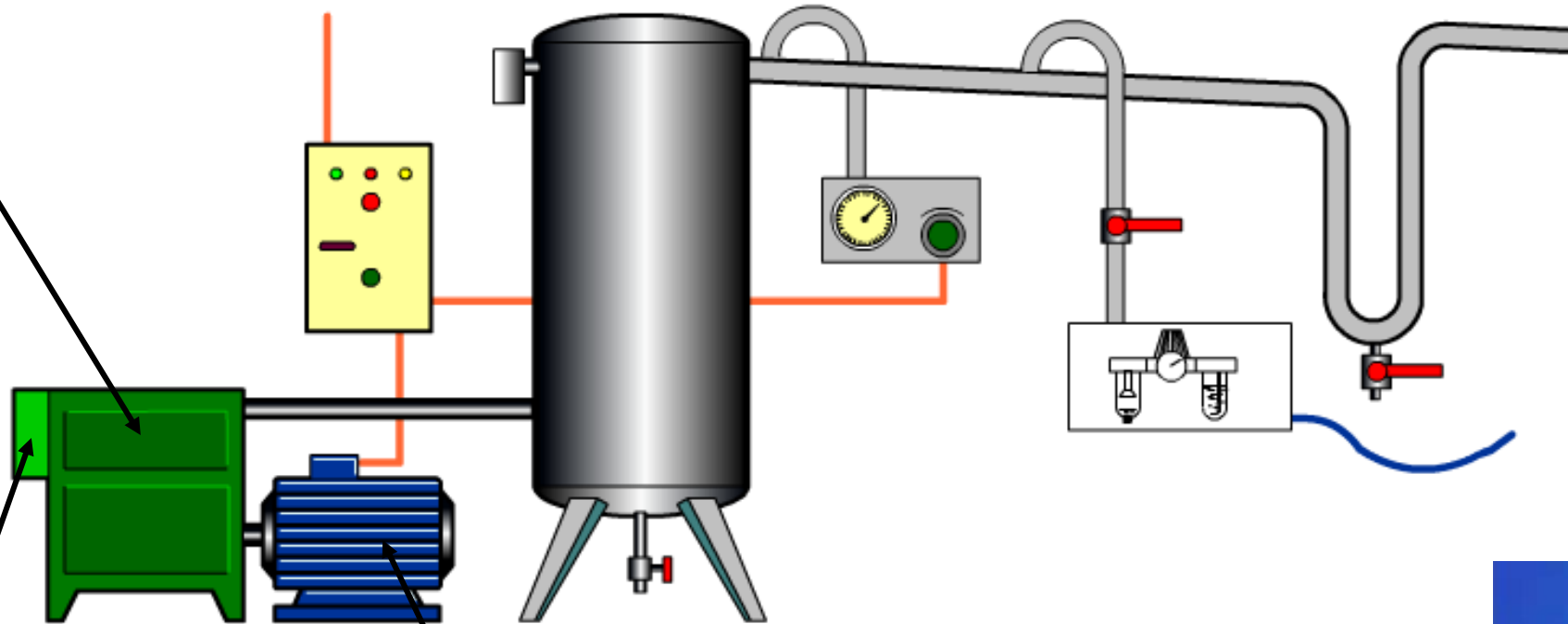
Compressed air distribution network.



**Compressed air**

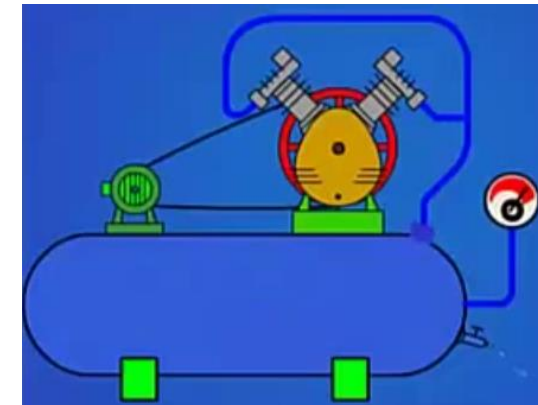
**Compressor:** Increase air pressure by minimizing the volume of air entering.

**Cooler :** The increase in pressure causes an increase in air temperature  
Need to cool.

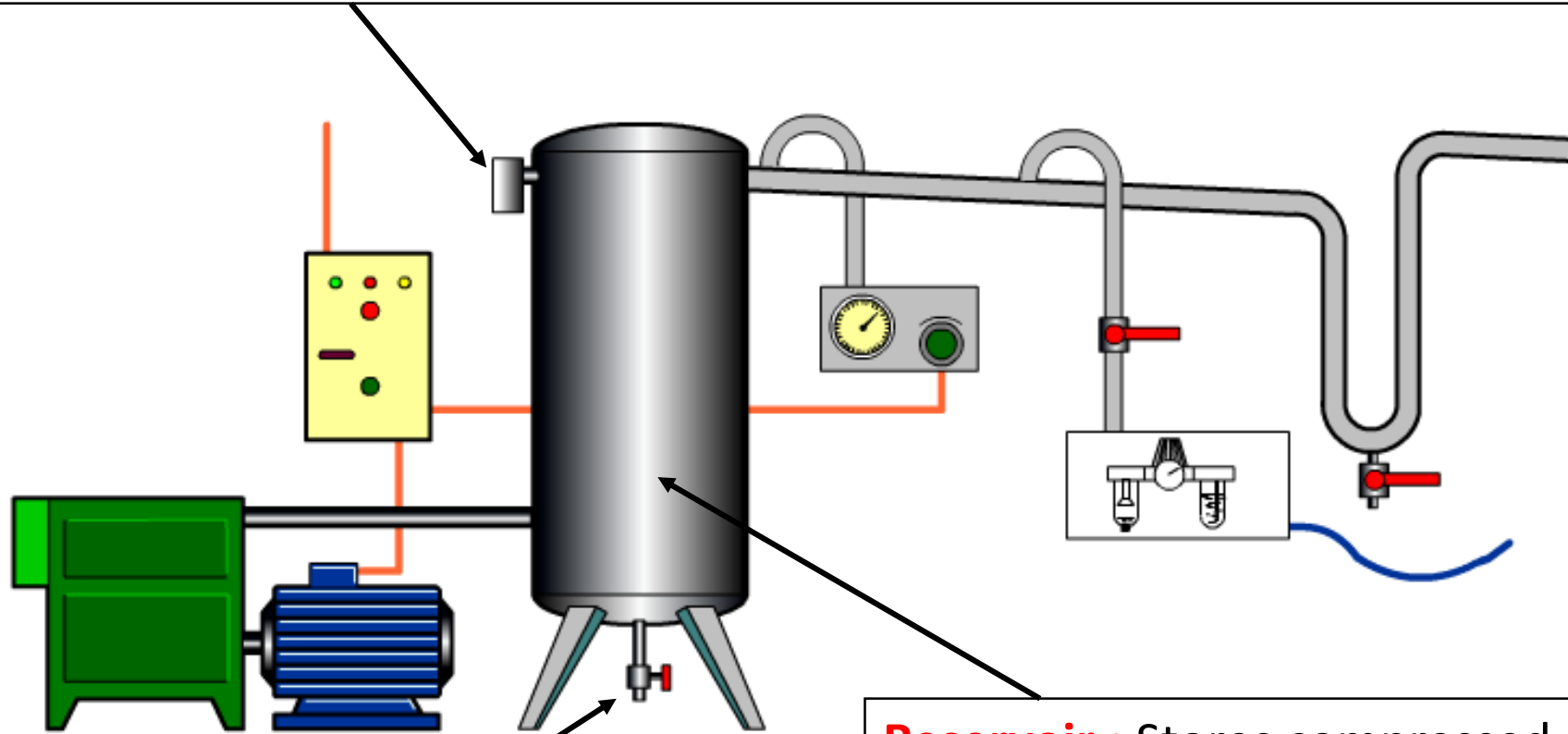


**Electric Motor:** Drive the compressor.

**Suction filter:** Prevent the aspiration of dust and particles  
when the compressor is running



**Safety valve** : Must open when pressure in tank exceeds pressure eligible.



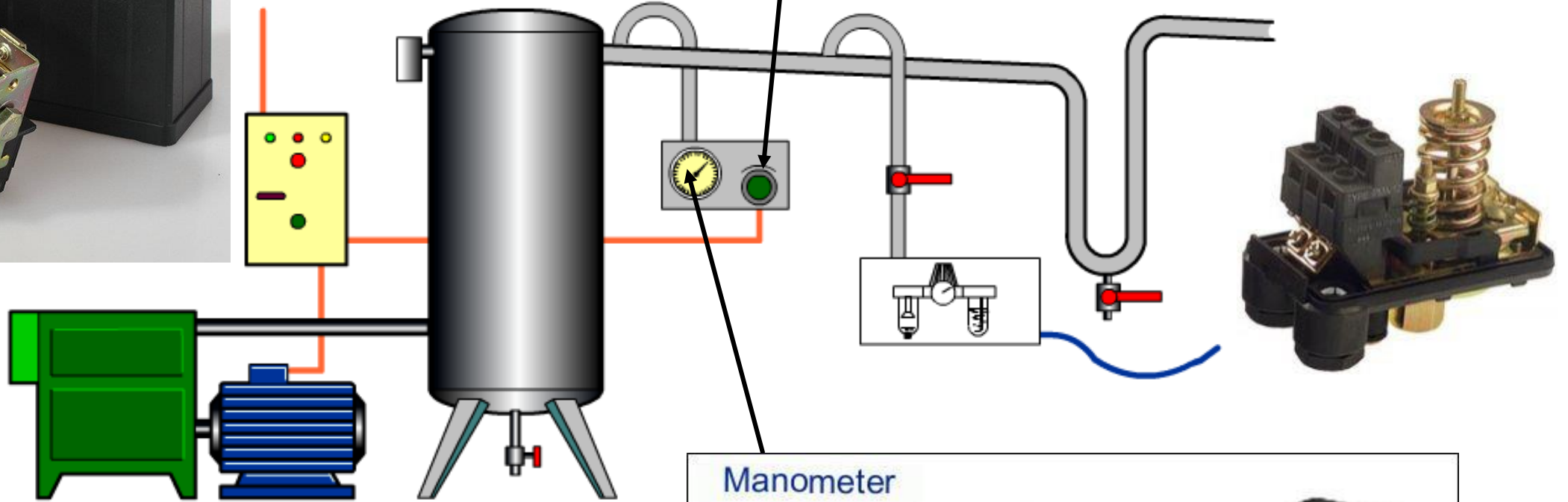
**Reservoir** : Stores compressed air.

**Draining the tank**: Compressed air contains vapor which condenses in the tank, It should be purged regularly.



pressure switch

Allows you to define the desired pressure in the tank and to control the start-up, running or stopping the engine.



Manometer

Used to measure the relative pressure inside the tank.



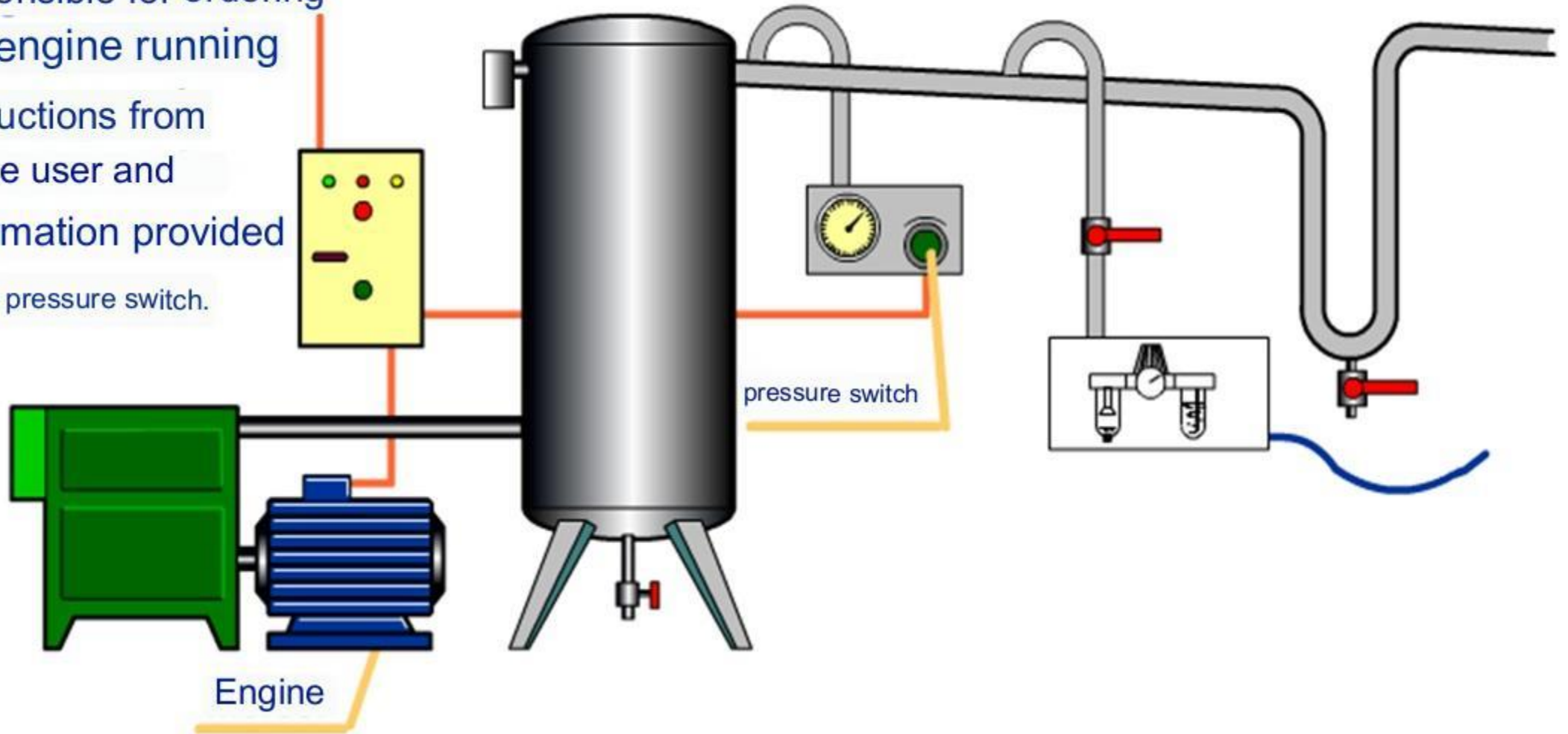
## Electrical control cabinet

responsible for ordering  
the engine running

instructions from  
the user and

information provided

by the pressure switch.

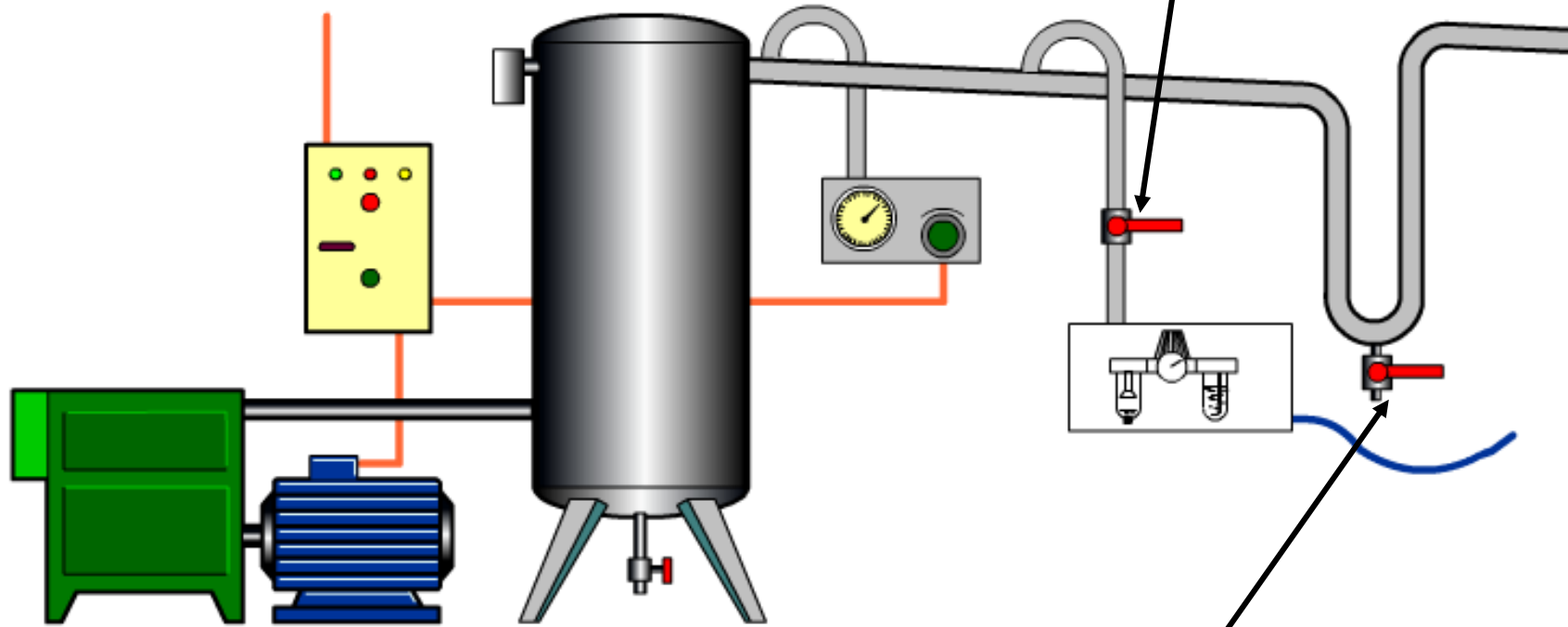


Engine

pressure switch

### Isolation valve

Allows the installation to be isolated from the general pneumatic energy distribution.

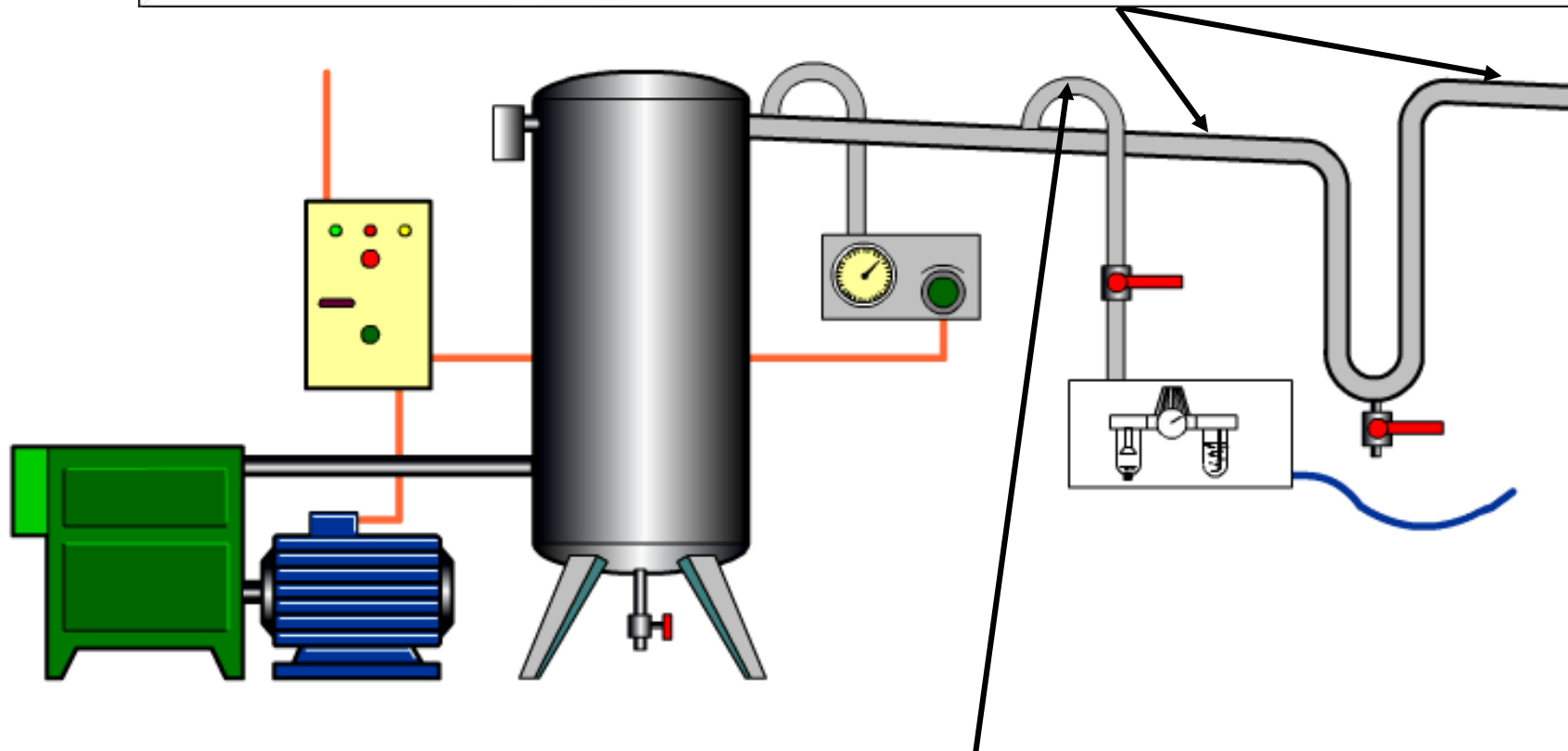


### Purge

Each low point of the installation is equipped with a tank to collect the condensation and a drain.

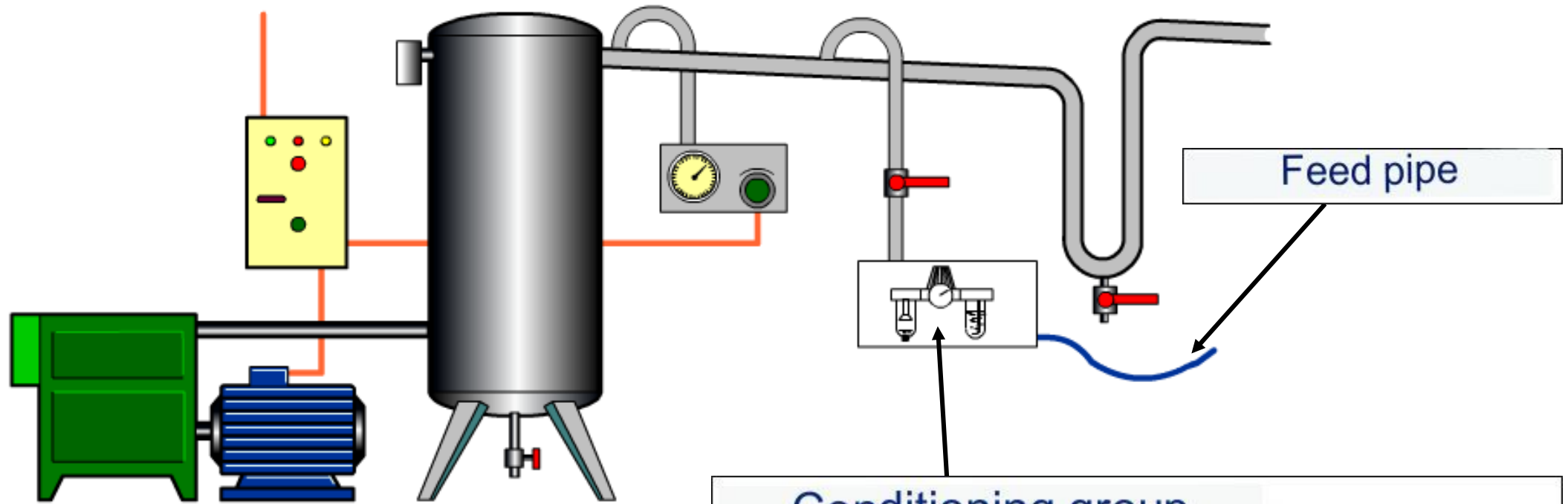
## Channeling

The main pipe follows a slight slope (1 to 3%) so that the condensation flows towards an elbow which includes a reservoir and a drain.



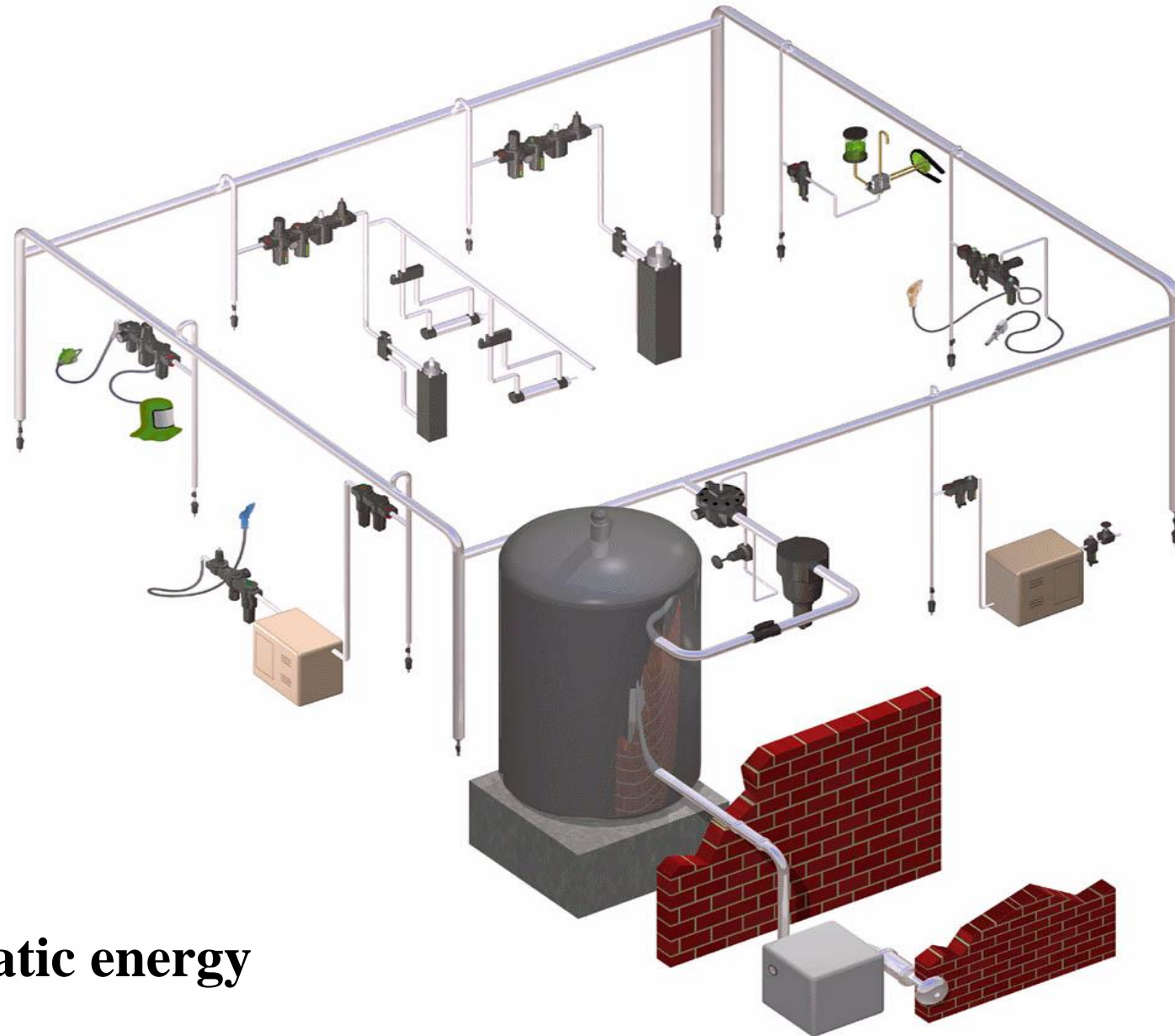
## Connection

The air intake connections are used to supply the production units. They are located above the pipe to avoid condensation.



### Conditioning group

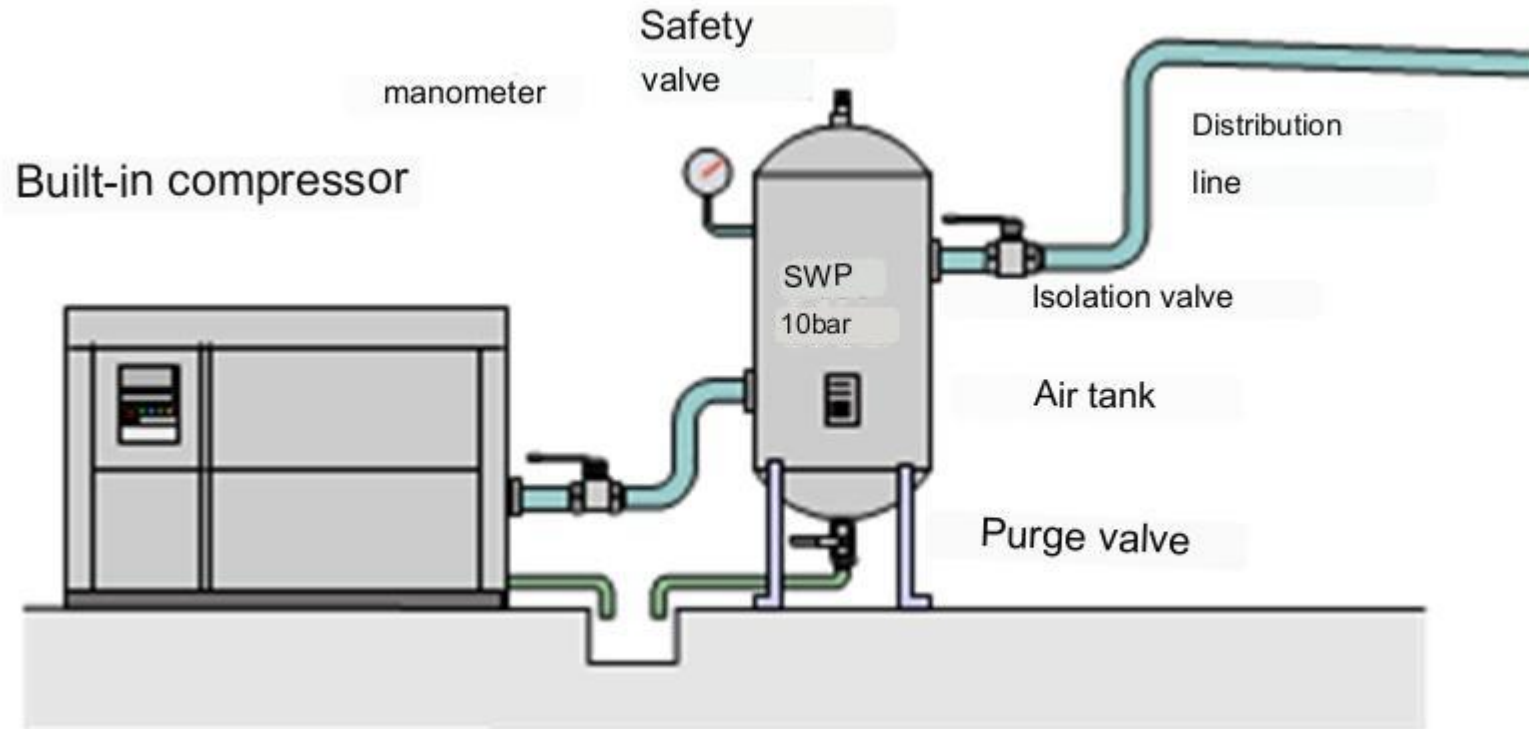
Each piece of equipment (machine, system, etc.) connected to the distribution network has its own air conditioning unit responsible for filtering, lubricating and adjusting the pressure.



**Example of pneumatic energy**

## 4. Pneumatic power generation

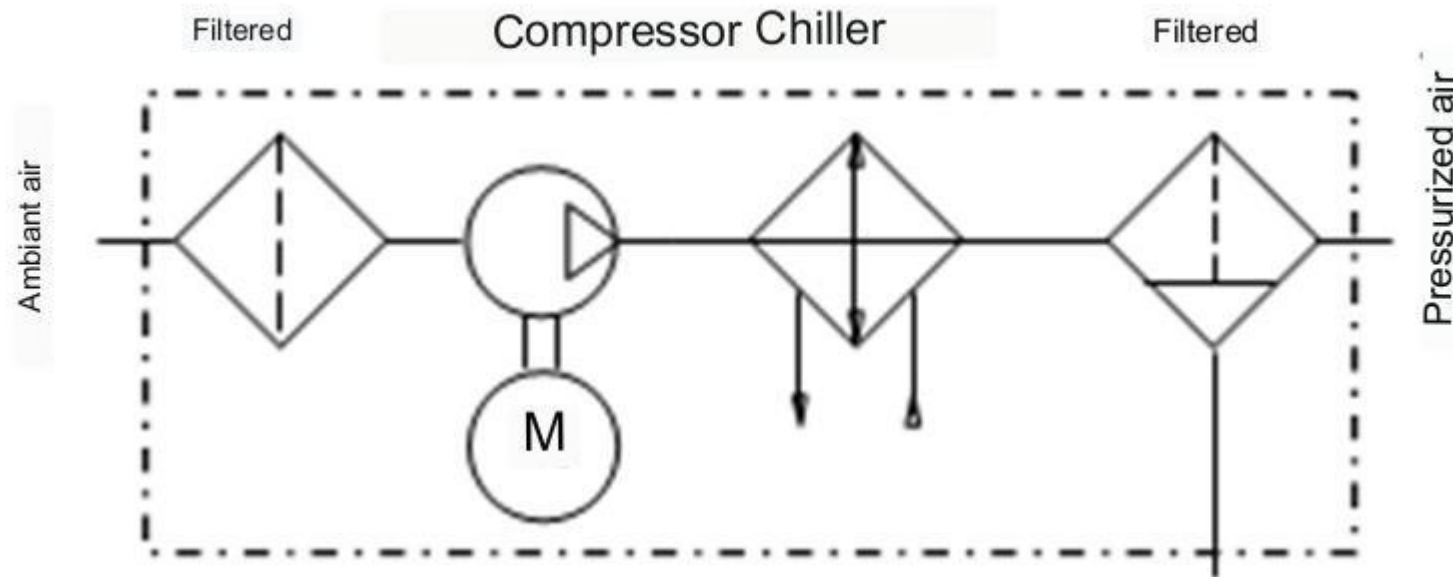
- It is ensured by a compressor, driven by an electric motor. This integrated compressor consists of a filter, the air compression system, a cooler- drier and a final filter.
- The outlet pressure is around 10 bars. A reservoir regulates consumption.



**Production of pneumatic energy**

## 4. Pneumatic power generation

- Polluted air can cause problems or damage to the compressed air network. Clean air guarantees the proper functioning of connected components, such as valves and cylinders.
- The reliability of a pneumatic installation depends on the quality of the compressed air.



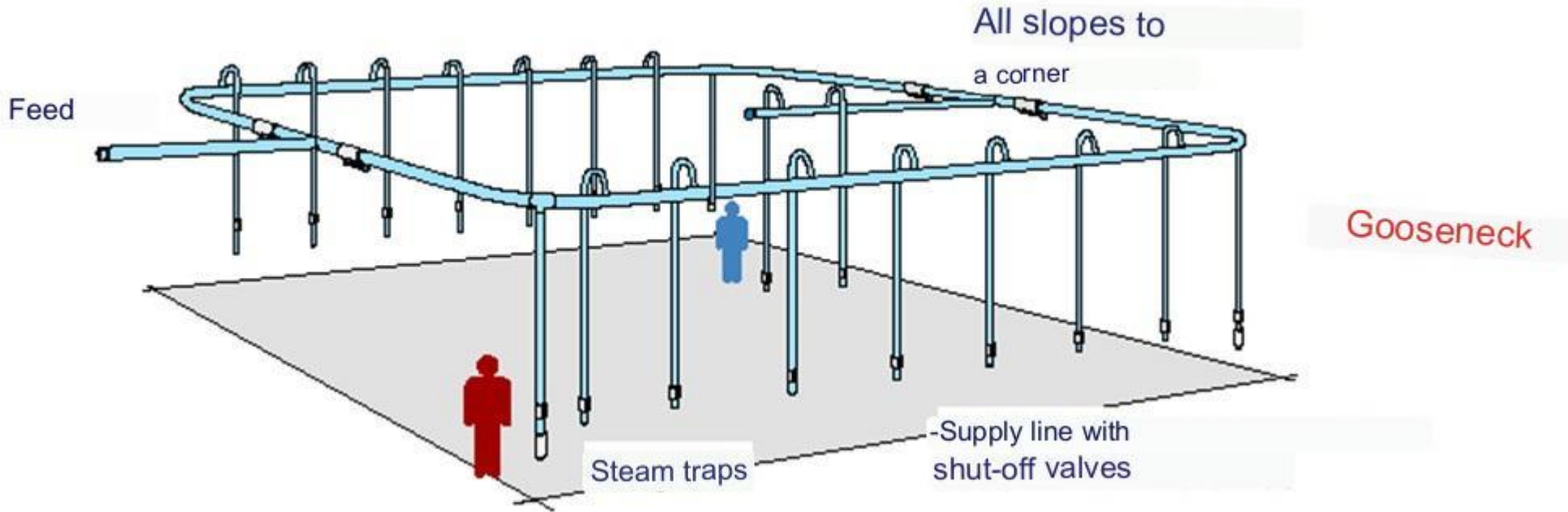
**Built-in compressor symbol**

## 4.1. Who are the polluters ?:

The polluters are essentially:

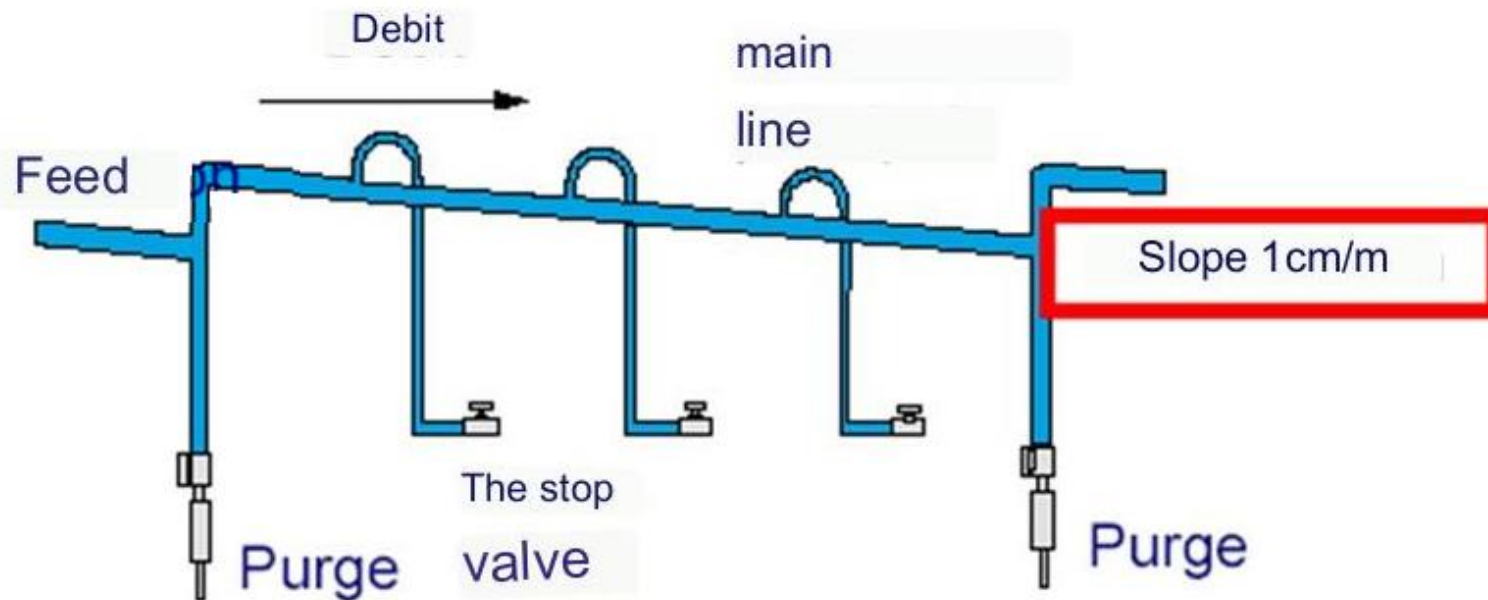
- Solid particles : ( dust, corrosion particles, etc.) which can be classified according to their size (large  $> 10 \mu\text{m}$ , small from 1 to  $10 \mu\text{m}$  and very fine  $< 1 \mu\text{m}$ );
- Water : when the compressed air cools, a significant amount of condensation forms. If the air is not dried, corrosion sets in and damages the components;
- The oil : a concentration of oil can clog sensitive pneumatic parts and damage protective fatty layers.

**Note 01:** The distribution of pneumatic energy is done by rigid pipes connected by goosenecks to avoid receiving impurities or water that may remain in the pipes.



**Goosenecks at each connection**

**Note 02:** To remove these impurities or stagnant water, there are traps at the low point of each connection, and the pipes have a slight slope.

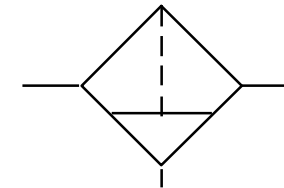


**A slight slope on each pipe**

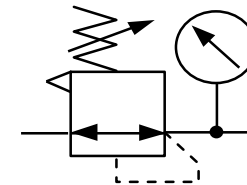
## 4.2. FRL Unit

- Before using the air, it must be filtered, dried, lubricated and its pressure regulated. Thus, before each SAP (Automated Production System), an FRL conditioning unit (also called “Line Head”) is placed which adapts the pneumatic energy to the system.
- This FRL unit consists of a **F**ilter, a mano - **R**egulator and a **L**ubricator .

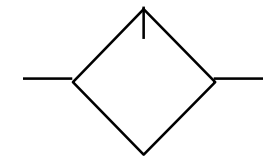
⇒ **Filter** : used to dry the air and filter dust.

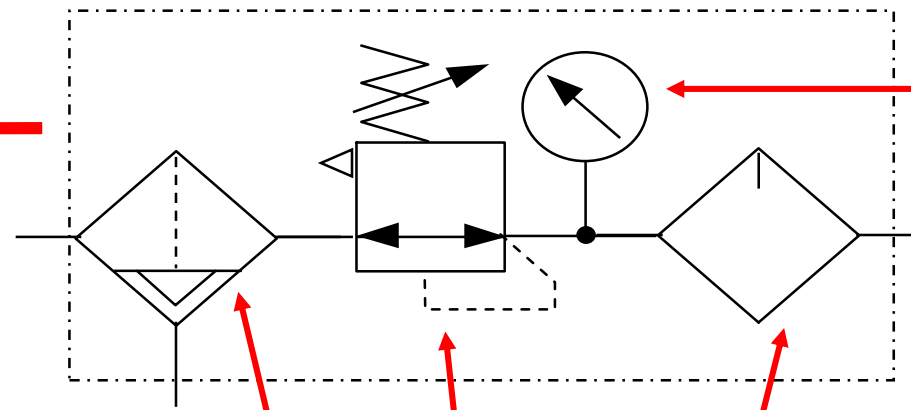
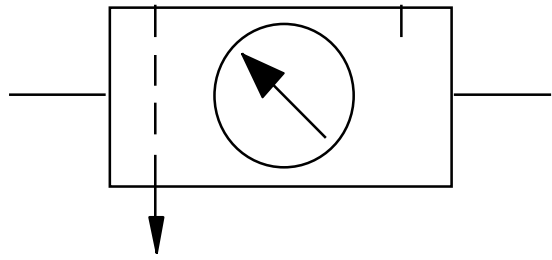


⇒ **Mano -regulator**: is used to adjust and regulate the air pressure.

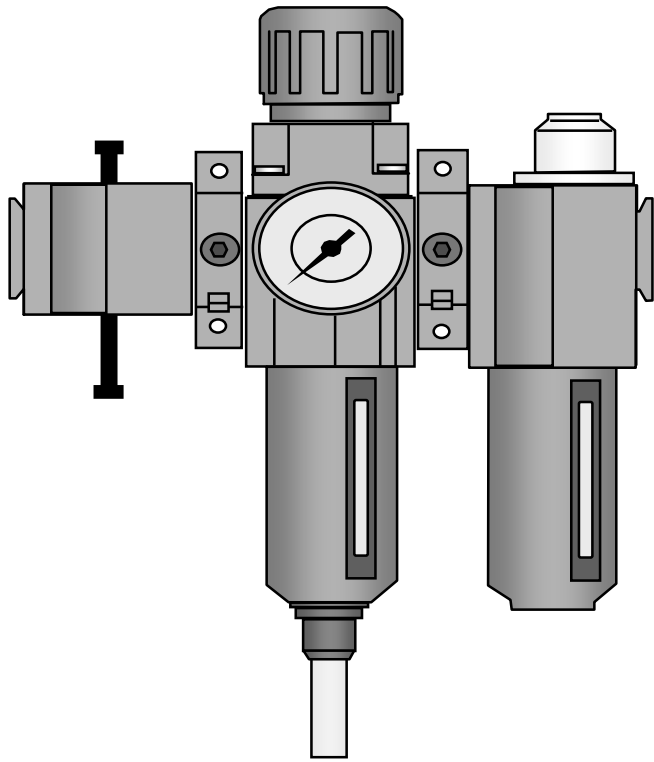


⇒ **Lubricator**: serves to prevent corrosion and improve sliding .





**Manometer**



**FRL**

