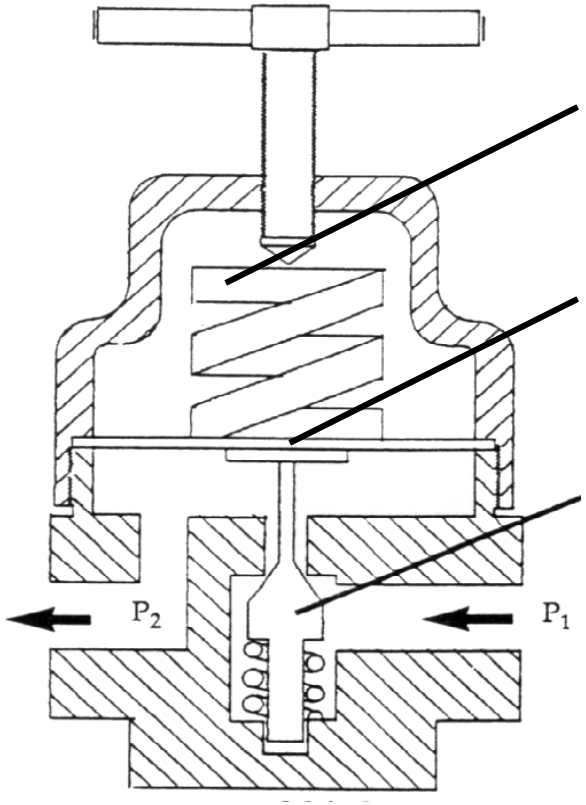
Le fonctionnement du détendeur

La fonction de régulation

Principaux composants du détendeur



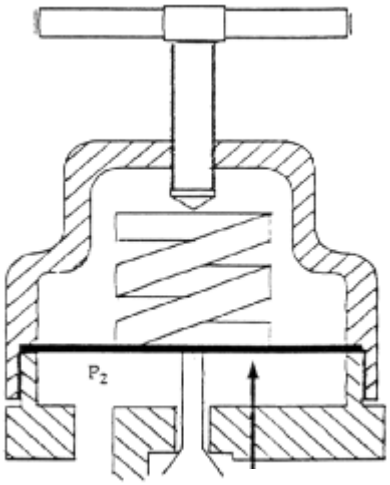
Ressort de réglage

Membrane

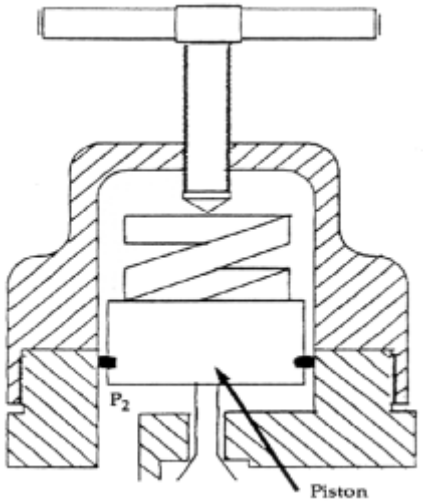
clapet

Type de régulateur à pression

caractéristiques



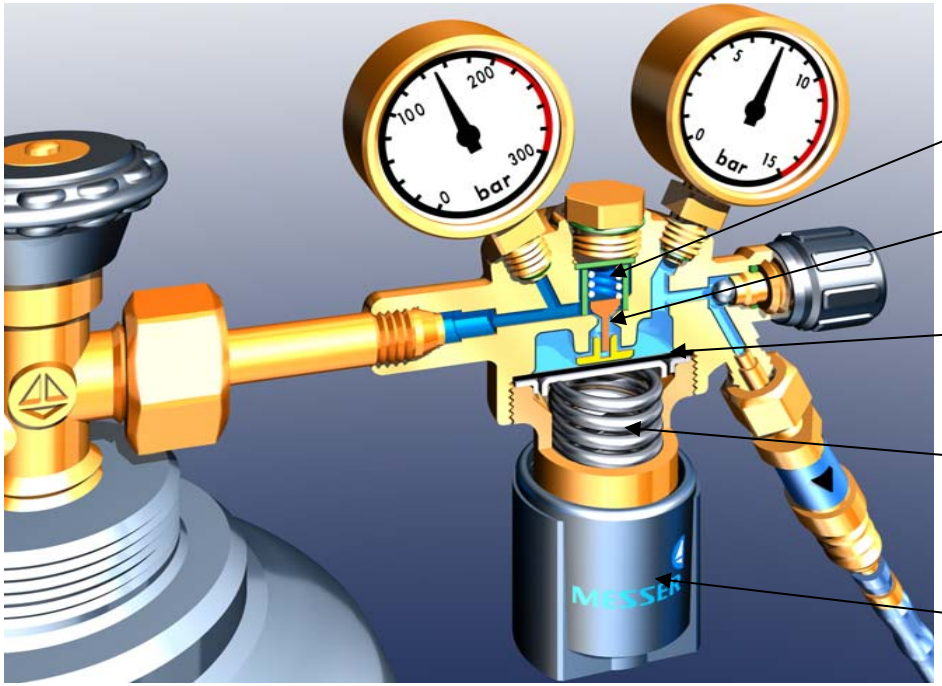
Membrane



Piston

Fonctionnement du détendeur

Régulateur simple étage



Ressort de clapet

clapet

membrane

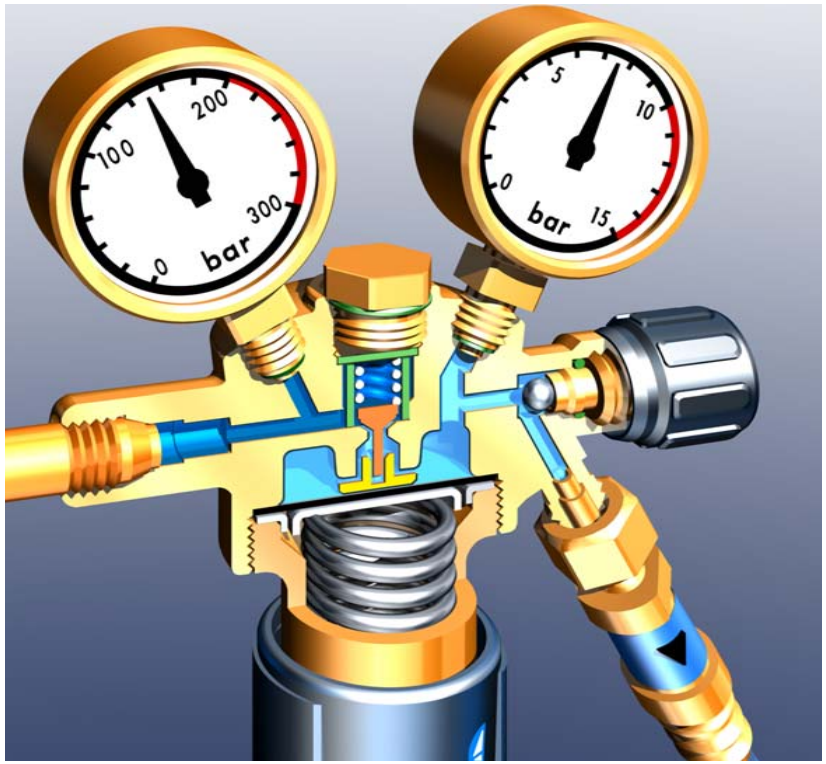
Ressort de poussée

Volant de réglage

Toujours détendre le ressort lors du branchement !!

La fonction de régulation

Les forces en présence…..



F ressort

\+

P_1 x **A clapet**

\+

P_2 x **A** Membrane

=

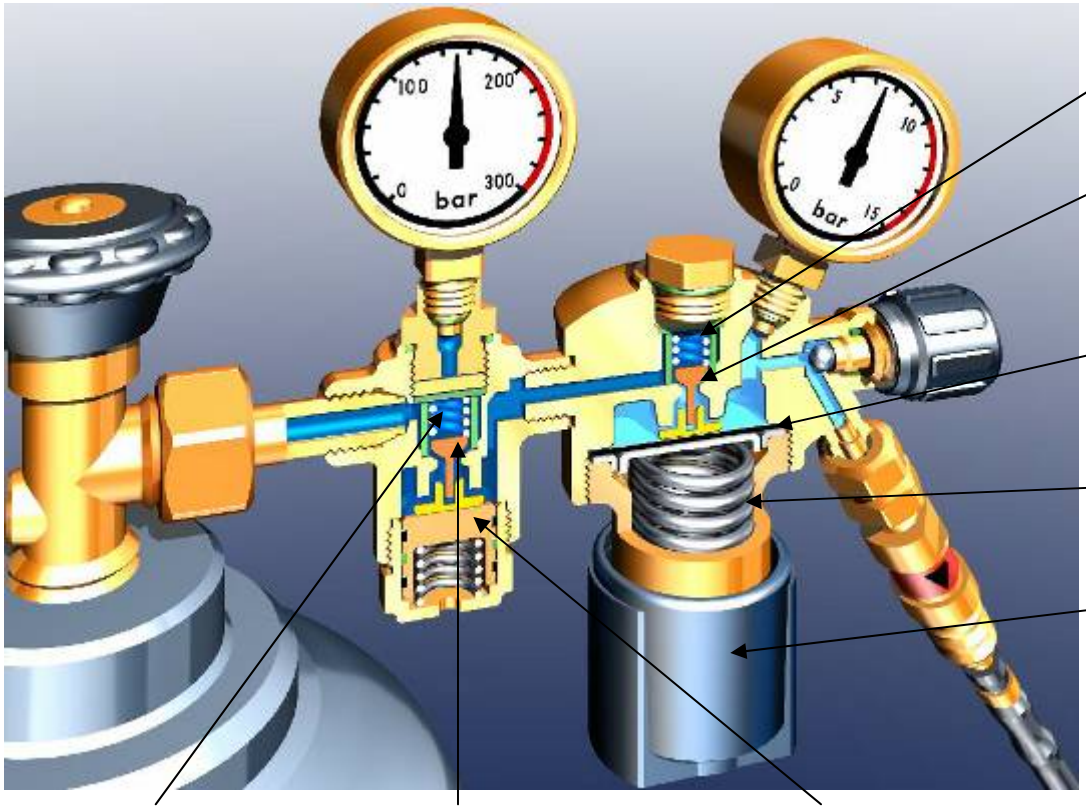
F Ressort

\+

P_2 x **A clapet**

La fonction de régulation

Régulateur bi-étagé



Ressort clapet

clapet

Membrane

Ressort

Molette réglage

Ressort clapet

clapet

Piston avec précontrainte

spectron

La fonction régulation

Différents types de détentes

Leak detection

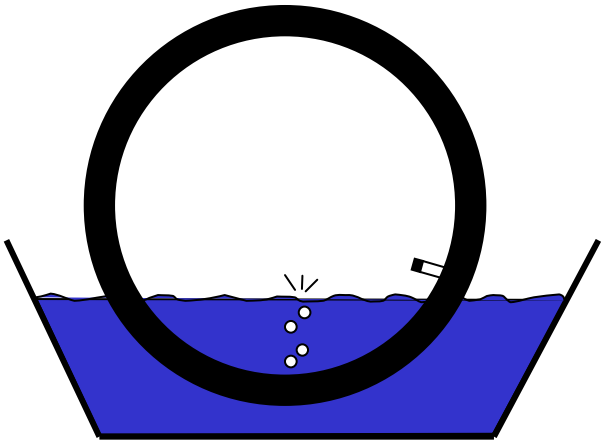
Leak detection

Example

A bicycle tyre lost 1 bar pressure over a period of 175 days (1/2 year).

What is the leak rate?

Leak detection



Example

Wanted:

- Q_L = Leak rate in mbar l/sec

Given:

- P_1 = Pressure at beginning of test in mbar
- P_2 = Pressure at end of test in mbar
- ΔP = Differential pressure ($P_1 - P_2$)
- V = Volume of inner tube in liters: 1,5 l
- t = duration: 175 days = $1,5 \times 10^7$ sec.

$$Q_L = \frac{\Delta P \times V}{t} = \frac{1.000 \times 1,5}{1,5 \times 10^7} = \mathbf{1,0 \times 10^{-4}\ mbar\ l/sec}$$

Leak detection

Leak diameter	Leak rate [mbar l/sec]
1,0 cm	10^4 (10.000)
1,0 mm	10^2
0,1 mm	10^0 (=1)
0,01 mm	10^{-2}
1,0 µm	10^{-4} (0,0001)
0,1 µm	10^{-6}
0,01 µm	10^{-8}
1 nm	10^{-10}
1,0 Angström	10^{-12}

At a differential pressure of 1 bar

Leak detection

Leak rate mbar l/s He	Loss l/year*
1×10^{-1}	3.150
1×10^{-2}	315
1×10^{-3}	31,5
1×10^{-4}	3,15
1×10^{-5}	0,315
1×10^{-6}	0,0315
1×10^{-7}	0,00315
1×10^{-8}	0,000315
1×10^{-9}	0,0000315
1×10^{-10}	0,00000315

* At a differential pressure of 1 bar

Definition

- The required tightness is normally defined as a maximum allowed leak rate.

- Types:
  - pressure drop at pressurized systems
  - pressure increase at vacuum systems

Definition

The leak rate is 1 mbar.l/sec if the pressure in a system with a volume of 1 liter decreases by 1 mbar per second

or

in a vacuum recipient increases by 1 mbar per second.

At a differential pressure of 1 bar

Test methods

Method	mbar.l/sec
Soap water	$< 10^{-4}$
Pressure drop (ΔP)	$< 10^{-5}$
Helium leak test sniffing method	$< 10^{-6}$
Helium leak test vacuum method	$< 10^{-12}$

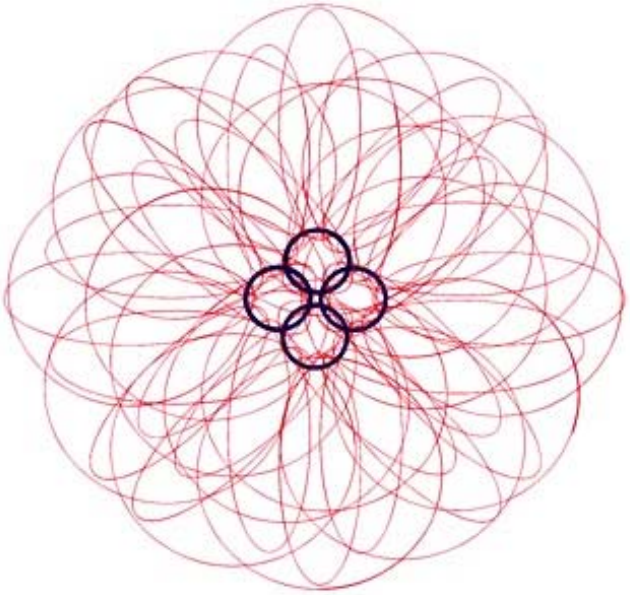
At a differential pressure of 1 bar

Pressure test

Sniffing method

Vakuum method

Leak detection

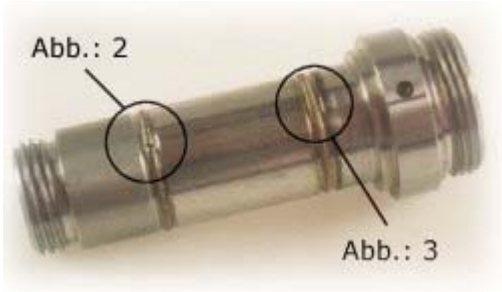


Why Helium as a test gas?

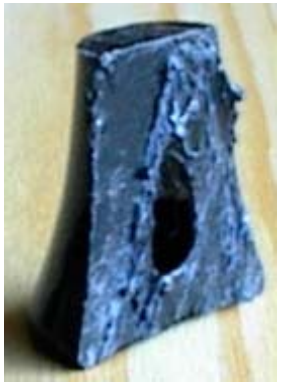
- Helium has the second smallest atom (mass 4)
- Very low percentage in air (5 ppm)
- Inert (no reaction with other materials or chemicals)
- Good to detect by analysis
- Easy to handle
- Quick spread (lighter than air)

Leak examples

- Separable connections



- Permanent connections



- In the material

- Permeation

Purging of Gas Supply Systems

Purging

Gas quality
N_2 5.0

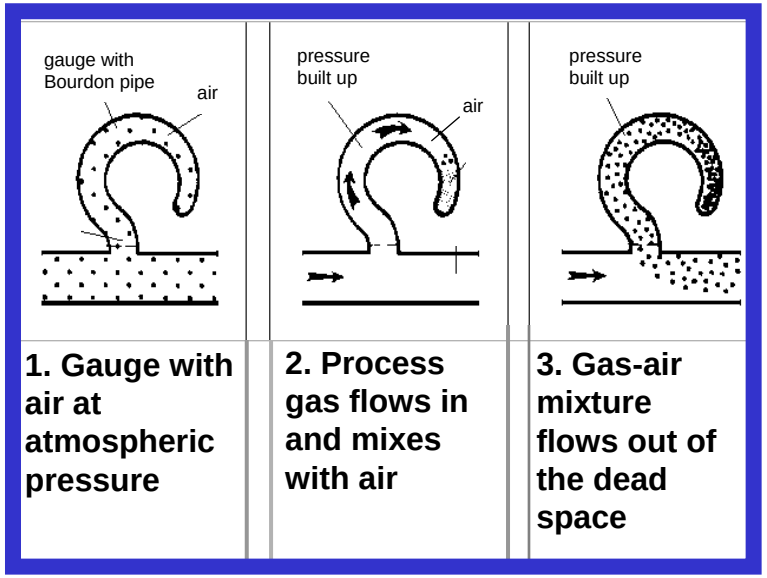
Gas properties

Purging?

- Corrosive
- Flammable
- Oxidizing
- Self-igniting
- Toxic
- Gas quality
- Security
- Lifetime components & material

Purging

Methods



- Flush purging
- Pressure build-up
- Vacuum purging
- Vacuum & pressure build-up

Purging

Methods

With process gas

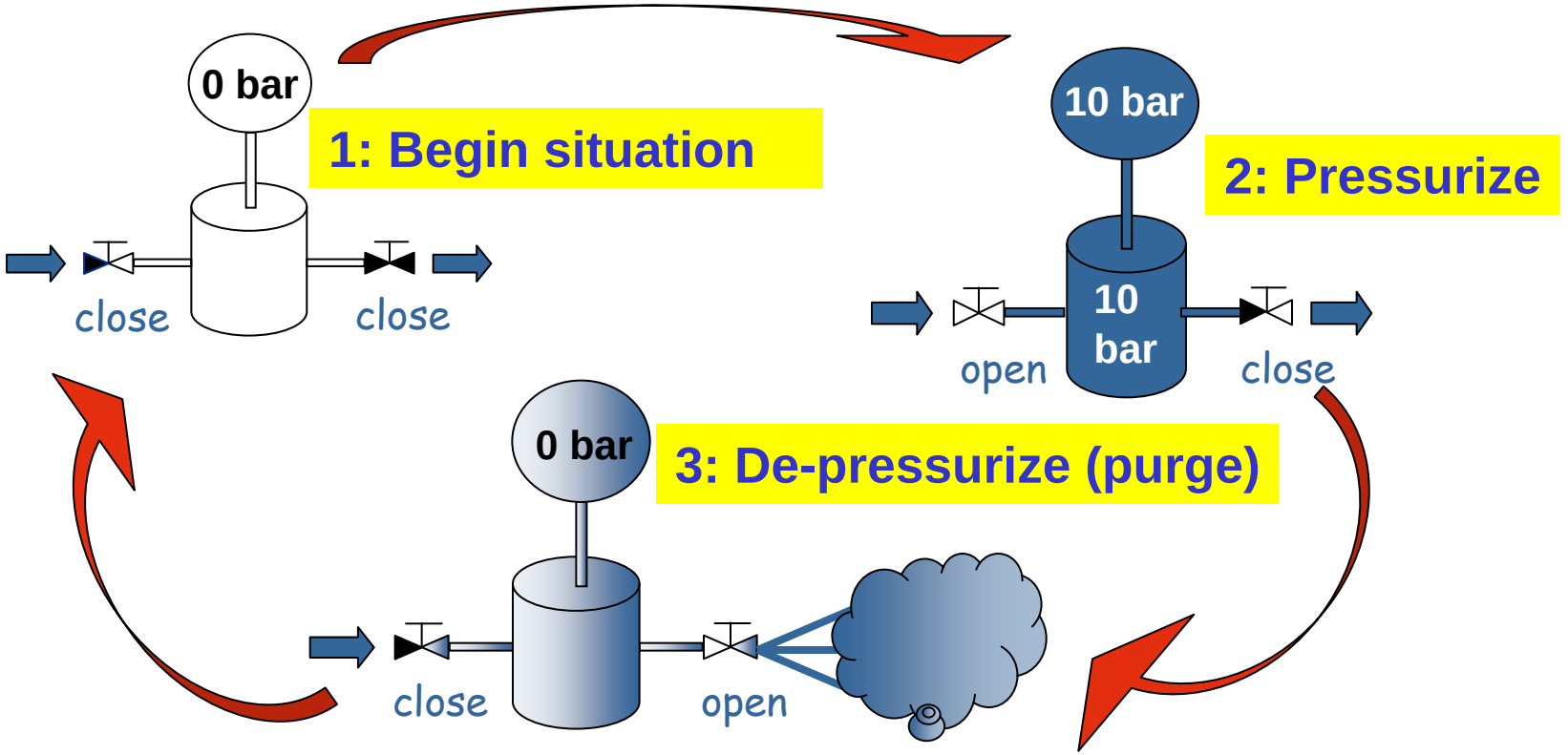
- Inert gases
- Flammable/ Oxidizing gases

With a separate purge gas

- Corrosive gases
- Toxic gases
- Self igniting gases
- High quality gas mixtures

Purging

Pressure built up



Purging

Purging with 10 bar purge gas

Cycle	Air		Gas	Impurities	Quality
	%	vpm	%	vpm	
0	100%	-	0%	-	-
1	10%	-	90%	-	-
2	1%	-	99%	-	-
3	0,1%	1.000	99,9%	1.000	3.0
4	0,01%	100	99,99%	100	4.0
5	0,001%	10	99,999%	10	5.0
6	0,0001%	1	99,9999%	1	6.0
7	0,00001%	0	99,99999%	0	7.0

Mix ratio 1:10 per cycle

Purging

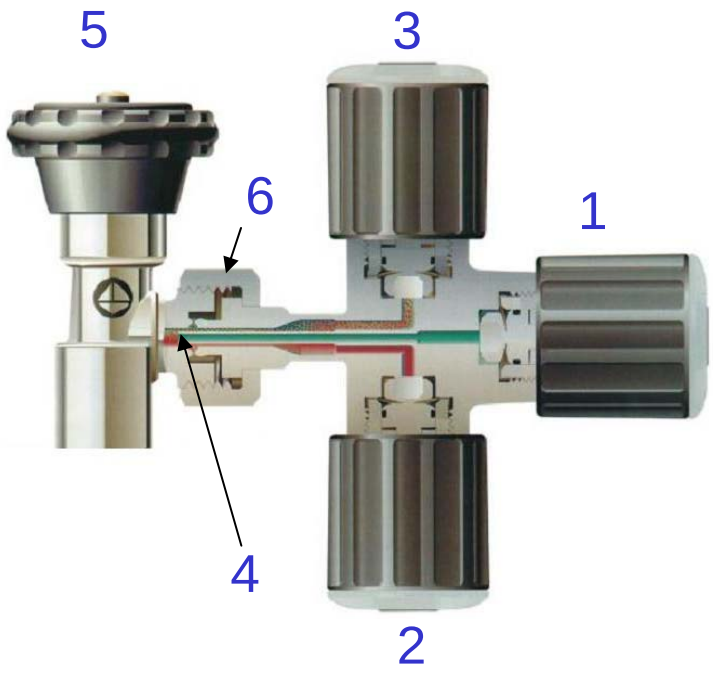
Purging with 200 bar

Cycle	Air		High purity gas 5.0		
			Gas	Impurities	Quality
	%	vpm	%	vpm	
0	100%	-	0%	-	-
1	0,5%	-	99,5%	5.000	2,5
2	0,0025%	-	99,9975%	25	4,7
3	0,00001%		99,999990%	0,1	7.0

Mix ratio 200:1 purge / process gas to air

Purging

Example

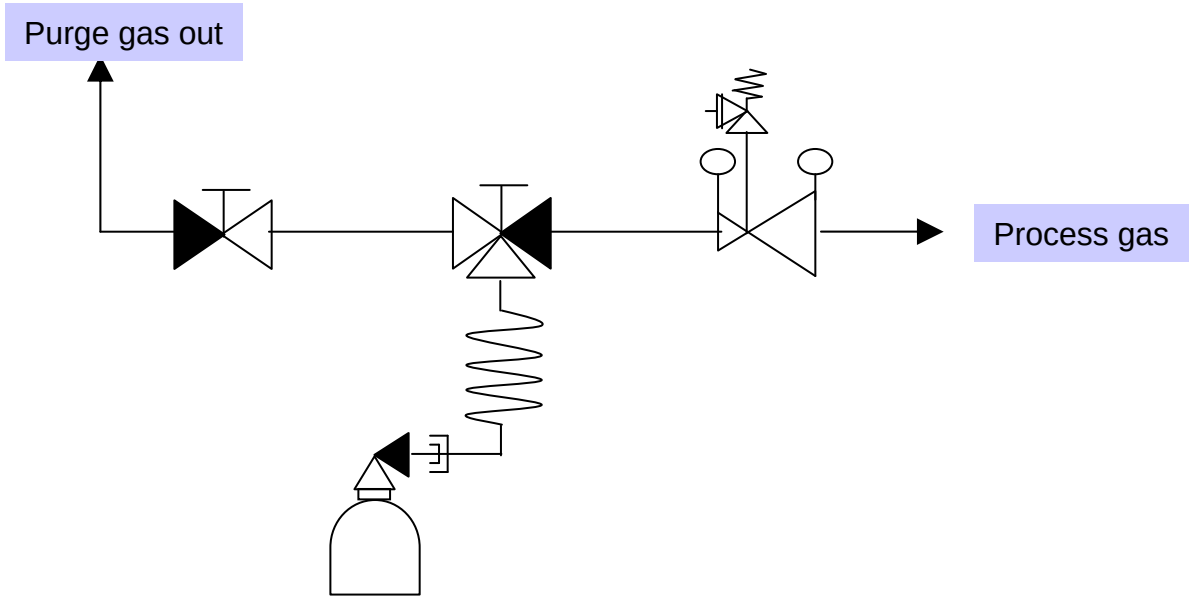


SBE-3-way-purge block

1 Purge gas
2 Process gas
3 Waste gas
4 Capillary tube
5 Cylinder valve
6 Cylinder connection

Purging

Scheme Purging



spectron