# SISTEMAS HIDRÁULICOS E PNEUMÁTICOS

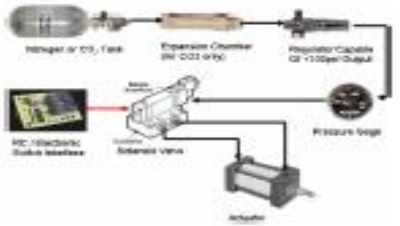
- TÉCNICO EM MECÂNICA

# Sistemas de transmissão de potência

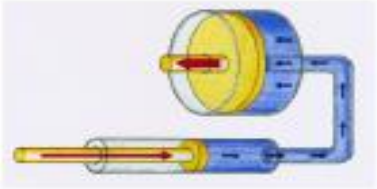
- Sistemas elétricos

- Sistemas mecânicos

- Sistemas pneumáticos



- Sistemas hidráulicos



# Resumo

1. Introdução hidráulica
2. Atuadores
3. Impulsores
4. Válvulas

# Resumo

5. Aplicações

6. Software Automation Studio

# 1. Introdução hidráulica

## Hidráulica

- Hidráulica é uma palavra que vem do grego e é a união de hydro = água, e aulos = condução/aula/tubo é, portanto, uma parte da física que se dedica a estudar o comportamento dos líquidos em movimento e em repouso. É responsável pelo conhecimento das leis que regem o transporte, a conversão de energia, a regulagem e o controle do fluido agindo sobre suas variáveis (pressão, vazão, temperatura, viscosidade, etc).

# 1. Introdução hidráulica

## A óleo-hidráulica

- A óleo-hidráulica se pode definir como o ramo da engenharia que estuda o uso de fluidos incompressíveis (neste caso o óleo), confinados e sob pressão, para transmitir potência.

# 1. Princípios de hidráulica

- **Tipo de Fluxo:**
  - **Laminar** **Re<2000**
  - **Turbulento** **Re>2000**

$$Re = \frac{\rho v D}{\eta} = \frac{v L}{\nu}$$

$D = Diametro\ da\ tubulação$

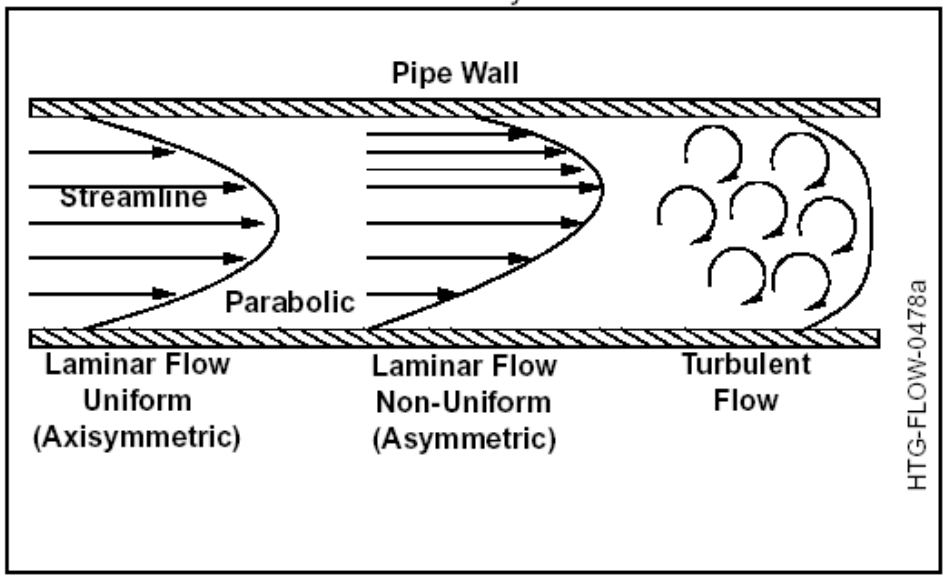
$\rho = densidade$

$\eta = vis\cos idade\ dinamica$

$v = velocidade\ do\ fluido$

$\nu = vis\cos idad\ cinematica$

FIGURE 1. Velocity Profiles



# 1. Princípios de hidráulica

- **Compressibilidade:**

  Uma variação infinitesimal do volume por unidade de variação de pressão.

  A compressibilidade dos líquidos é quase nula.

  A aplicação de uma força um gás faz que seu volume se reduza.

  Pneumática < 10 bar
  Óleo-Hidráulica > 10 bar

# 1. Princípios de hidráulica

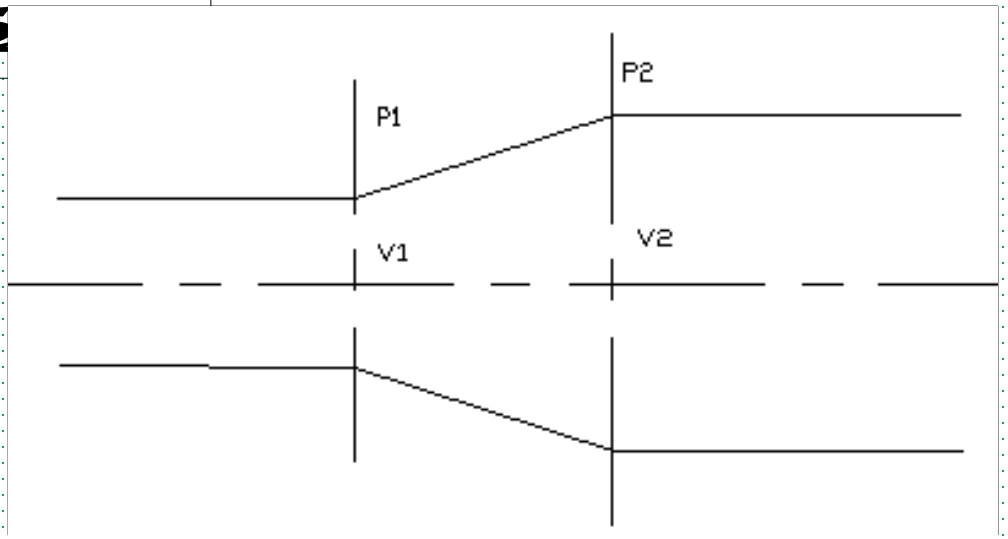
- **Lei de Bernoulli**

Descreve o comportamento de um fluido que se move ao longo de um tubo.

$$E = mgh + \frac{p}{\rho}$$

$$\frac{p}{\rho} + \frac{1}{2} \cdot v^2 = cte$$

$$\frac{p_1}{\rho} + \frac{1}{2} \cdot v_1^2 = \frac{p_2}{\rho} + \frac{1}{2} \cdot v_2^2$$

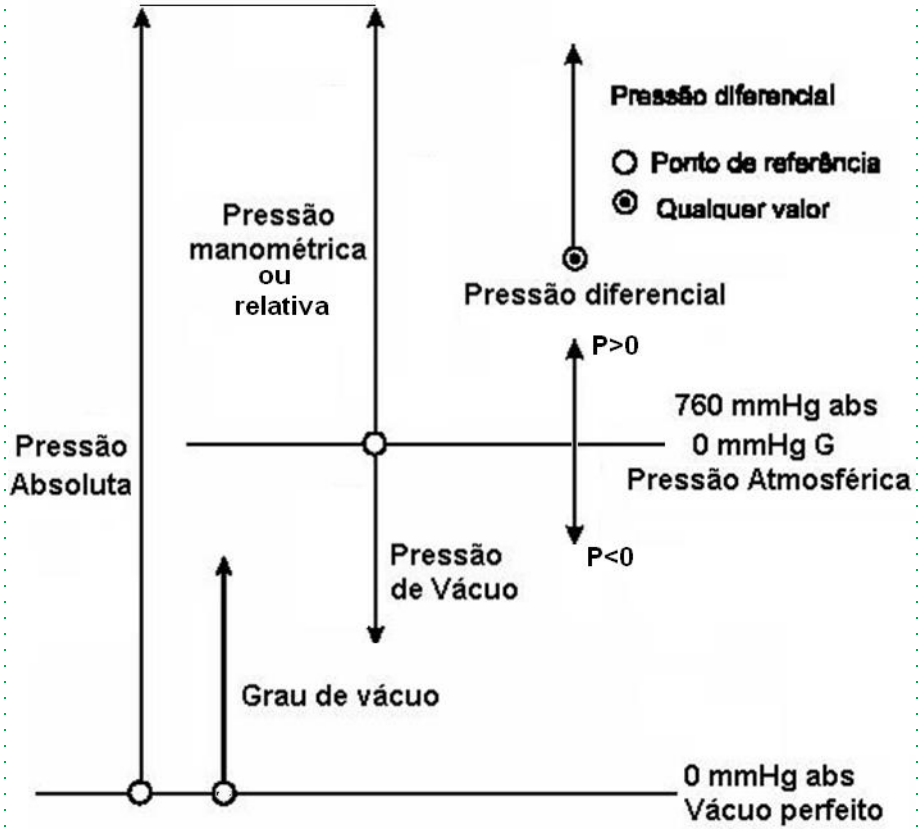


# 1. Princípios de hidráulica

- **Pressão**

Força por unidade de área.

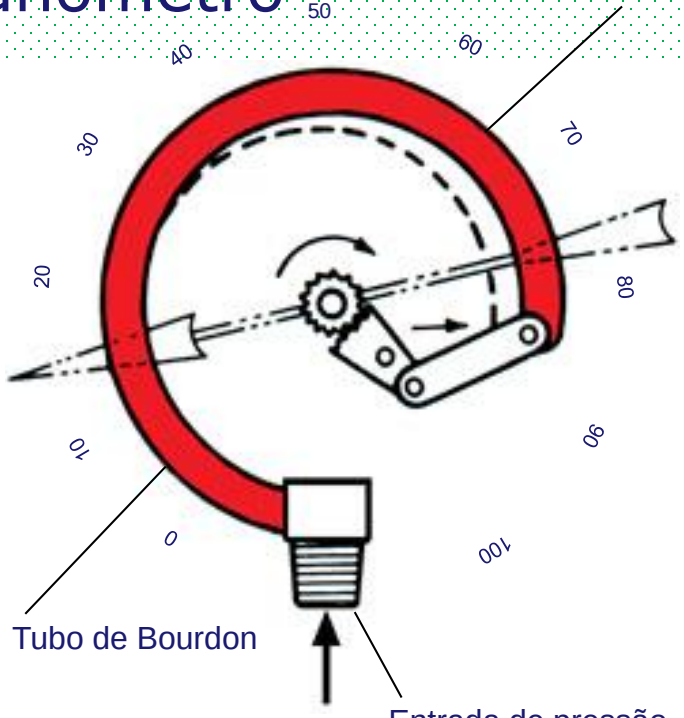
$$p = \frac{F}{A}$$

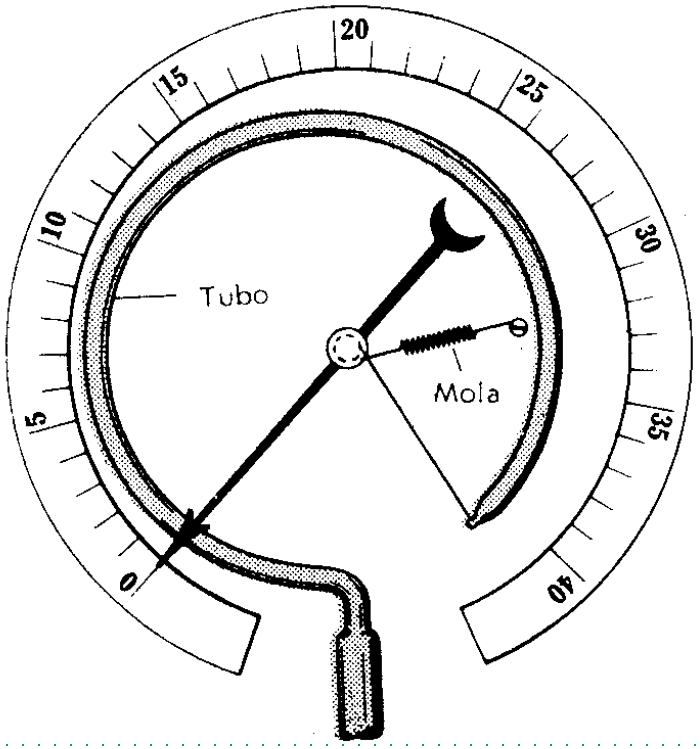


# 1. Princípios de hidráulica

- **Pressão manométrica ou relativa:**

A medição é realizada com a utilização de manômetro



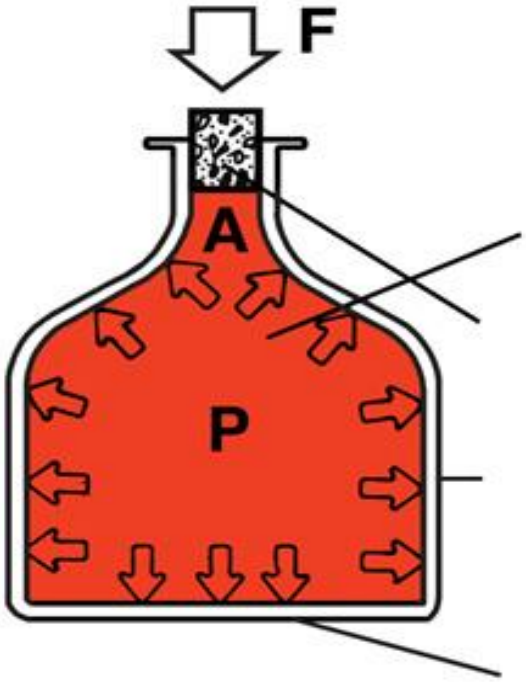
# 1. Princípios de hidráulica

- **Fatores de conversão de unidades de pressão:**

| | Atmosfera | Pascal | Bar | milibar o hPa | mm Hg | m $H_2O$ | kgf/cm² |
|---|---|---|---|---|---|---|---|
| Atmosfera | 1 | $1{,}01325\times10^{5}$ | 1,01325 | 1013,25 | 760,0 | 10,33 | 1,033 |
| Pascal | $9{,}869\times10^{-6}$ | 1 | $10^{-5}$ | 0,01 | $7{,}501\times10^{-3}$ | $1{,}020\times10^{-4}$ | $1{,}019\times10^{-5}$ |
| Bar | 0,9869 | 100000 | 1 | 1000 | 750,1 | 10,20 | 1,020 |
| milibar | $9{,}869\times10^{-4}$ | 100 | 0,001 | 1 | 0,7501 | $1{,}020\times10^{-2}$ | 10,20 |
| mm Hg | $1{,}316\times10^{-3}$ | 133,3 | $1{,}333\times10^{-3}$ | 1,333 | 1 | $1{,}360\times10^{-2}$ | 13,60 |
| m $H_2O$ | $9{,}678\times10^{-2}$ | 9807 | $9{,}807\times10^{-2}$ | 98,06 | 73,56 | 1 | 0,100 |
| kgf/cm² | 0,968 | $9{,}810\times10^{4}$ | 0,9810 | 981,0 | 735,8 | 10,00 | 1 |

# 1. Princípios de hidráulica

- **Lei da pascal.**




1.Suponhamos uma garrafa cheia de um líquido, o qual é, praticamente, incompressível

2. Se aplicarmos uma força de 10kgf numa rolha de 1 $cm^2$ de área...

3.O resultado será uma força de 10kgf em cada centímetro quadrado das paredes da garrafa

4.Se o fundo da garrafa tiver uma área de 20 $cm^2$ e cada centímetro estiver sujeito a uma força de 10kgf, teremos, como resultante, uma força de 200kgf aplicada ao fundo da garrafa.

F = Força A = Área P = Pressão

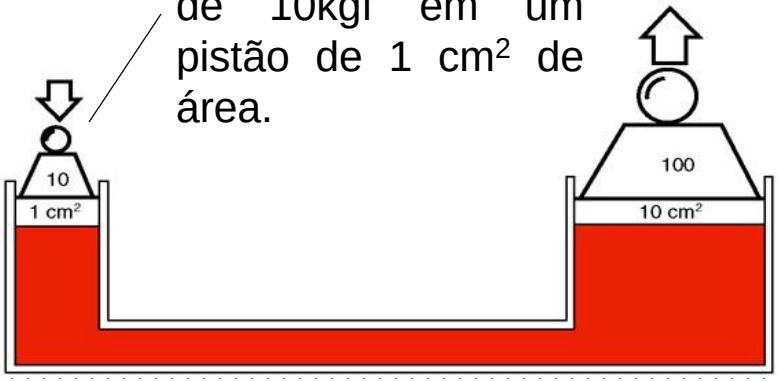
$$p = \frac{F}{A}$$

# 1. Princípios de hidráulica

- **Lei da pascal.**

Princípio Prensa Hidráulica

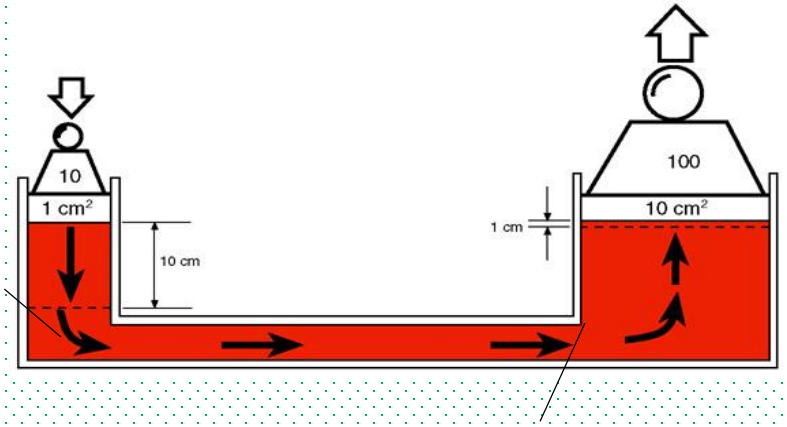
Se aplica uma força de 10kgf em um pistão de 1 $cm^2$ de área.




ENTRADA=SAÍDA

$$p_1 = p_2$$

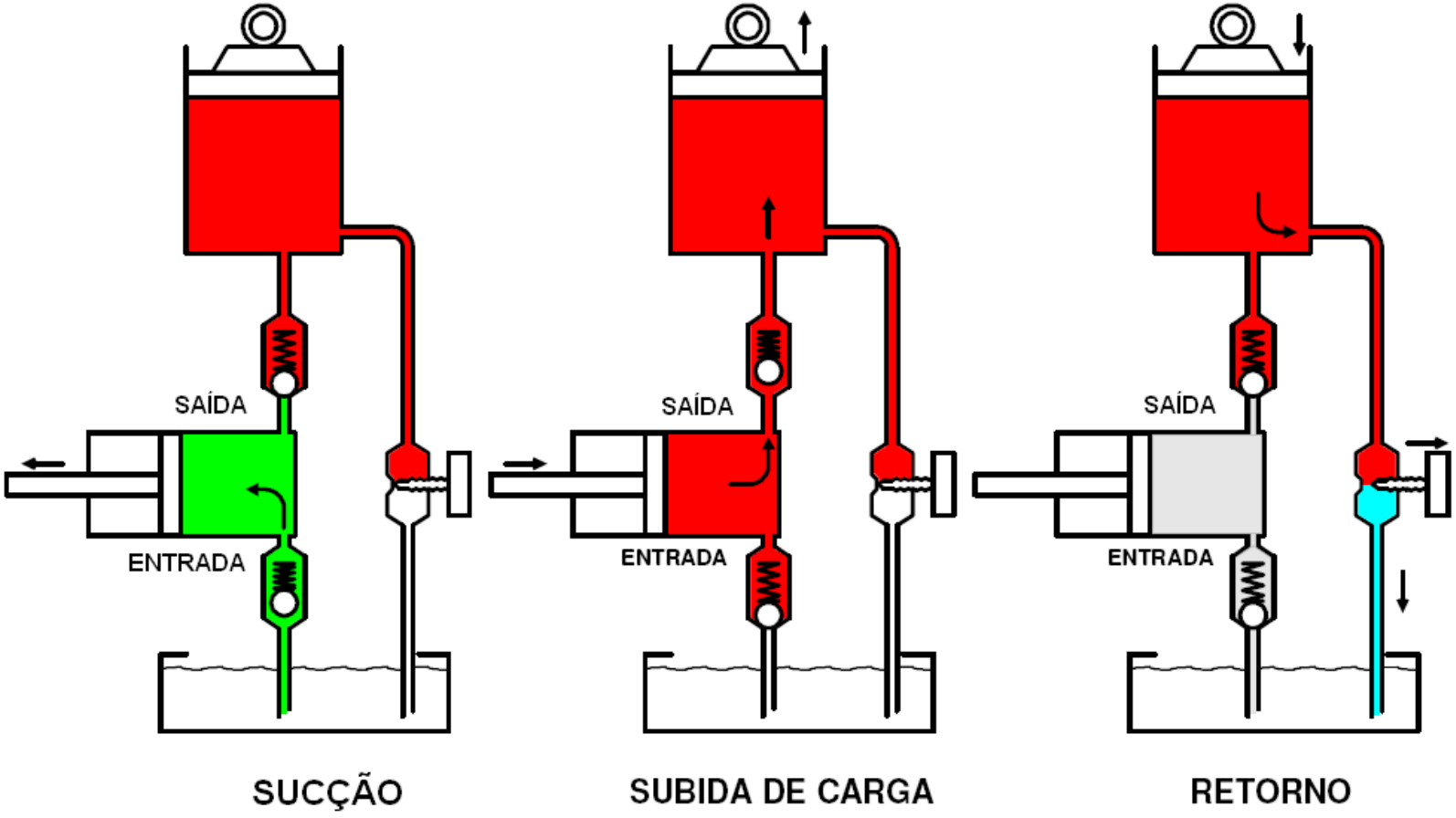
Conservação de Energia




$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

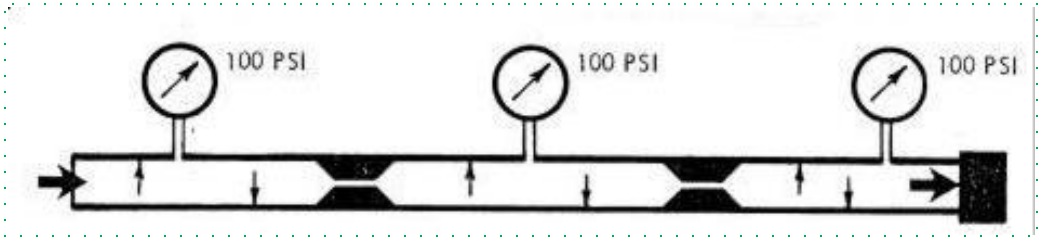
# 1. Princípios de hidráulica

- Aplicação
  - Macaco Hidráulico



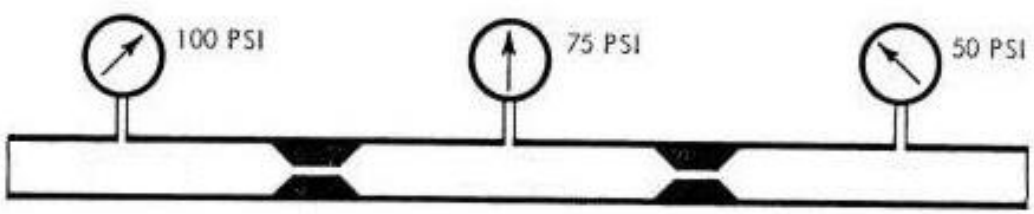
# 1. Princípios de hidráulica

- Aplicação
  - Perdas de pressão (ou de carga)




Fluído em repouso

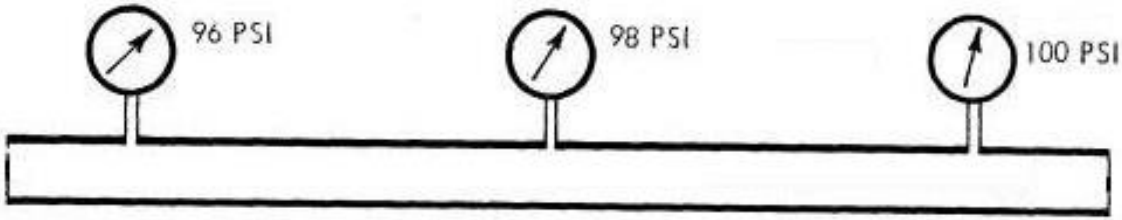
$$\Delta p = 0$$




Fluído em movimento

+ obstruções

$$\Delta p \neq 0$$




Fluído em movimento

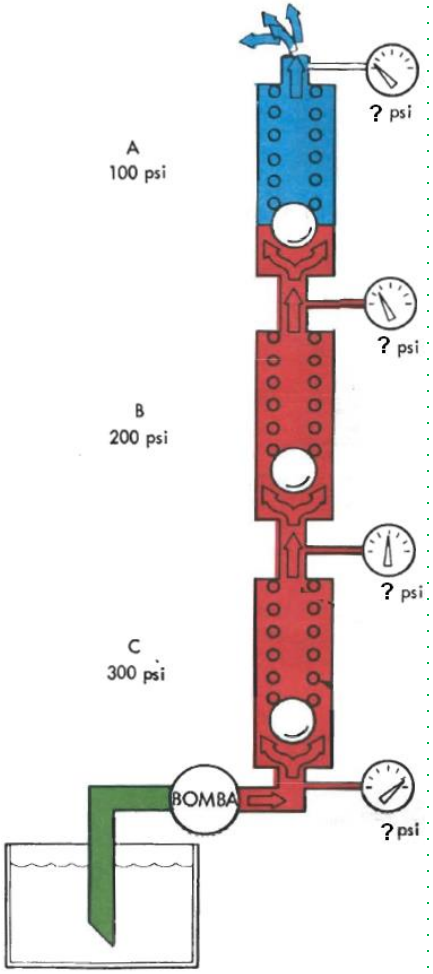
Sem obstruções

$$\Delta p \neq 0$$

# 1. Princípios de hidráulica

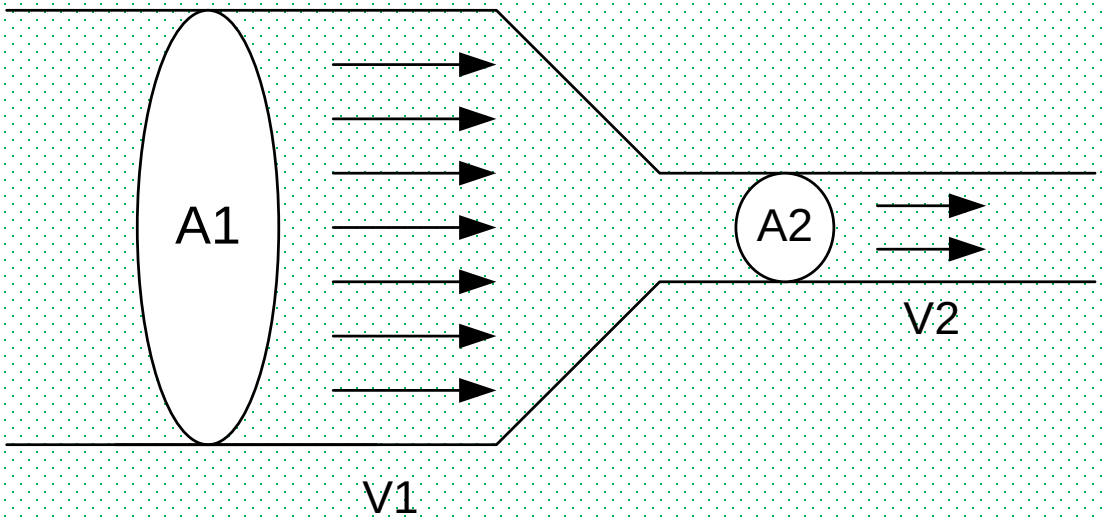
- Aplicação Perdas de pressão
  - Exercício

Determinar o valor de pressão em cada um dos manômetros.



# 1. Princípios de hidráulica

- Vazão Volumétrica




$$Q = \frac{V}{t}$$

$$Q = v.A$$

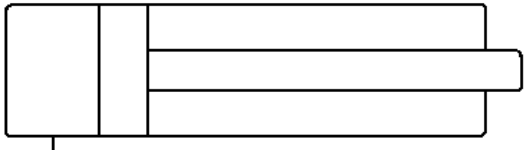
$$Q_1 = Q_2$$

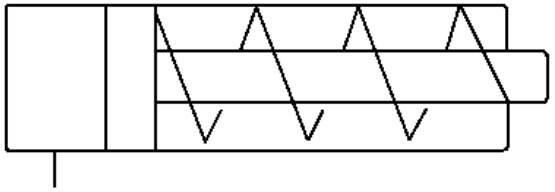
$$V_1 = \frac{A_2}{A_1} V_2$$

# 2. Atuadores

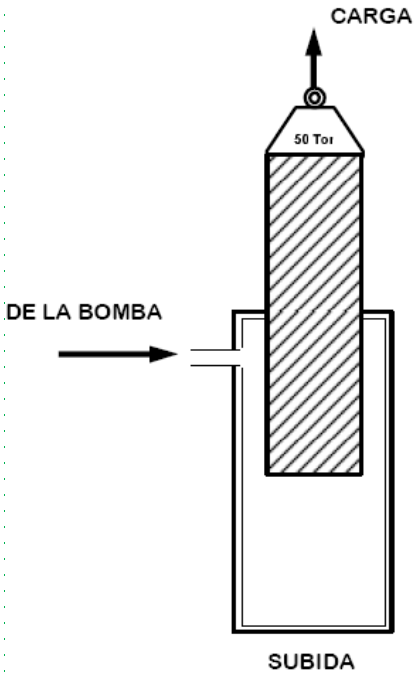
## Cilindros Hidráulicos

- Cilindros de simples ação





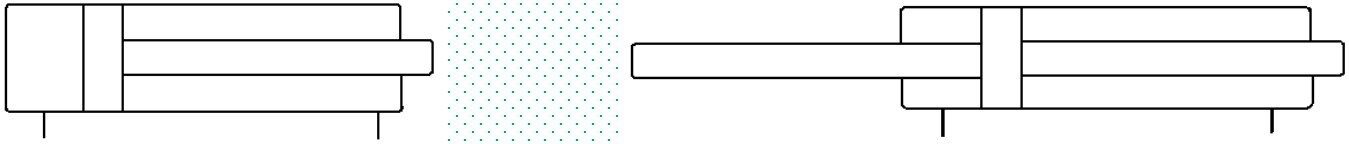
Cilindro com Retorno com Mola



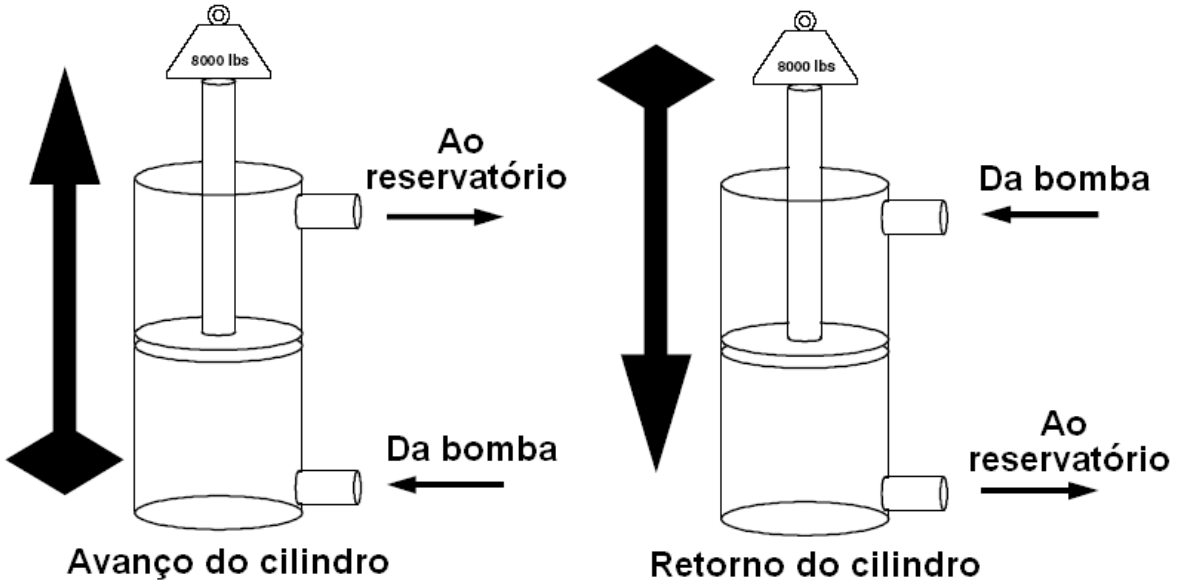
# 2. Atuadores

## Cilindros Hidráulicos

- Cilindros de dupla ação



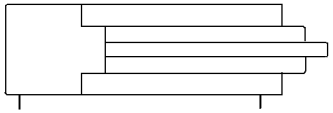
Cilindro de Haste Dupla



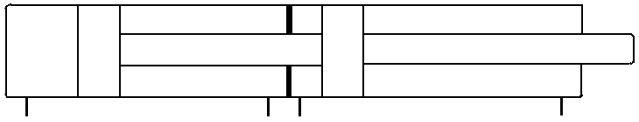
# 2. Atuadores

## Cilindros Hidráulicos

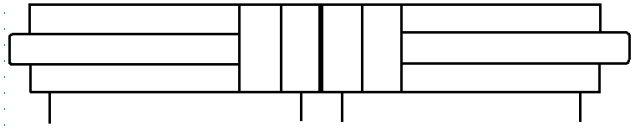
- Cilindros de dupla ação



Cilindro Telescópico ou de Múltiplo Estágio



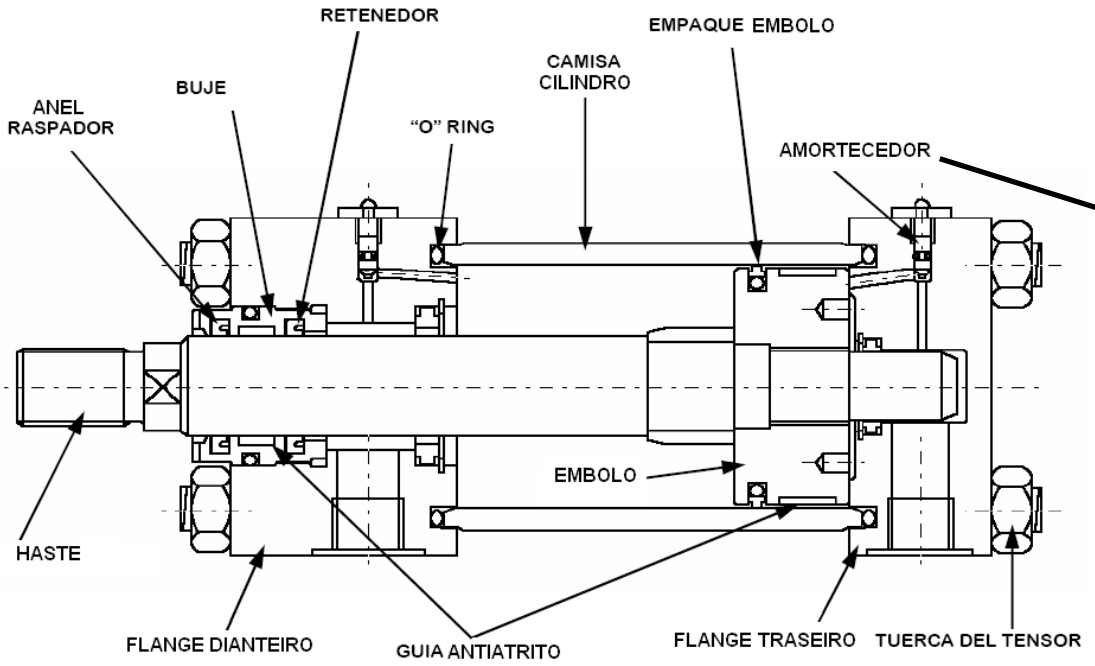
Cilindro Duplex Contínuo ou Cilindro Tandem

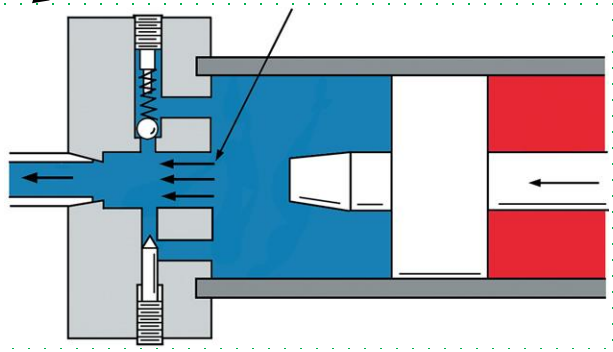


Cilindro Duplex

# 2. Atuadores

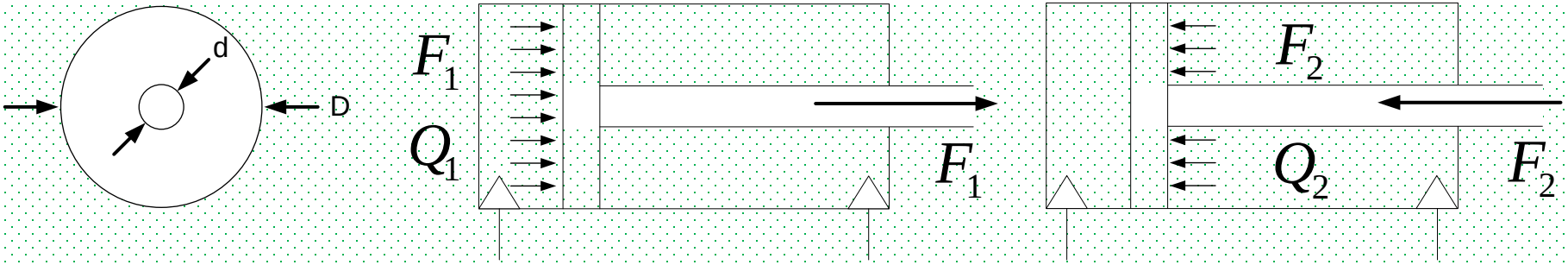
- **Cilindros Hidráulicos**
  - Amortecimento do cilindro



# 2. Atuadores

- **Cilindros Hidráulicos**
  - Forças do embolo



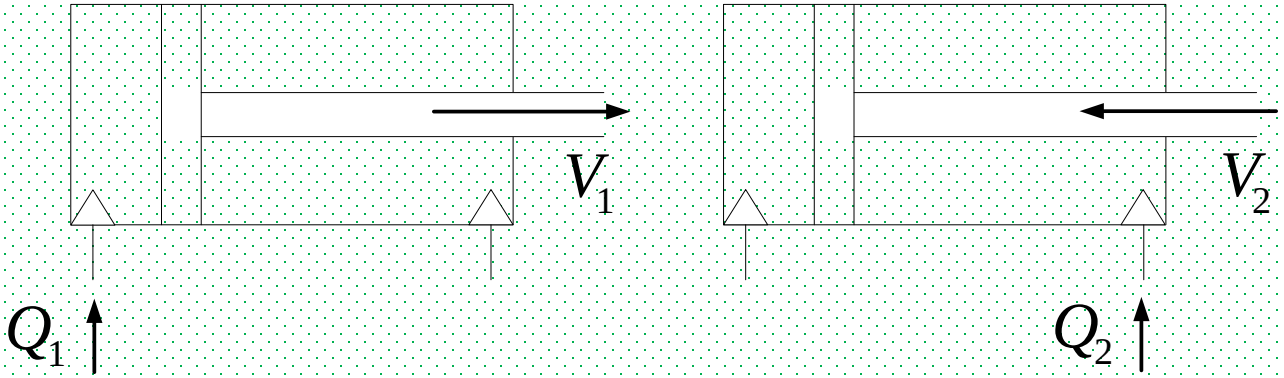

$$A_1 = \frac{\pi D^2}{4} \qquad A_2 = \frac{\left(D^2 - d^2\right)\pi}{4}$$

$$F_1 = F_2$$

$$P_1 = \frac{A_2}{A_1} P_2$$

# 2. Atuadores

- **Cilindros Hidráulicos**
  - Velocidade do êmbolo




$$F_1 = F_2$$

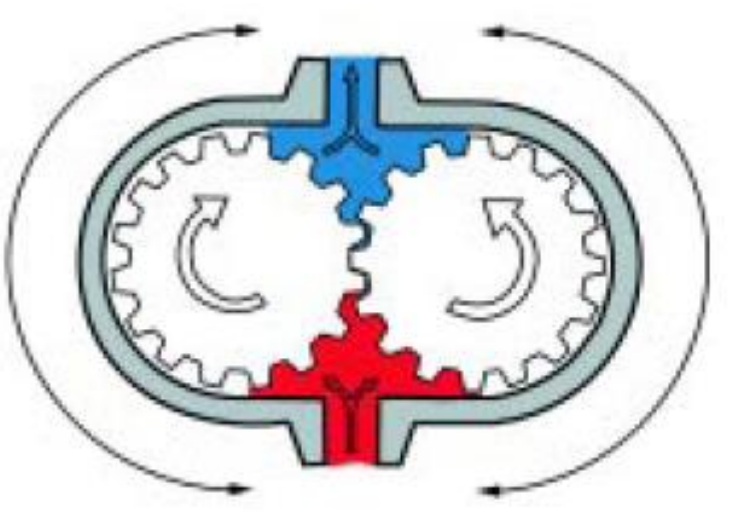
$$P_1 = \frac{A_2}{A_1} P_2$$

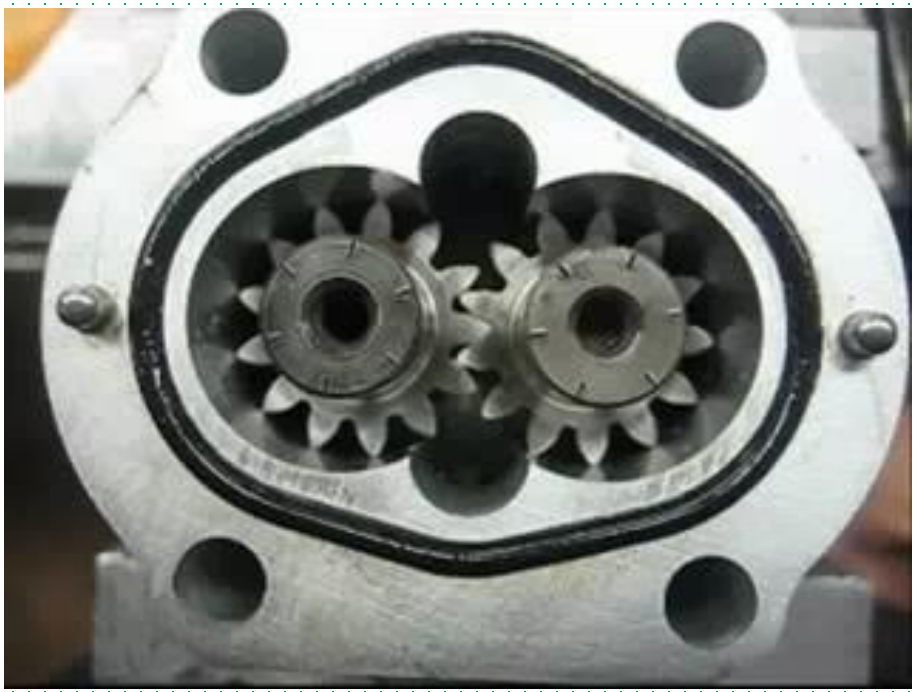
$$Q_1 = Q_2$$

$$V_1 = \frac{A_2}{A_1} V_2$$

# 2. Atuadores

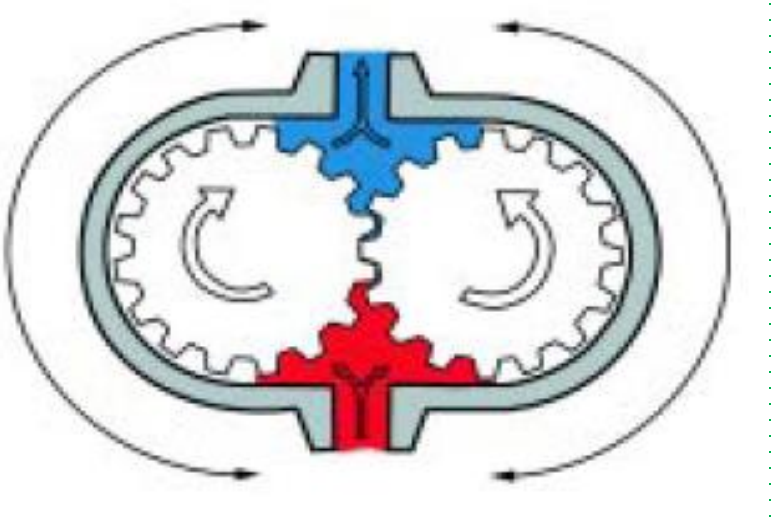
- **Motores Hidráulicos**
  - De Engrenagens

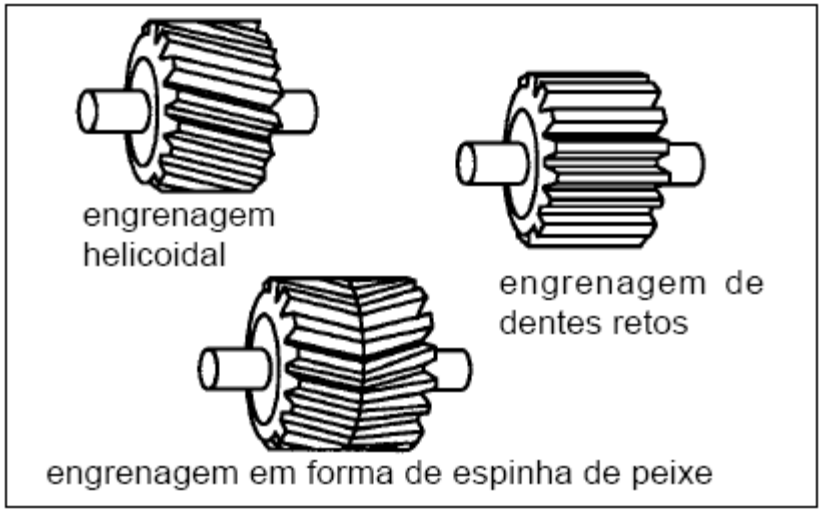




# 2. Atuadores

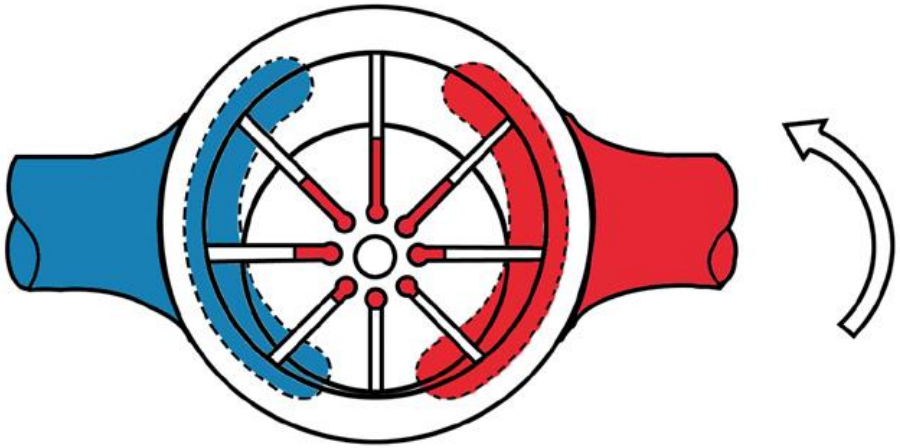
- **Motores Hidráulicos**
  - De Engrenagens

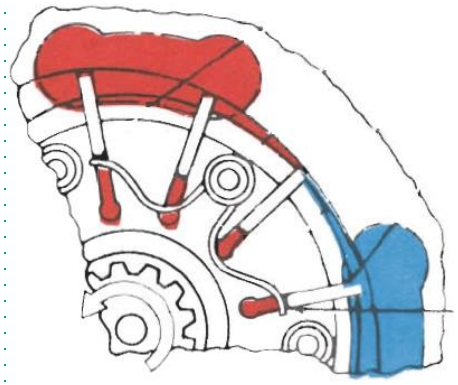


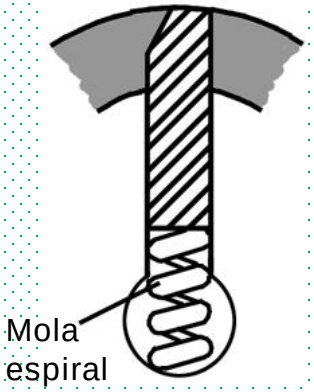


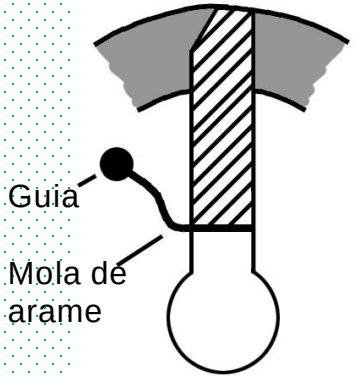
# 2. Atuadores

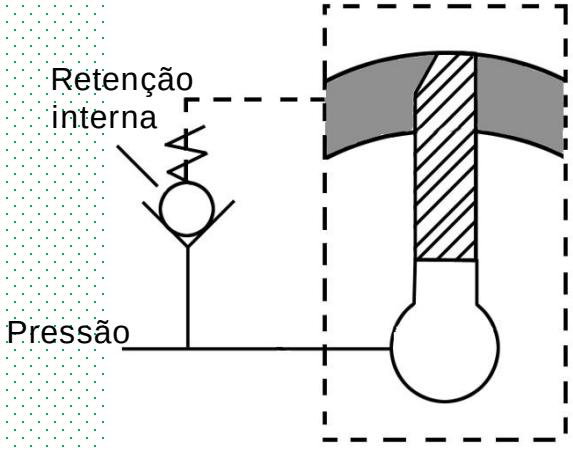
- **Motores Hidráulicos**
  - De Palhetas





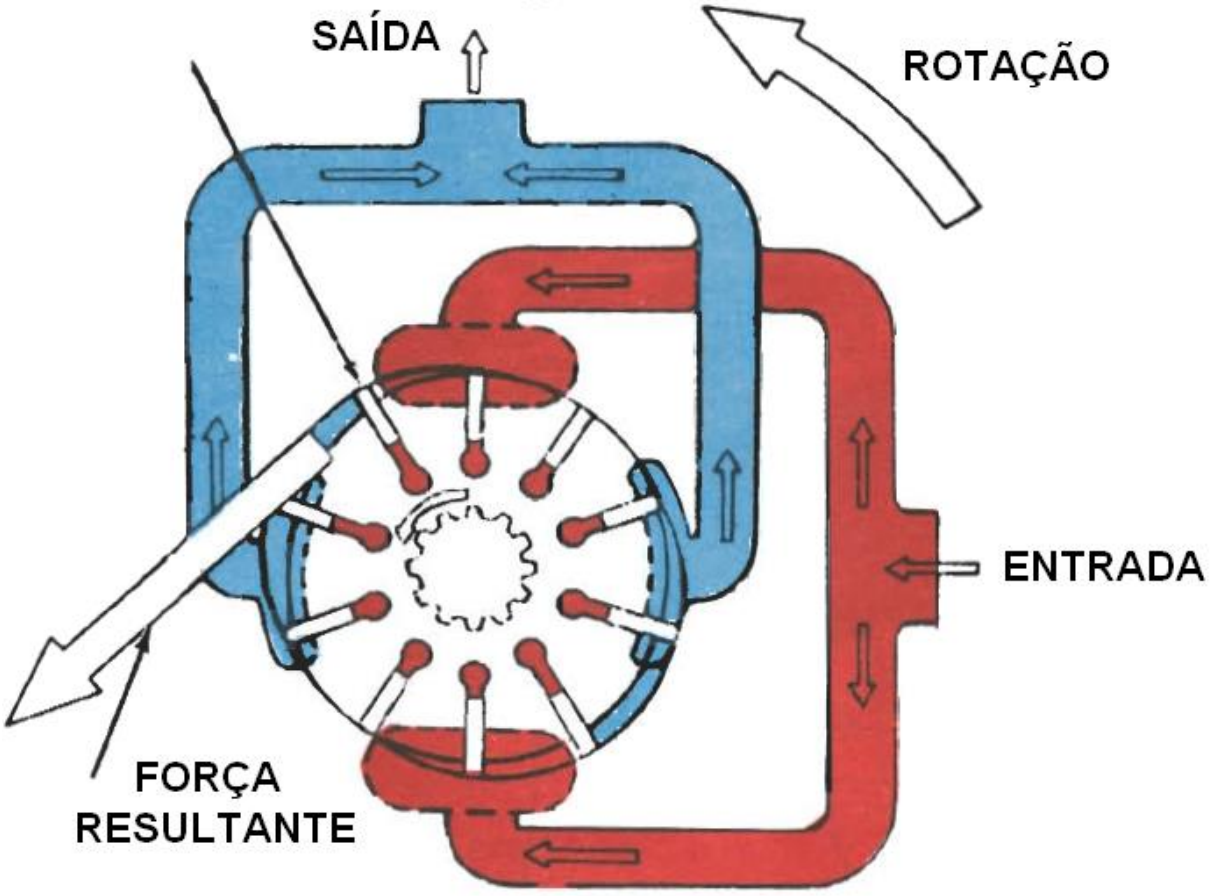


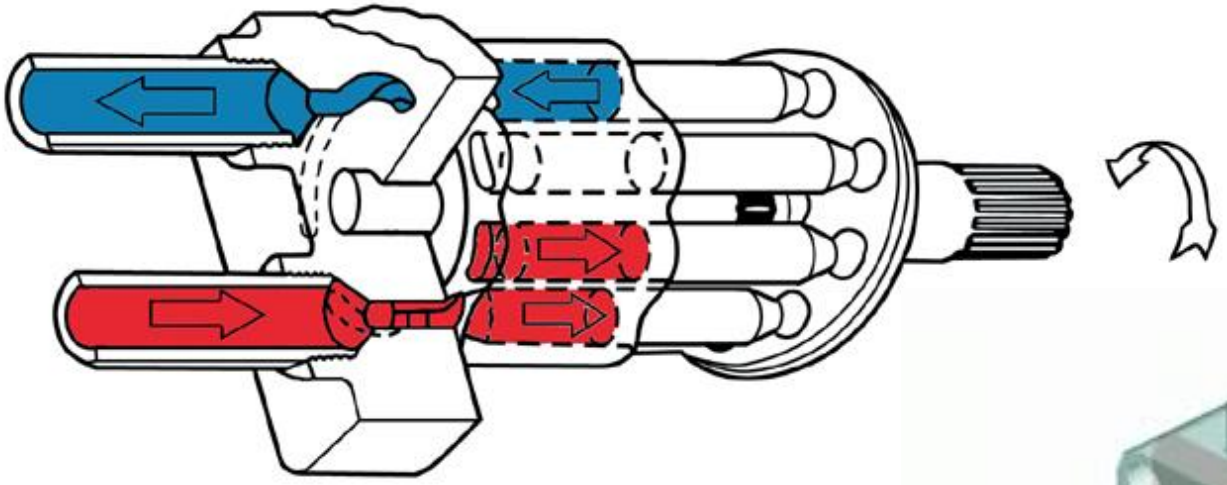
# 2. Atuadores

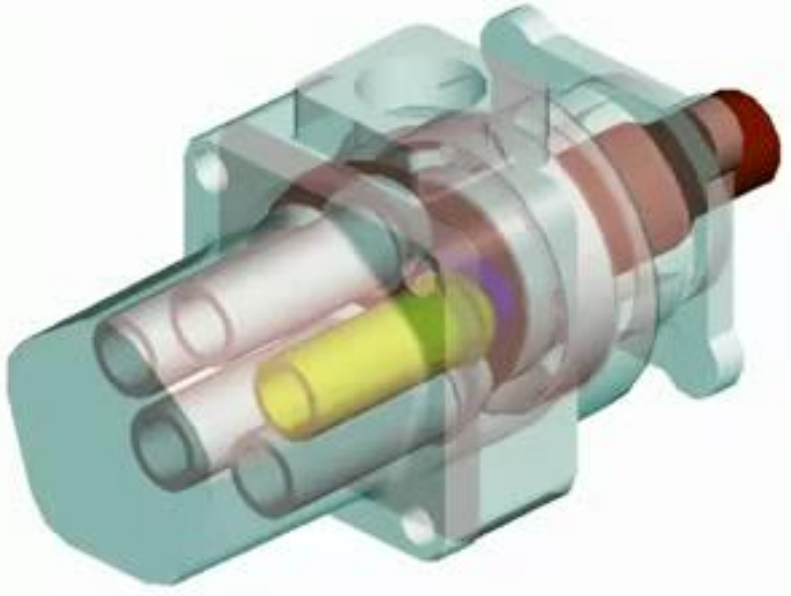
- **Motores Hidráulicos**
  - De Palhetas



# 2. Atuadores

- **Motores Hidráulicos**
  - De Pistões





# 2. Atuadores

- **Motores Hidráulicos. Resumem de formulas de cálculos.**

$$Q = \frac{V \bullet n}{1000 \bullet \eta_{vol}}$$

$$n = \frac{Q \bullet \eta_{vol} \bullet 1000}{V}$$

$$M_{ab} = \frac{\Delta p \bullet V \bullet \eta_{mh}}{200 \bullet \pi} = 1{,}59 \bullet V \bullet \Delta p \bullet \eta_{mh} \bullet 10^{-3}$$

$$P_{ab} = \frac{\Delta p \bullet Q \bullet \eta_{ges}}{600}$$

Q = Vazão (ou fluxo volumétrico) [l/min]

V = Volume nominal [$cm^3$]

n = Rotação de saída do motor [$min^{-1}$]

$\eta_{ges}$ = Rendimento total (0,8-0,85)

$\eta_{vol}$ = Rendimento volumétrico (0,9-0,95)

$\eta_{mh}$ = Rendimento mecânico hidráulico (0,9-0,95)

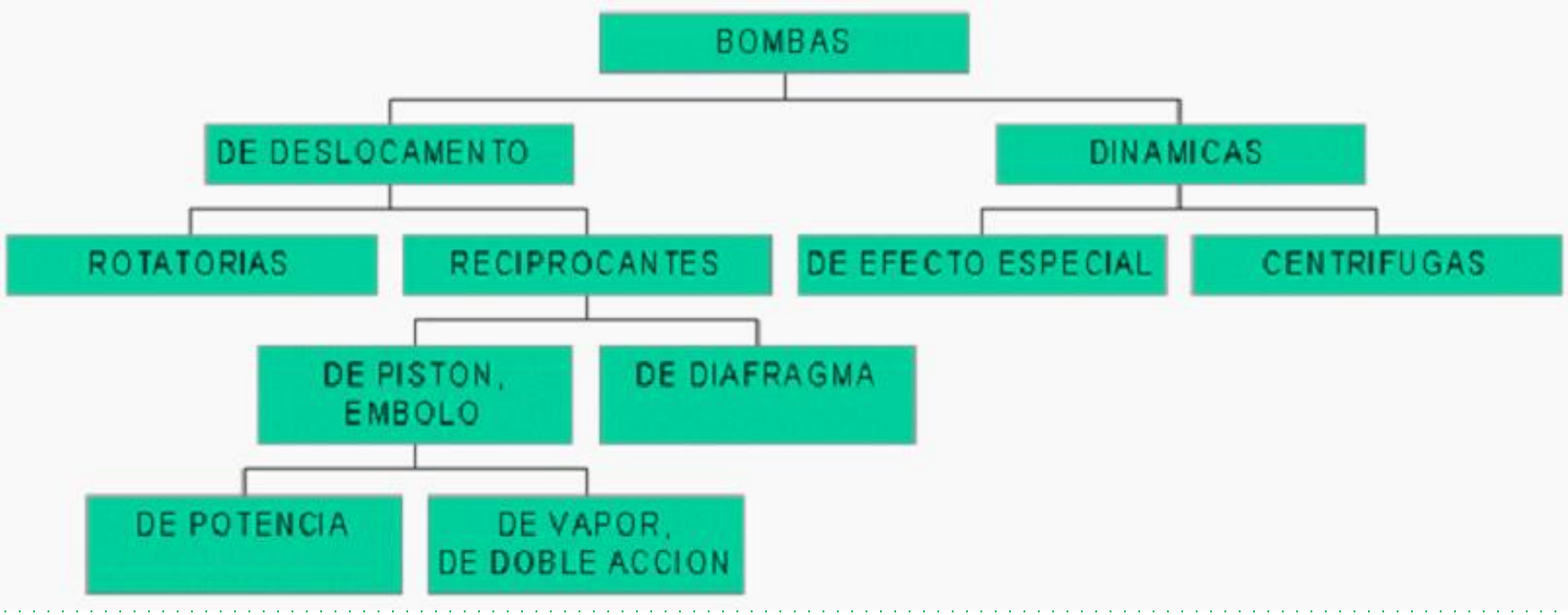
$\Delta p$ = Diferença de pressão entre entrada e saída no motor [bar]

$P_{ab}$ = Potência de saída do motor [kW]

$M_{ab}$ = Torque de saída do motor [daNm]

# 3. Impulsores

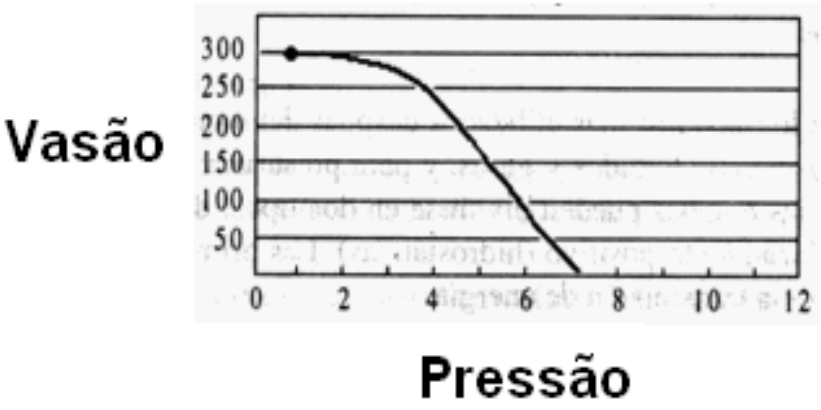
- **Bombas Hidráulicas**



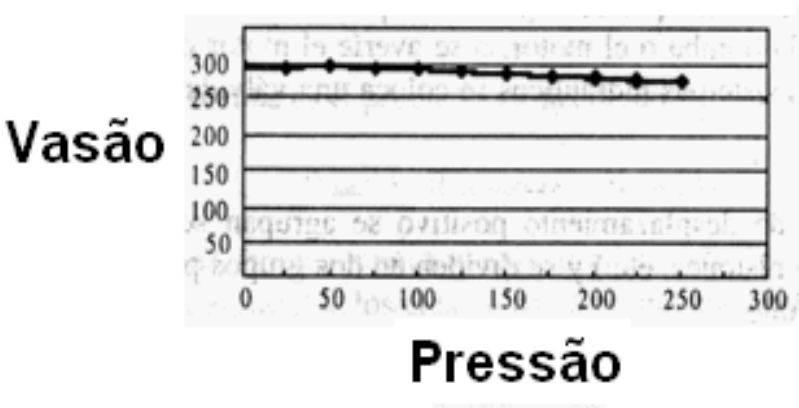
# 3. Impulsores

- **Bombas Hidráulicas**

**Centrífuga**



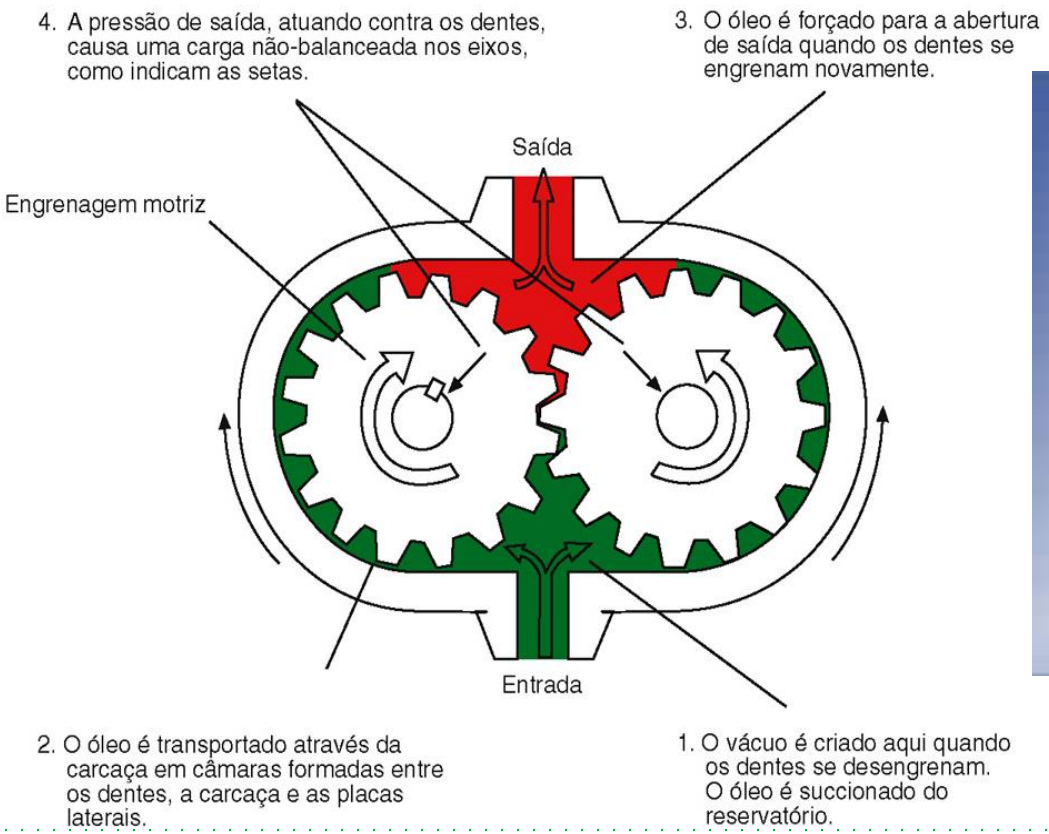

**Deslocamento positivo**

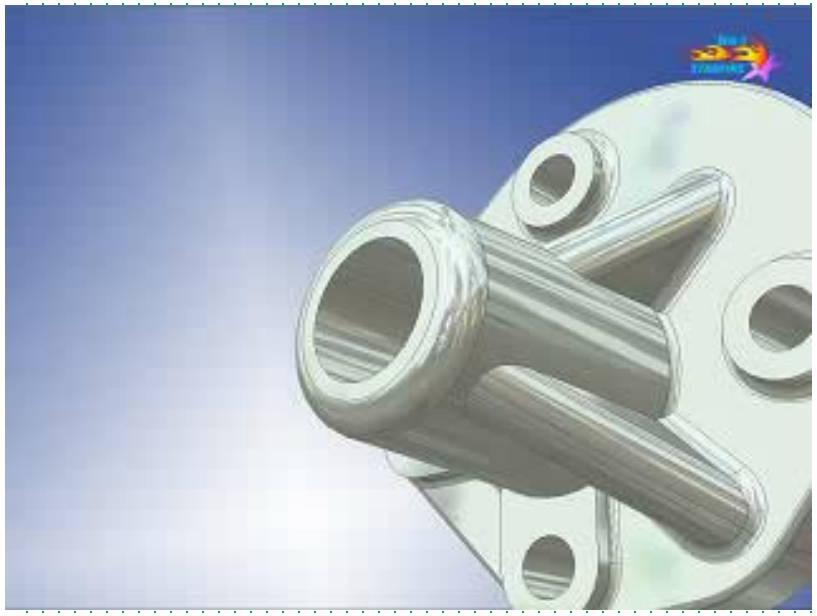


# 3. Impulsores

## Bombas Hidráulicas

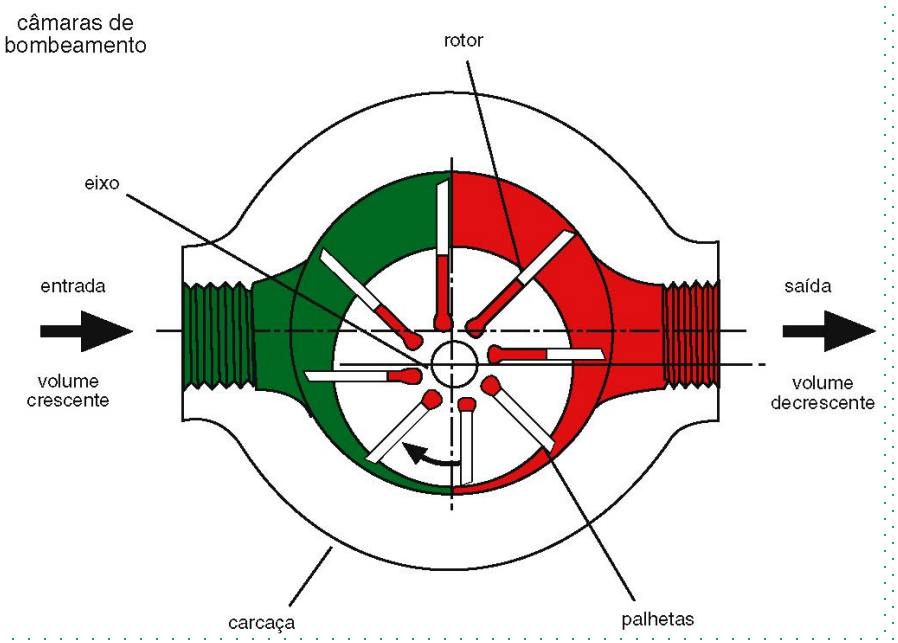
- De Engrenagens



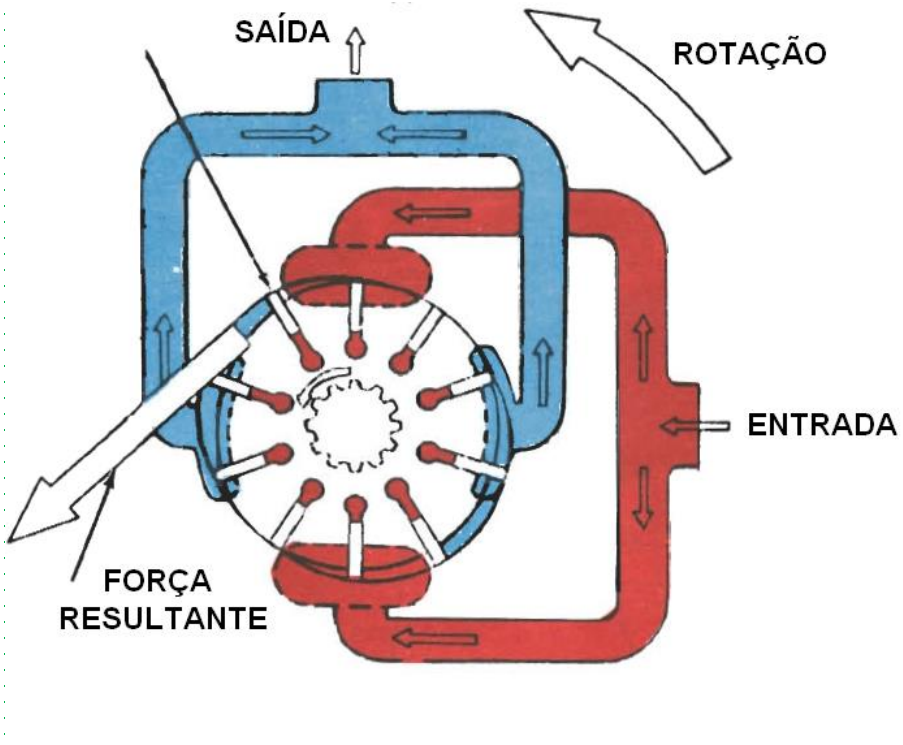
# 3. Impulsores

- **Bombas Hidráulicas**
  - De Palhetas



# 3. Impulsores

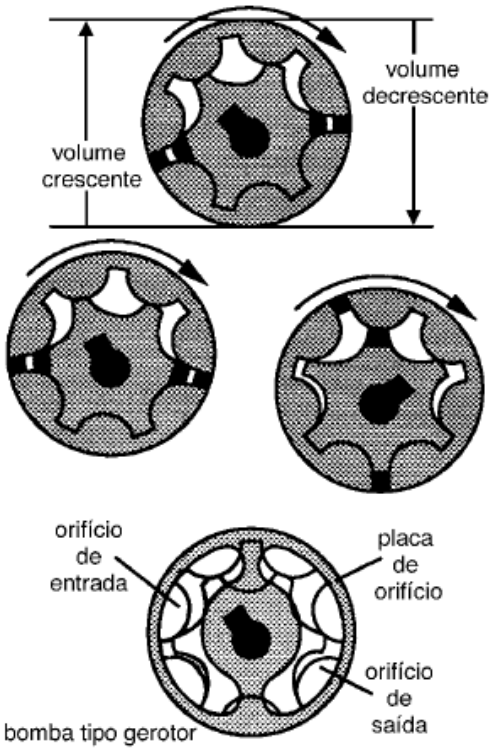
- **Bombas Hidráulicas**
  - De Palhetas



# 3. Impulsores

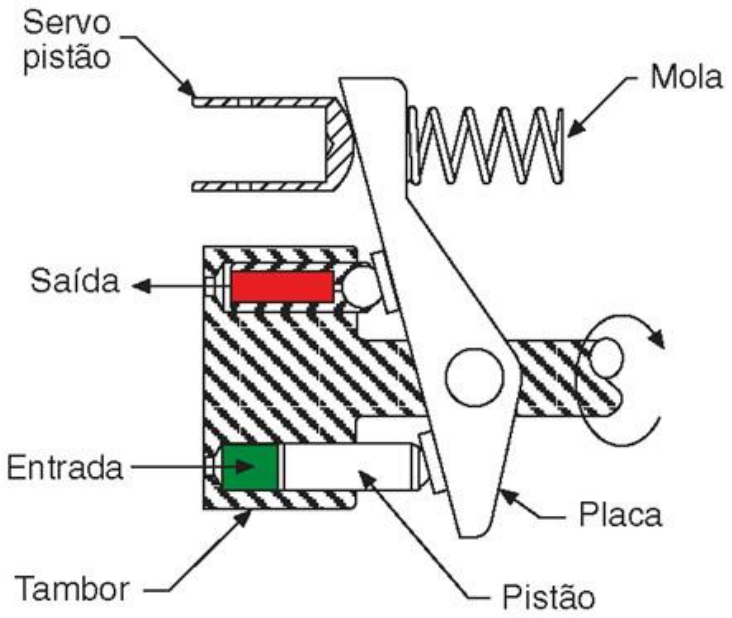
## Bombas Hidráulicas

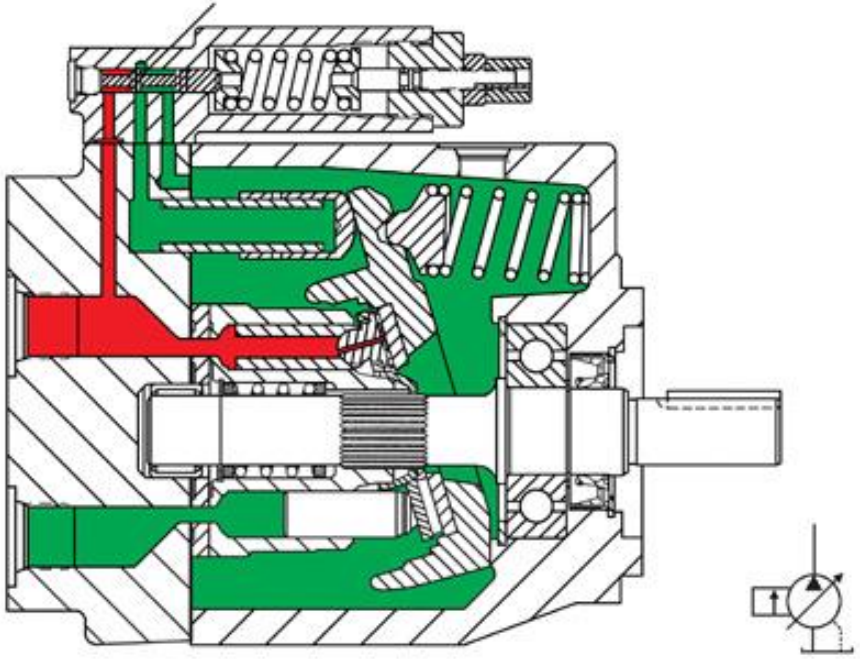
- Gerotor



# 3. Impulsores

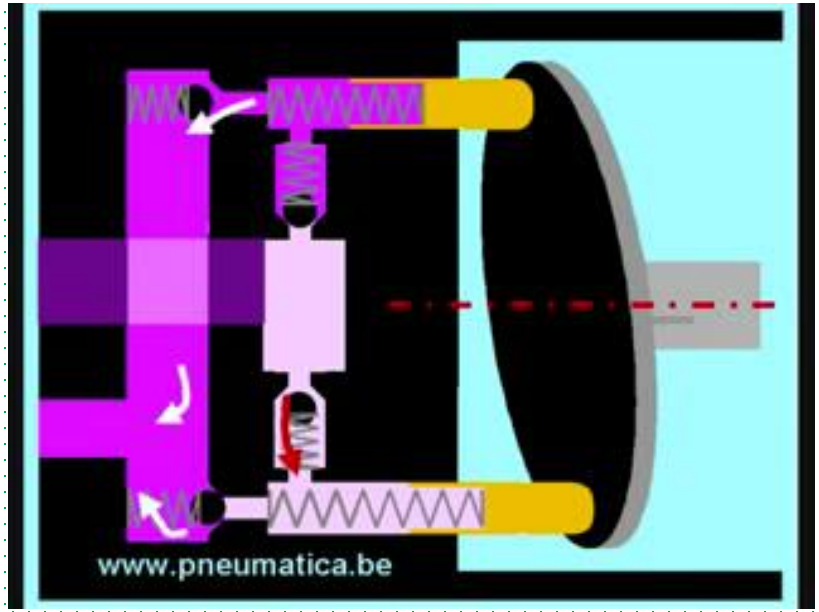
- **Bombas Hidráulicas**
  - De Pistões



# 3. Impulsores

- **Bombas Hidráulicas**
  - De Pistões



# 3. Impulsores

- **Bombas Hidráulicas.**

**Resumo de fórmulas.**

***Bomba hidráulica***

$$Q = \frac{V \bullet n \bullet \eta_{vol}}{1000} \text{ [l/min]}$$

$$P_{an} = \frac{p \bullet Q}{600 \bullet \eta_{ges}} \text{ [kW]}$$

$$M = \frac{1{,}59 \bullet V \bullet \Delta p}{100 \bullet \eta_{mh}} \text{ [Nm]}$$

$$\eta_{ges} = \eta_{vol} \bullet \eta_{mh}$$

Q = Vazão (ou fluxo volumétrico) [l/min]

V = Volume nominal [$cm^3$]

n = Rotação de acionamento da bomba [$min^{-1}$]

$P_{an}$ = Potência de acionamento [kW]

p = Pressão operacional [bar]

M = Torque de acionamento [Nm]

$\eta_{ges}$ = Rendimento total (0,8-0,85)

$\eta_{vol}$ = Rendimento volumétrico (0,9-0,95)

$\eta_{mh}$ = Rendimento hidráulico mecânico (0,9-0,95)

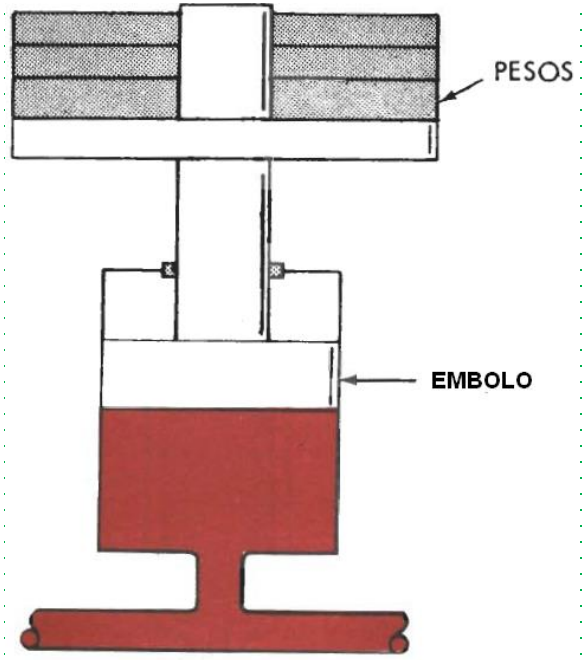
# 3. Impulsores

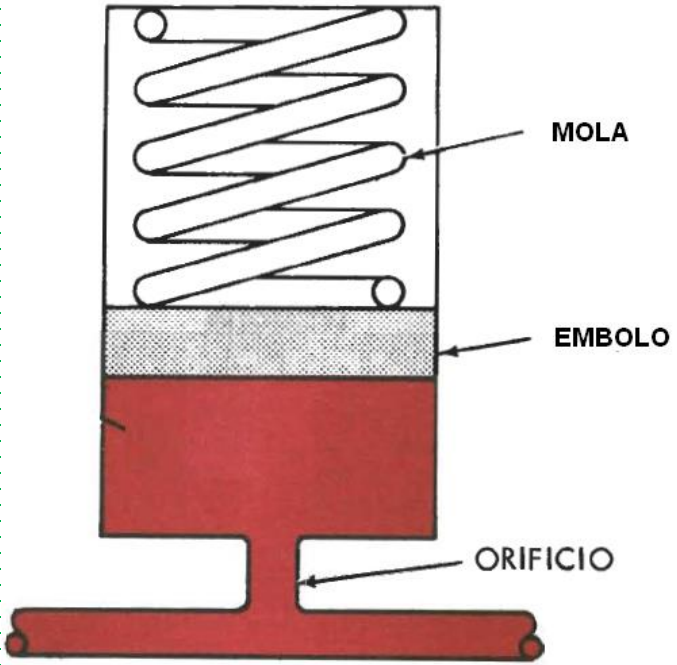
## Acumuladores

- São encarregados de manter a pressão quando o sistema necessita.
- Utilizado em diversos processos que precisam manter a pressão num tempo prolongado.

# 3. Impulsores

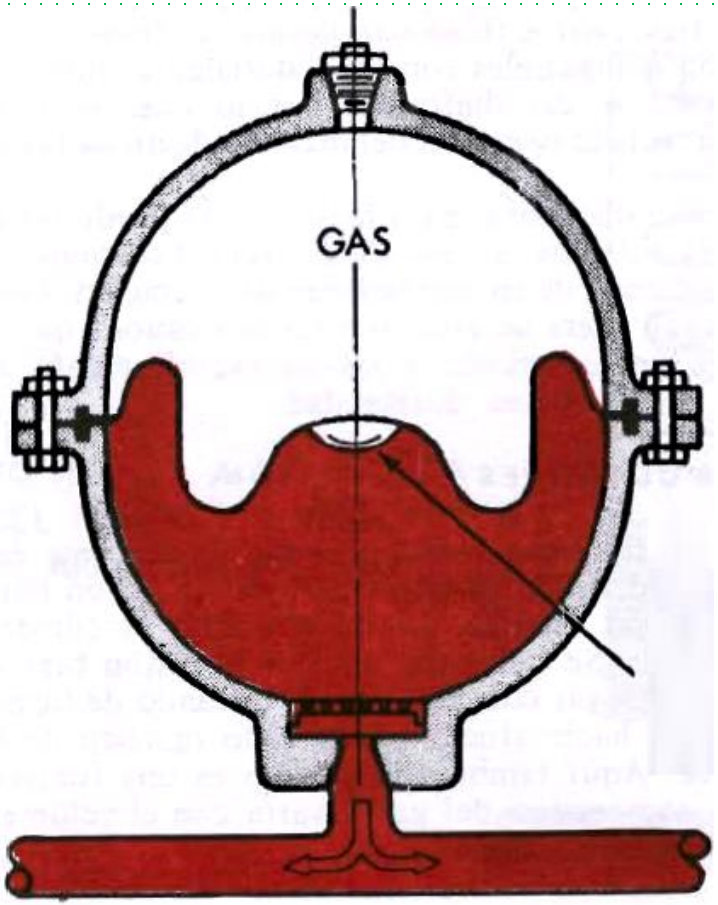
- **Acumuladores**



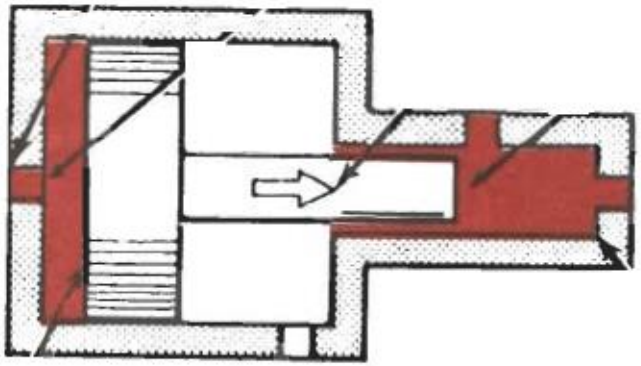
# 3. Impulsores

- **Acumuladores**

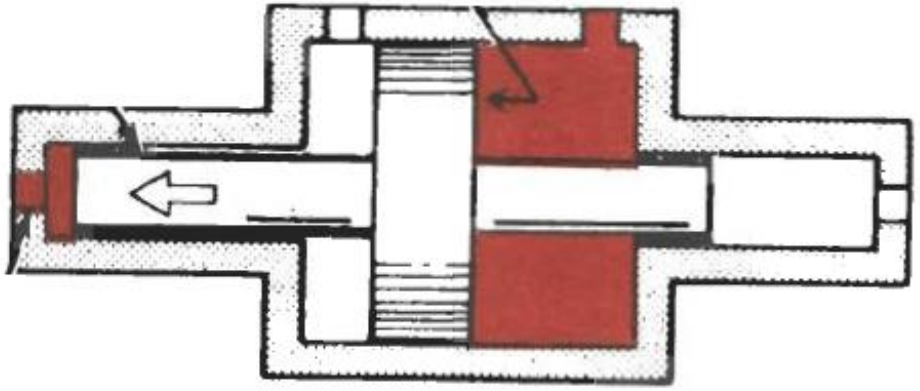


# 3. Impulsores

- **Multiplicadores de Pressão**



MULTIPLICADOR DE PRESSÃO
DE SIMPLE AÇÃO



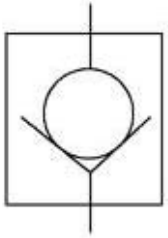
MULTIPLICADOR DE PRESSÃO
DE DUPLA AÇÃO

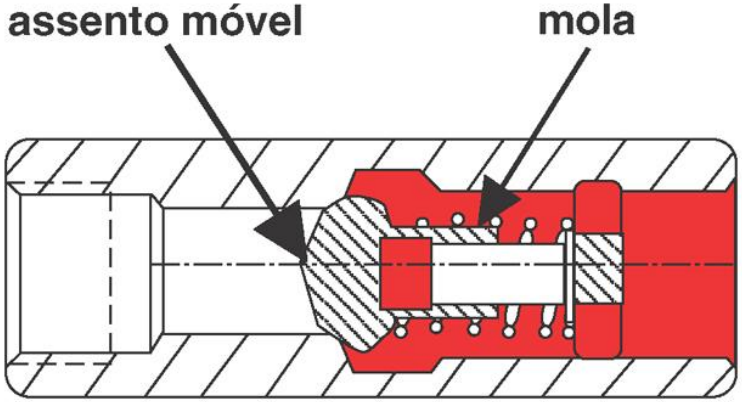
$$F_1 = F_2$$

$$P_1 = \frac{A_2}{A_1} P_2$$

# 4. Válvulas

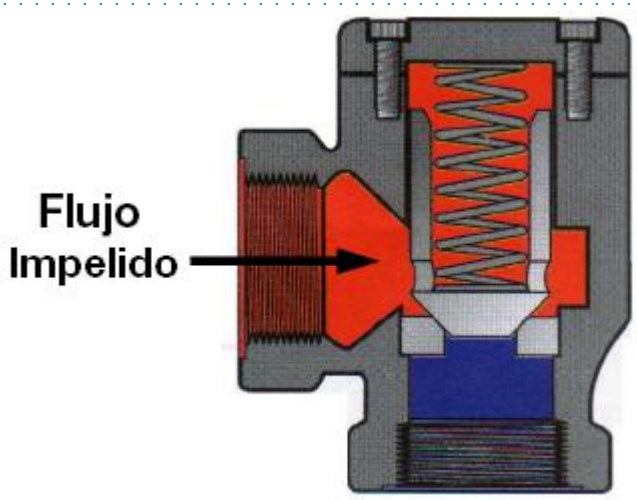
- **Válvulas de direção.**
  - **Válvulas de retenção**

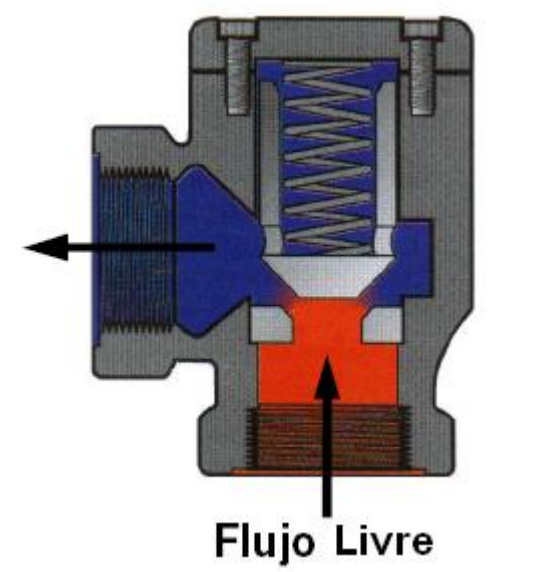




# 4. Válvulas

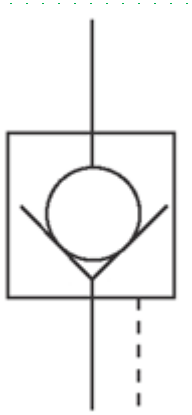
- **Válvulas de direção.**
  - **Válvulas de retenção**

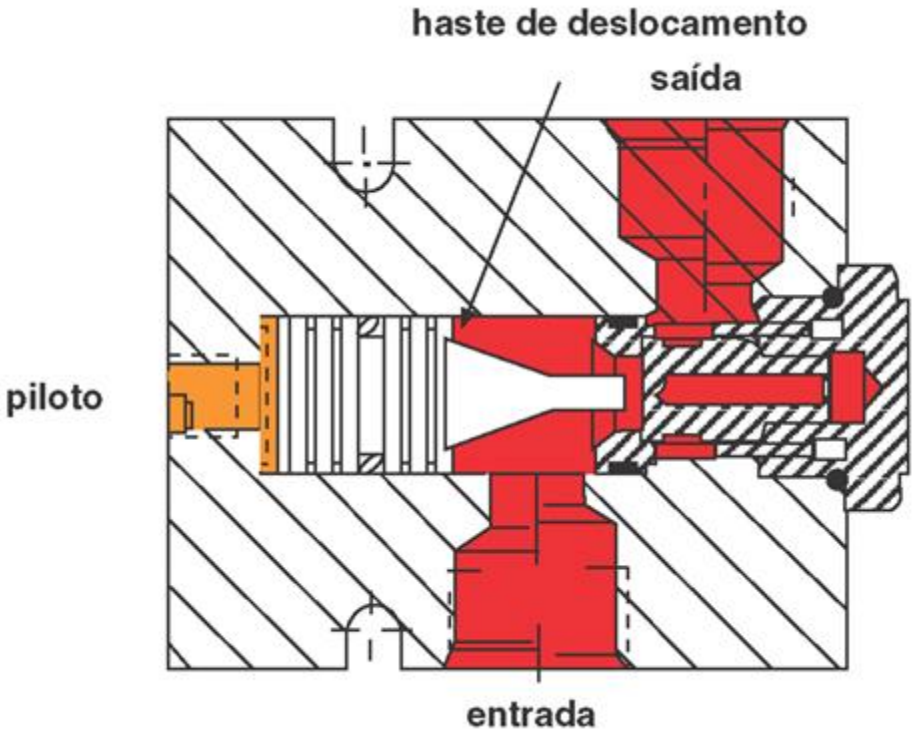


# 4. Válvulas

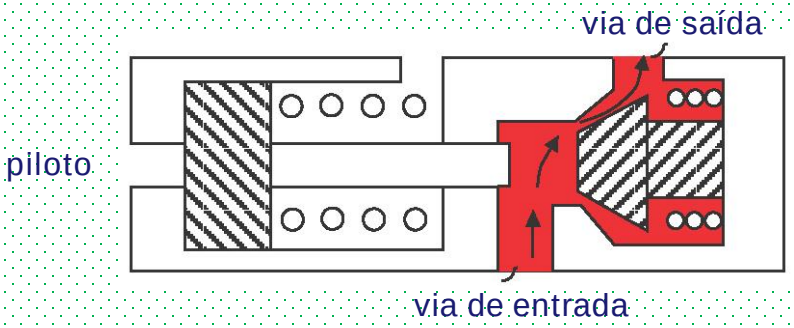
- **Válvulas de direção.**
  - **Válvulas de retenção pilotadas**

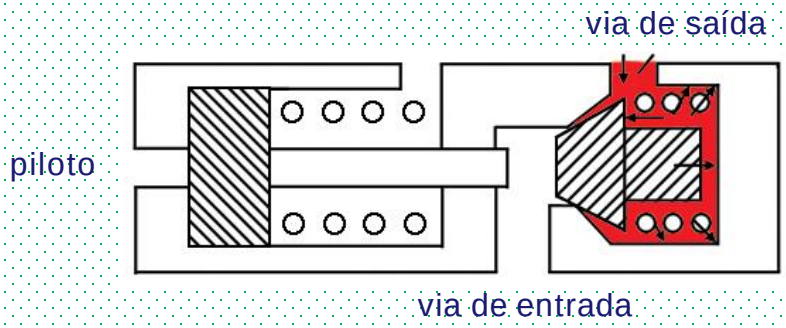


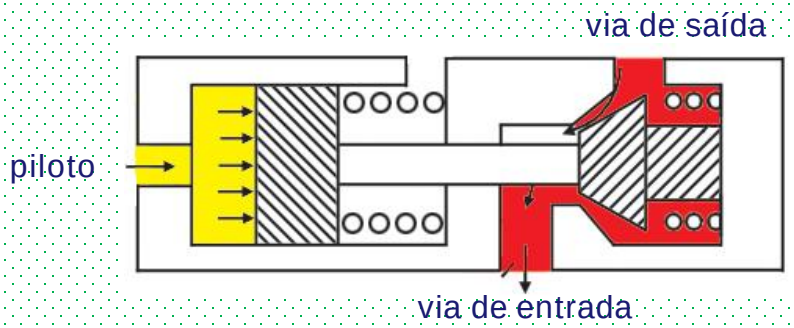


# 4. Válvulas

- **Válvulas de direção.**
  - **Válvulas de retenção pilotadas**



# 4. Válvulas

## Válvulas de direção.

- **Válvulas direcionais:** Sua função principal como seu nome indica é direcionar o fluido, nesse caso óleo, para as diferentes vias.

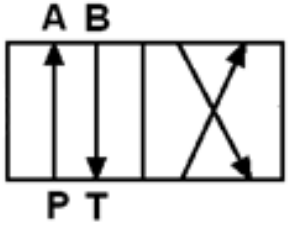
  As válvulas direcionais geralmente tem duas ou mais vias e duas ou três posições normalmente mas se pode ter válvulas de mais posições.

- **Simbologia:**

  Número de posições.

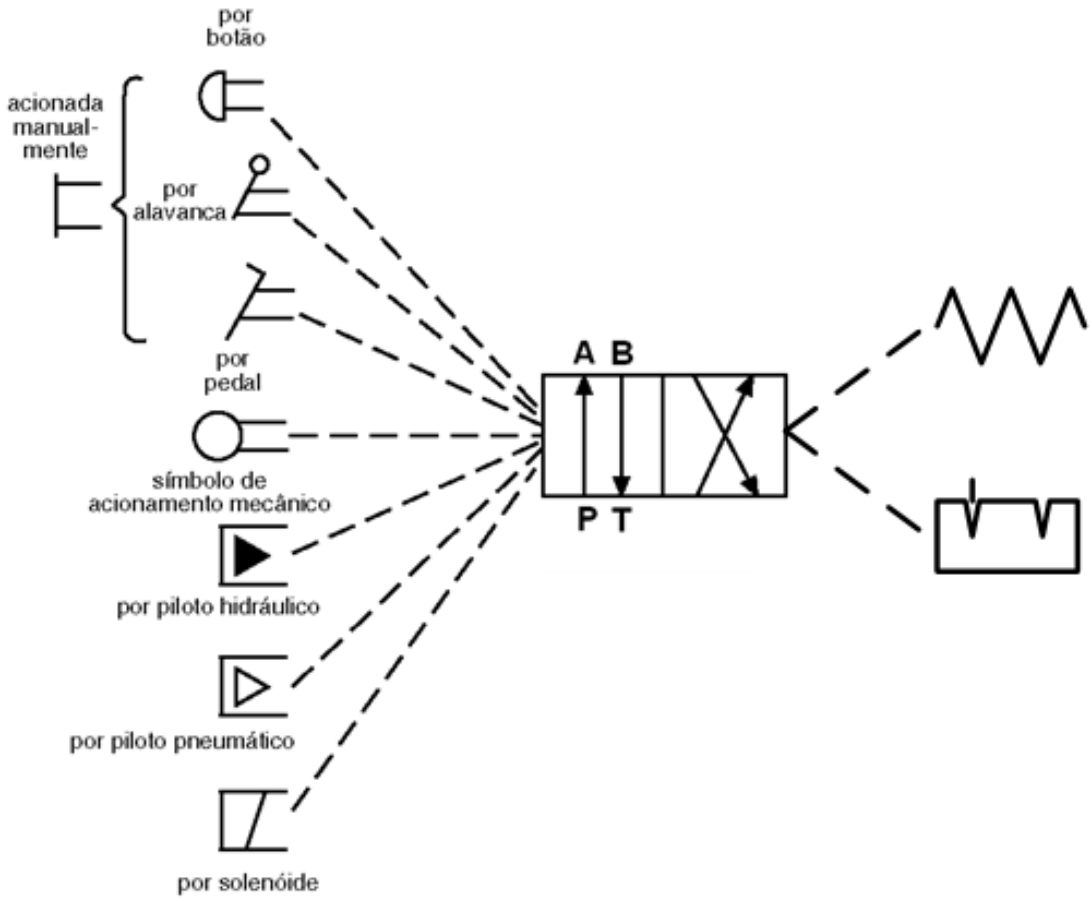
  Número de vias.

  Tipo de atuador



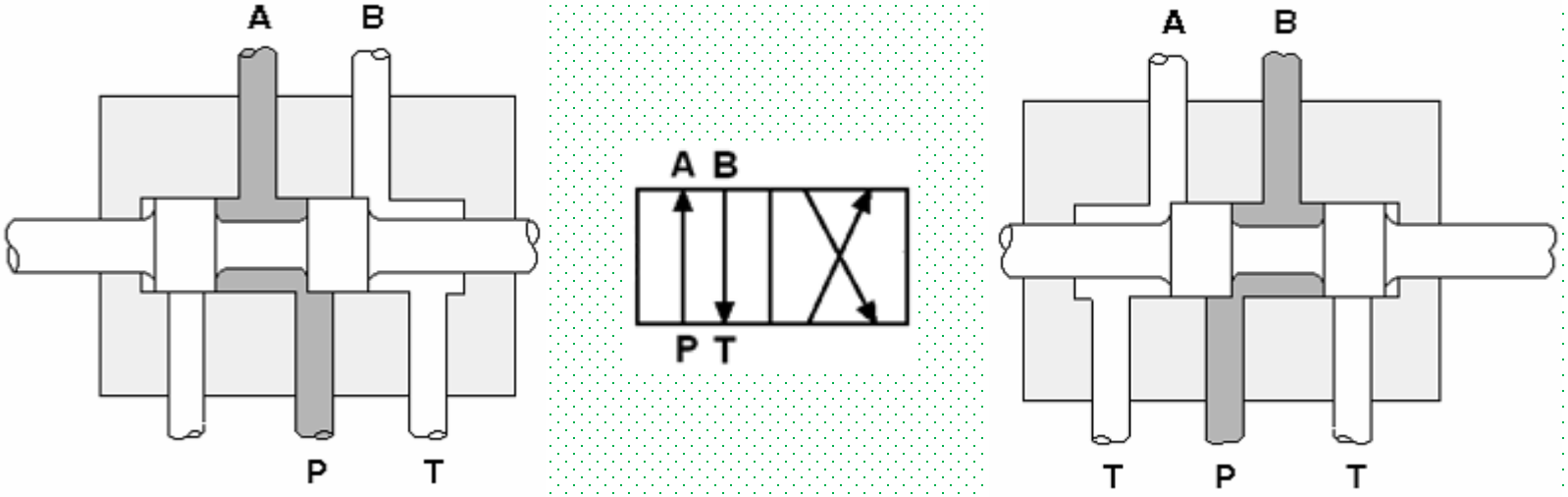
# 4. Válvulas

- **Válvulas de direção.**
  - **Simbologia:**



# 4. Válvulas

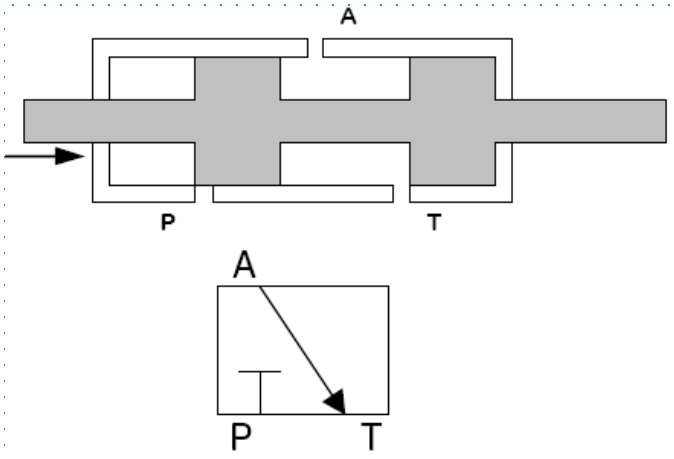
- **Válvulas de direção.**
  - **Simbologia:**

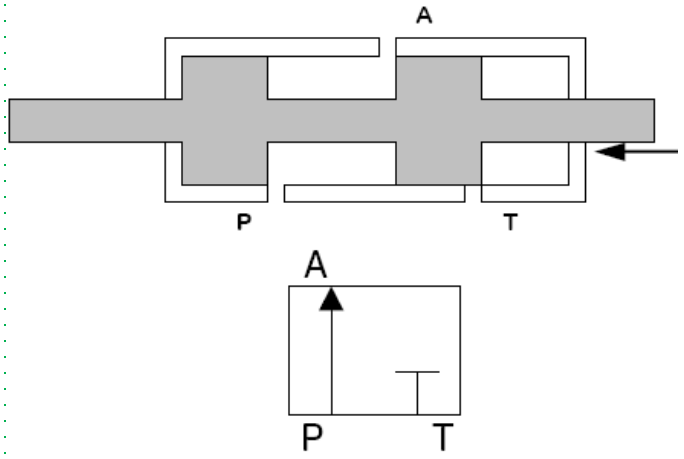


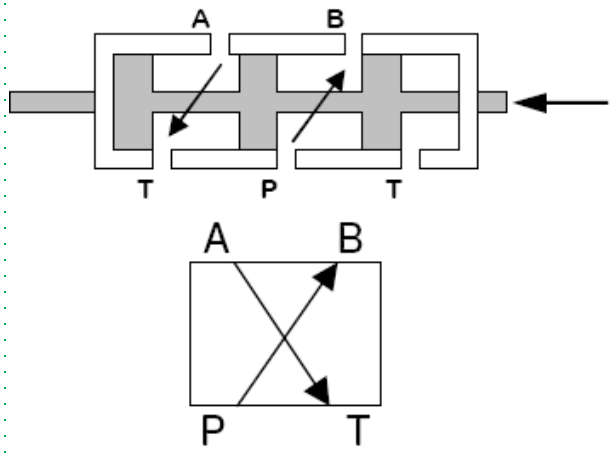
# 4. Válvulas

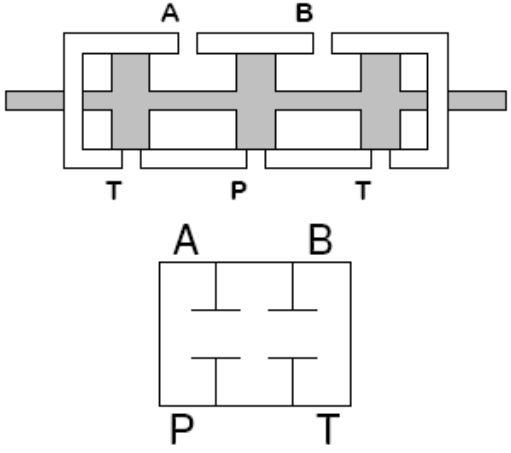
## Válvulas de direção.

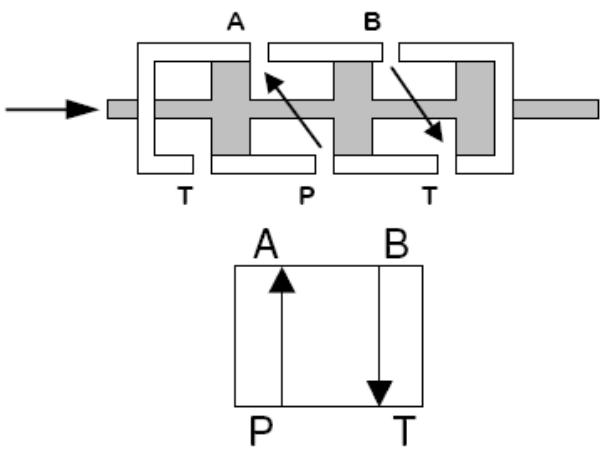
- Simbologia:



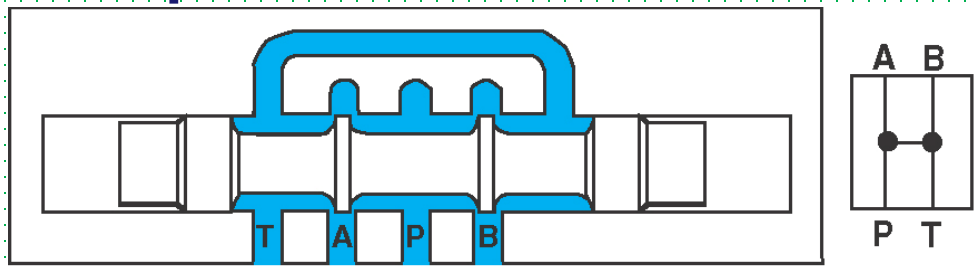



# 4. Válvulas

## Válvulas de direção.

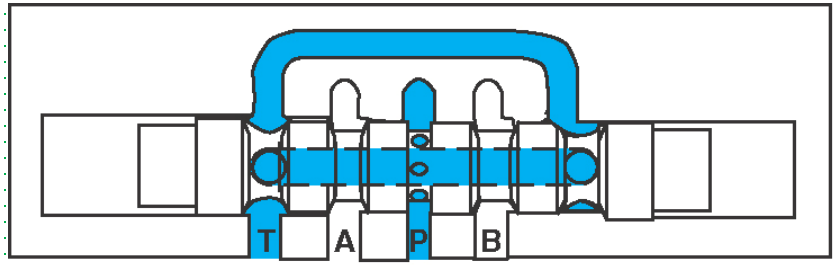
- Tipos de centros:

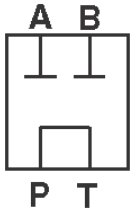




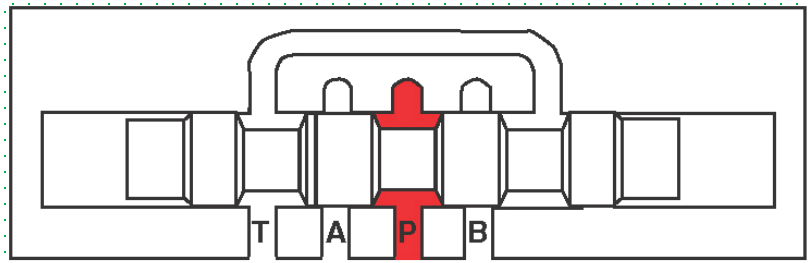


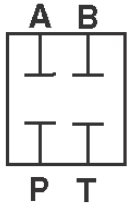
Centro Aberto




Tandem P aberto ao tanque, A e B bloqueados

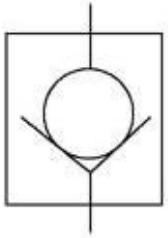


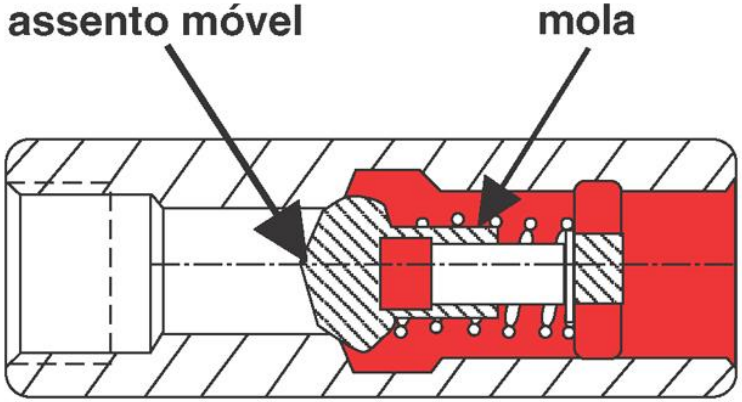




Todas as aberturas bloqueadas

# 4. Válvulas

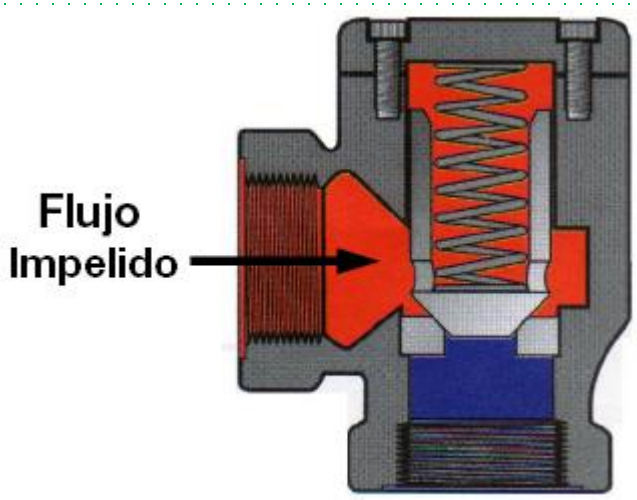
- **Válvulas de direção.**
  - **Válvulas de retenção**

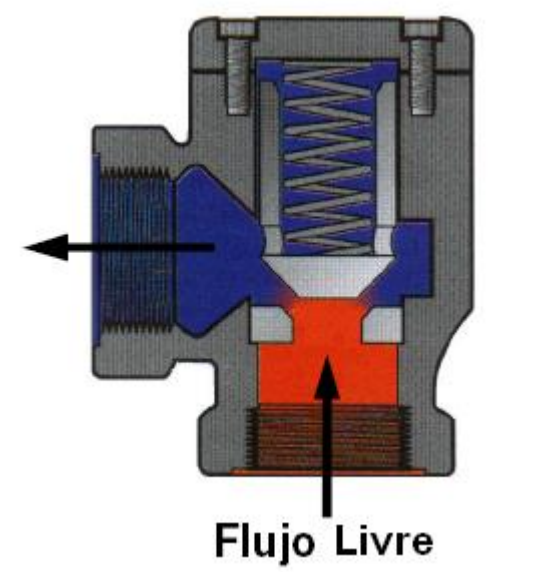




# 4. Válvulas

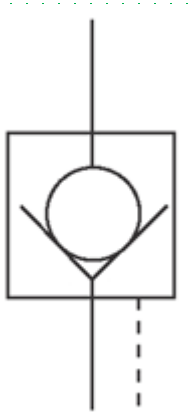
- **Válvulas de direção.**
  - **Válvulas de retenção**

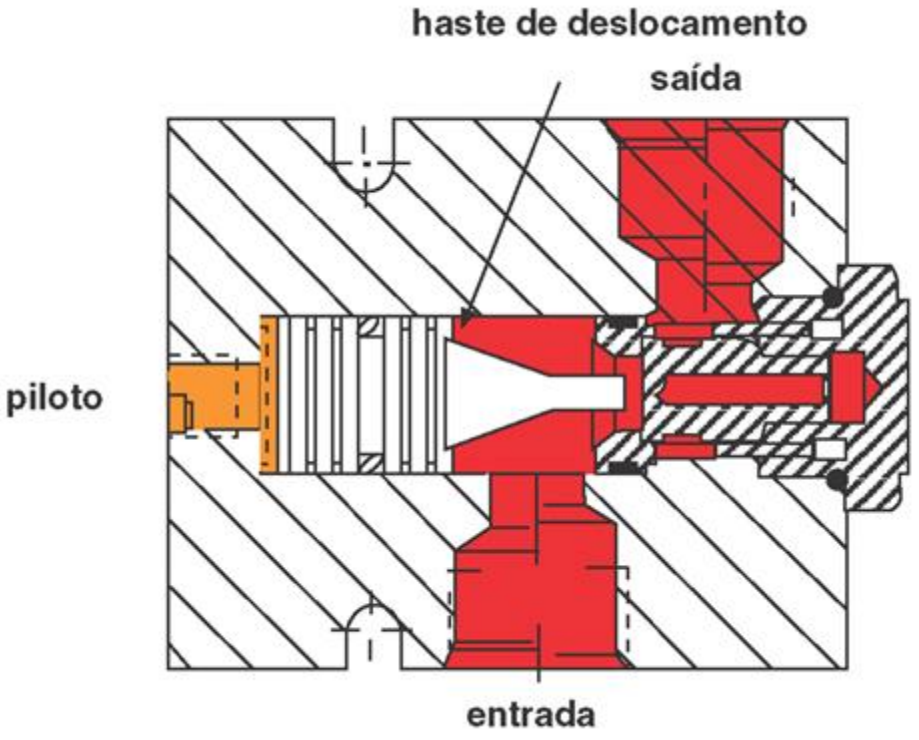


# 4. Válvulas

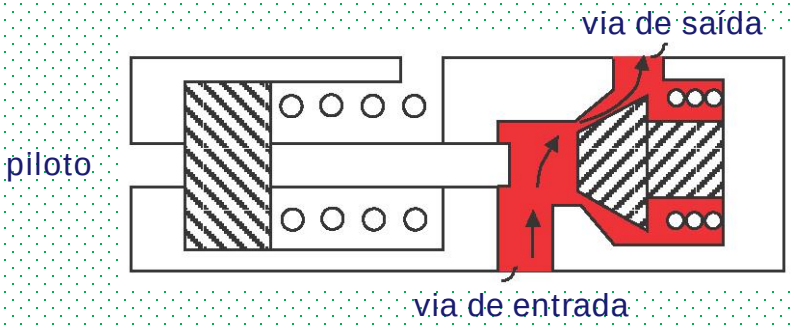
- **Válvulas de direção.**
  - **Válvulas de retenção pilotadas**

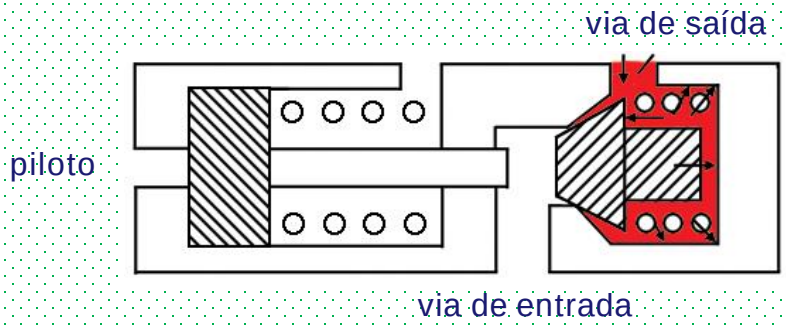


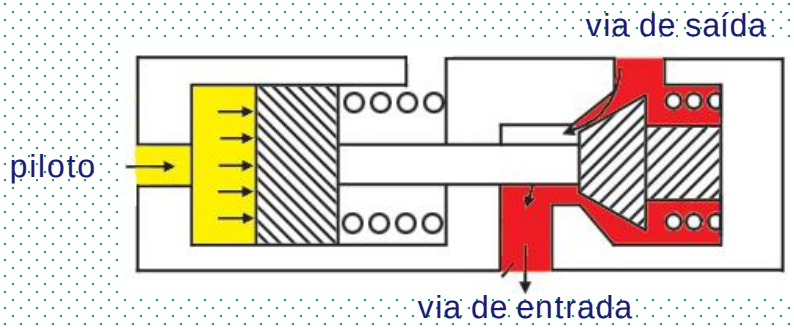


# 4. Válvulas

- **Válvulas de direção.**
  - **Válvulas de retenção pilotadas**



# 4. Válvulas

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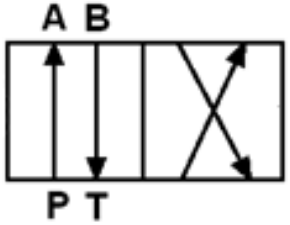
  As válvulas direcionais geralmente tem duas ou mais vias e duas ou três posições normalmente mas se pode ter válvulas de mais posições.

- **Simbologia:**

  Número de posições.

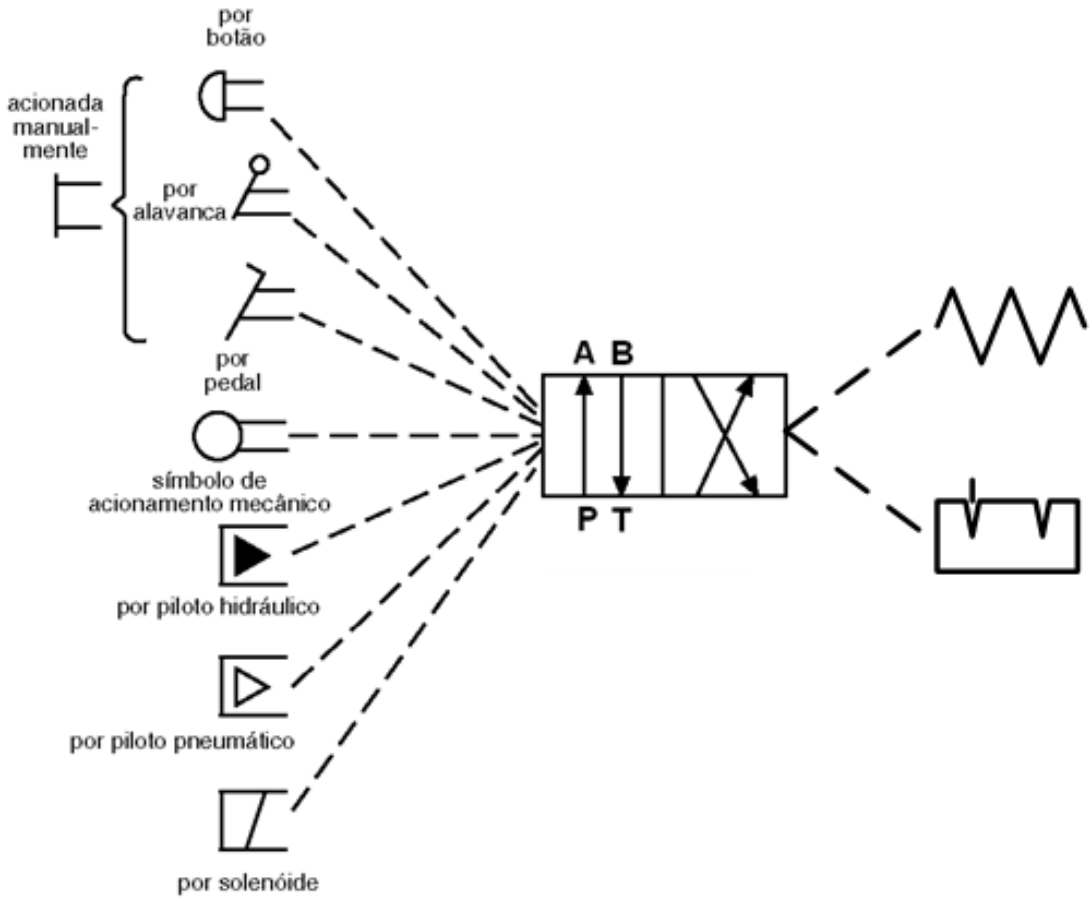
  Número de vias.

  Tipo de atuador



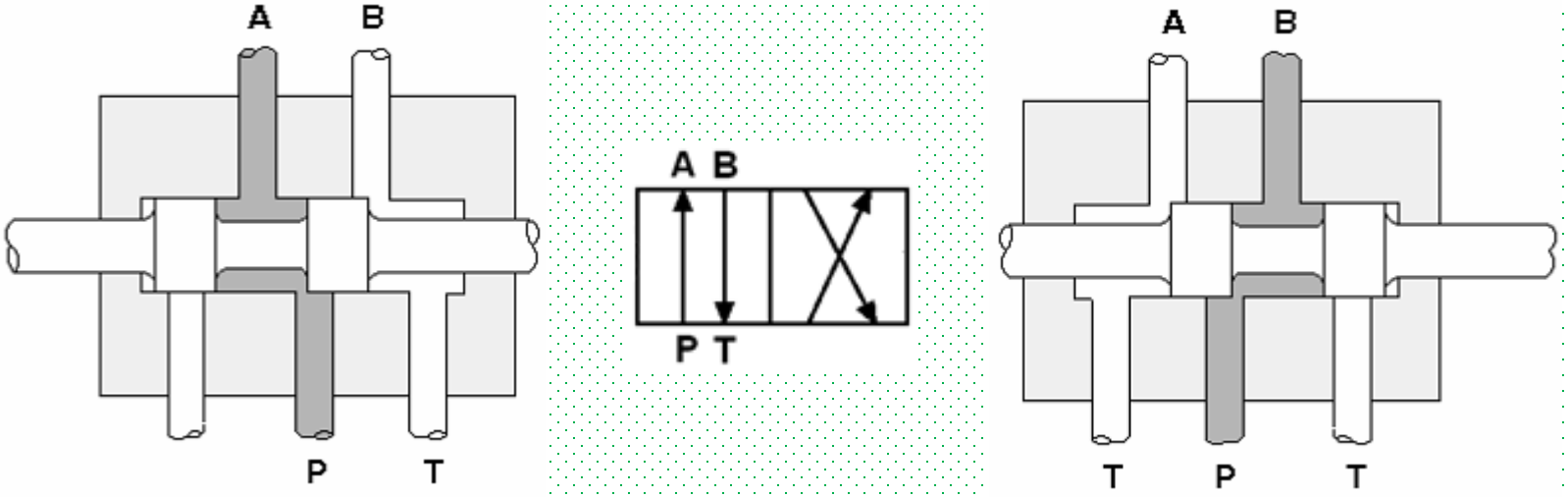
# 4. Válvulas

- **Válvulas de direção.**
  - **Simbologia:**



# 4. Válvulas

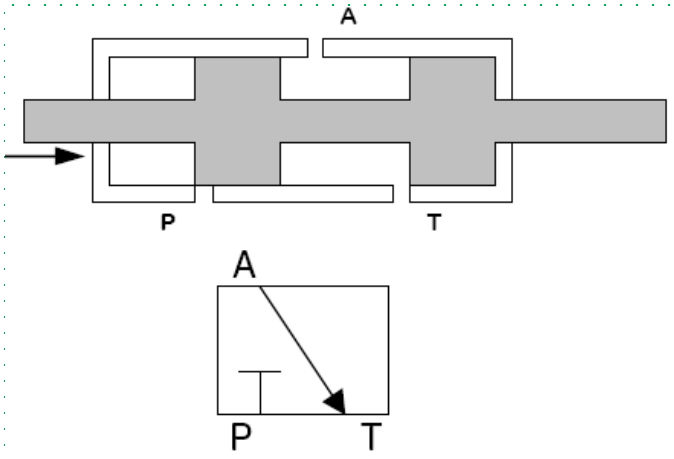
- **Válvulas de direção.**
  - **Simbologia:**

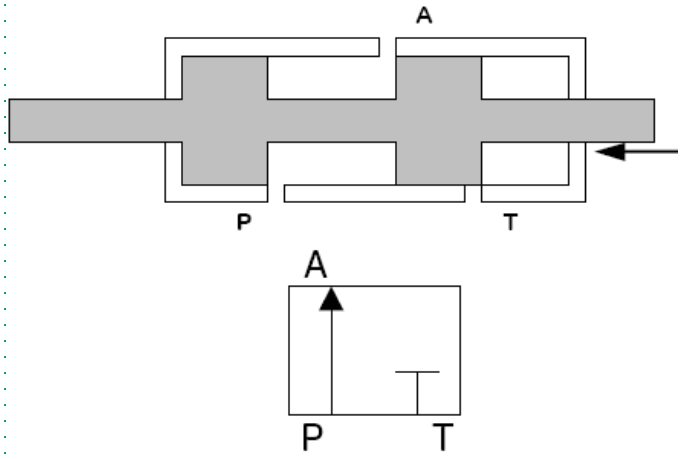


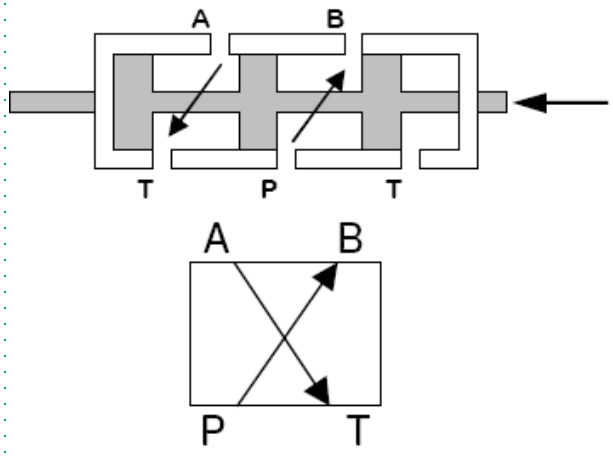
# 4. Válvulas

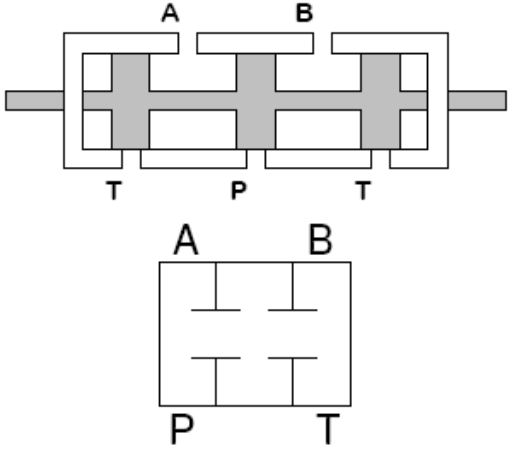
## Válvulas de direção.

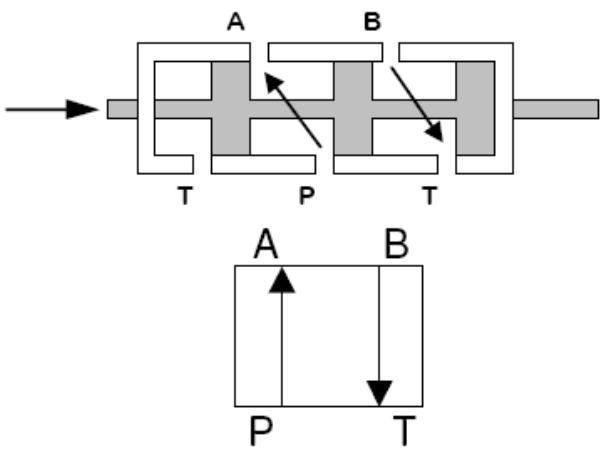
- Simbologia:



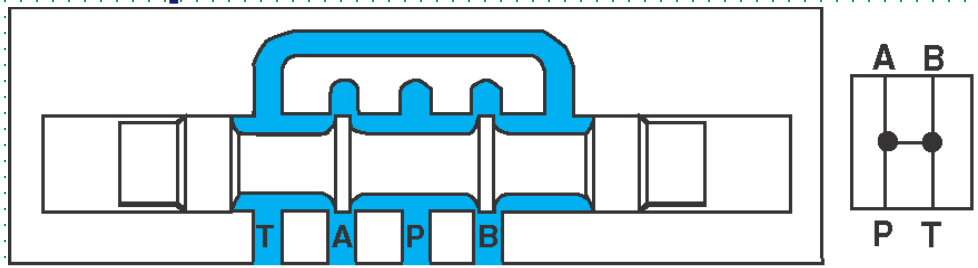



# 4. Válvulas

## Válvulas de direção.

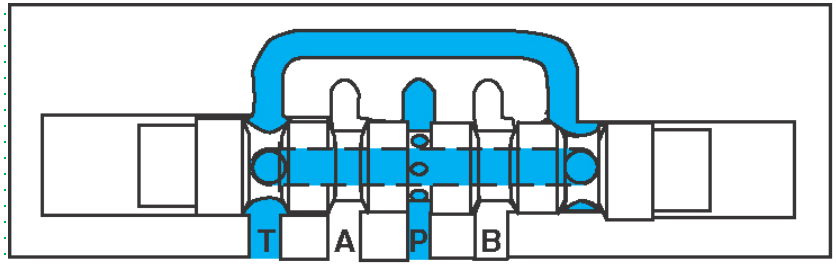
- Tipos de centros:

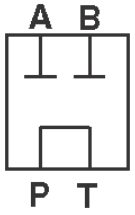




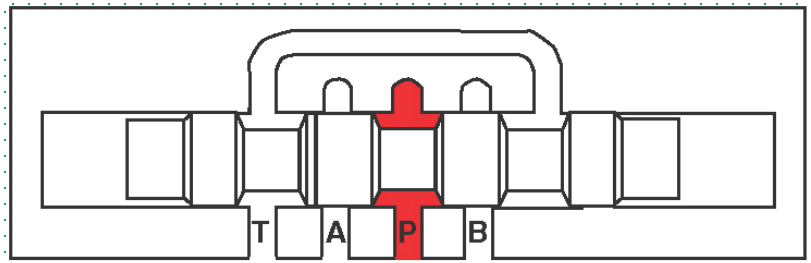


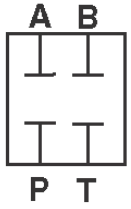
Centro Aberto




Tandem P aberto ao tanque, A e B bloqueados



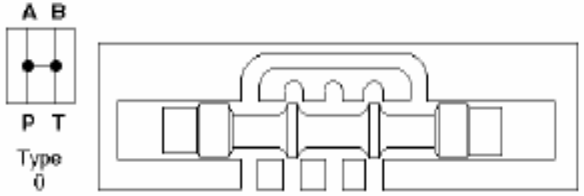




Todas as aberturas bloqueadas

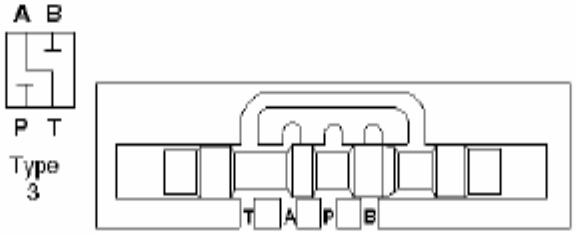
# 4. Válvulas

## Válvulas de direção.

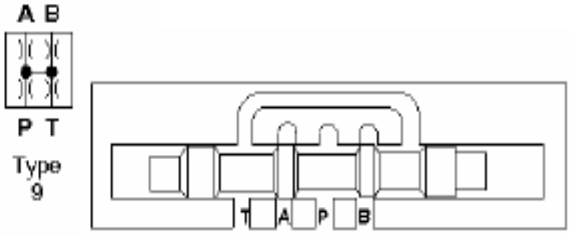
- Tipos de centros:



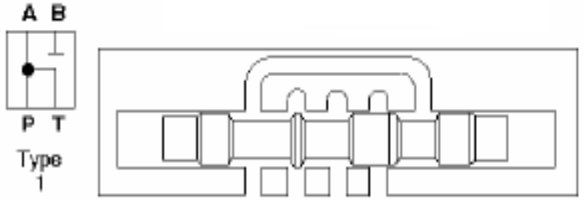

Centro aberto



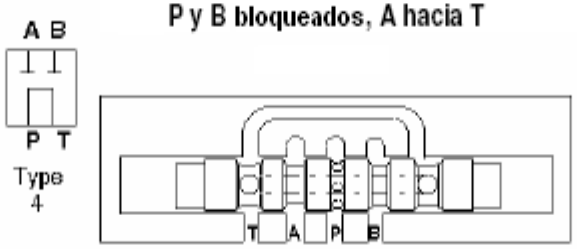

P y B bloqueados, A hacia T



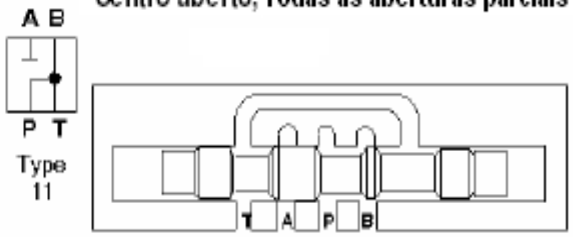

Centro aberto, Todas as aberturas parciais



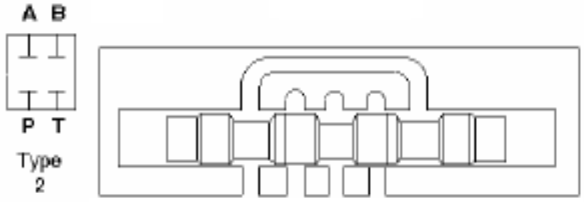

B bloqueado P y A hacia T



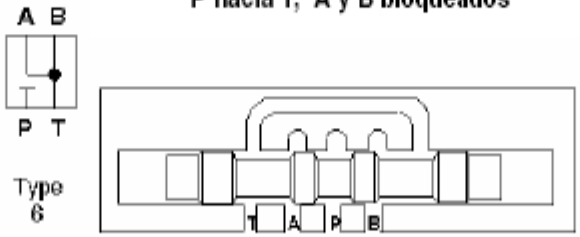

P hacia T, A y B bloqueados



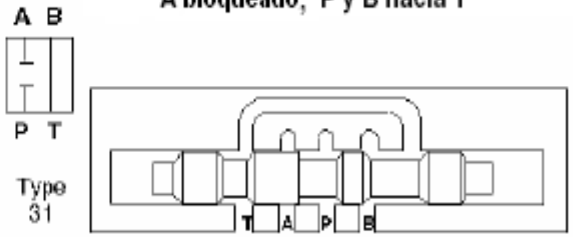

A bloqueado, P y B hacia T




Todas as aberturas bloqueadas



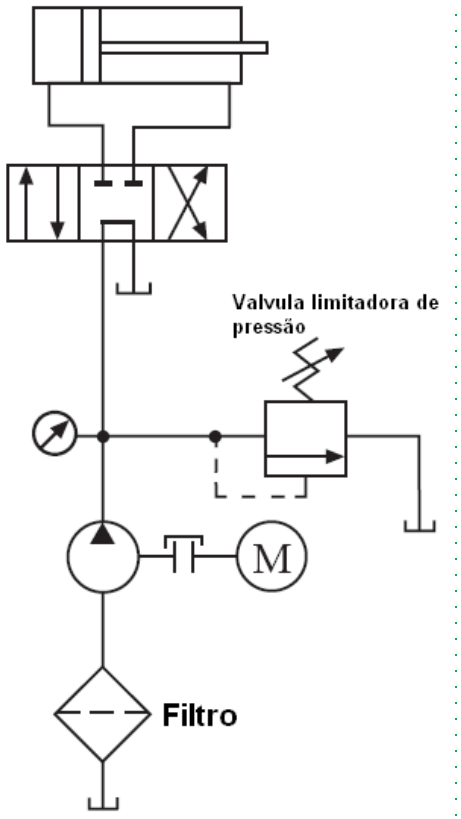

P bloqueado, A y B hacia T




P y A bloqueados, B hacia T

# 4. Válvulas

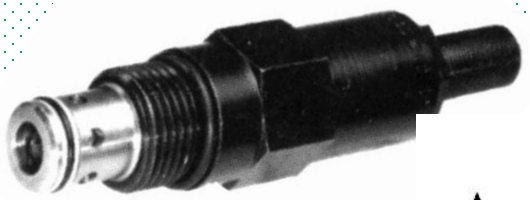
- **Circuitos com válvulas direcionais**

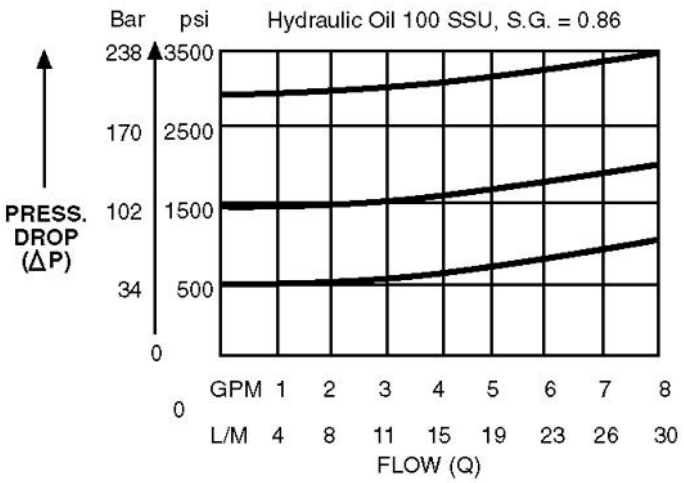


# 4. Válvulas

## Controle de pressão

- Válvulas de Alivio.



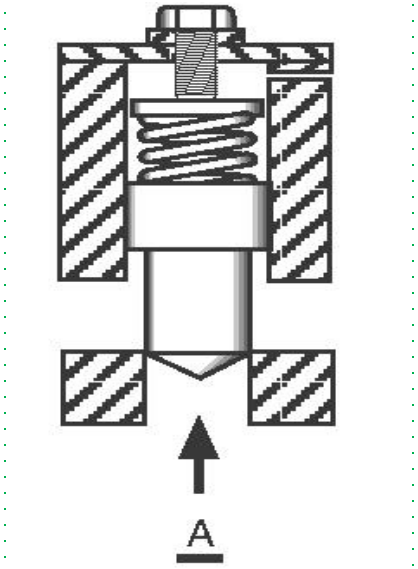


# 4. Válvulas

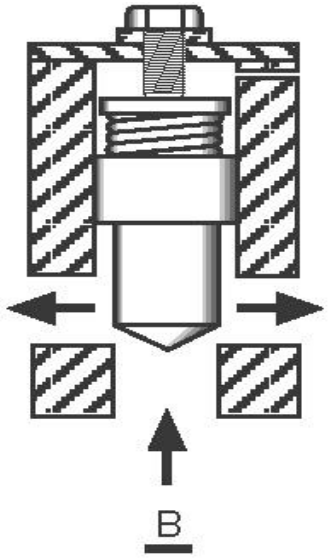
## Controle de pressão

- Válvulas de Alivio

A Válvula pode Assumir Várias Posições entre os Limites de Totalmente Fechada a Totalmente Aberta




Totalmente Fechada

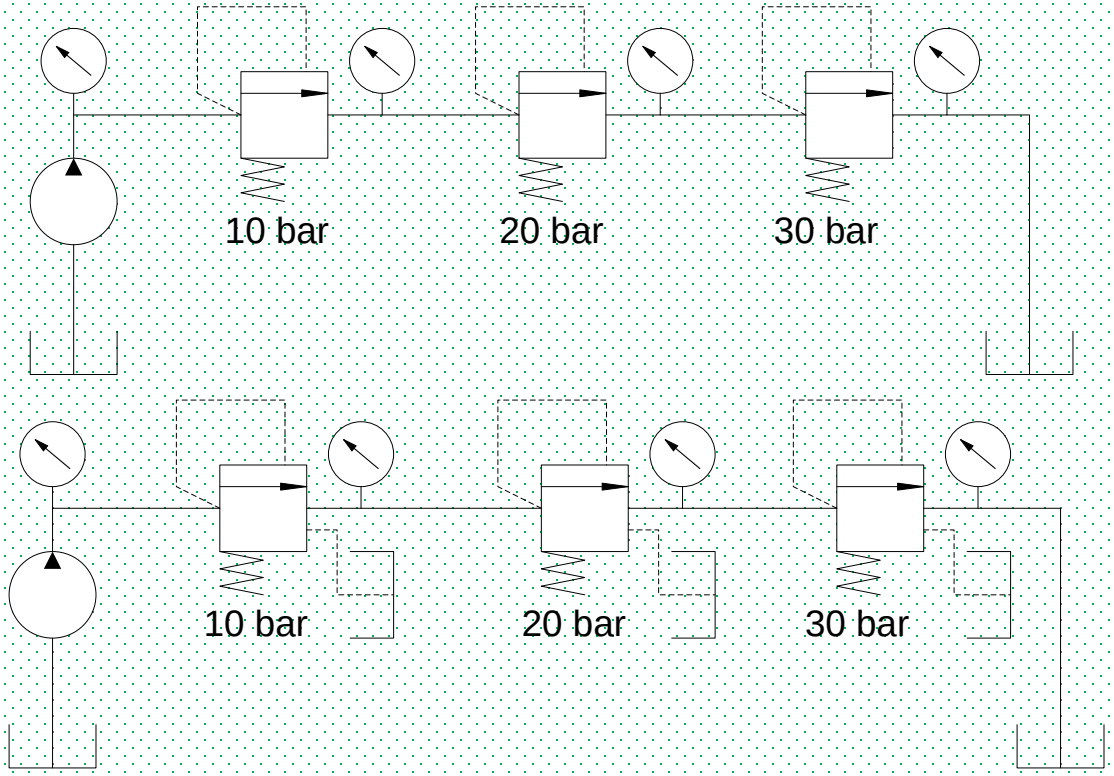



Totalmente Aberta

# 4. Válvulas

## Controle de pressão

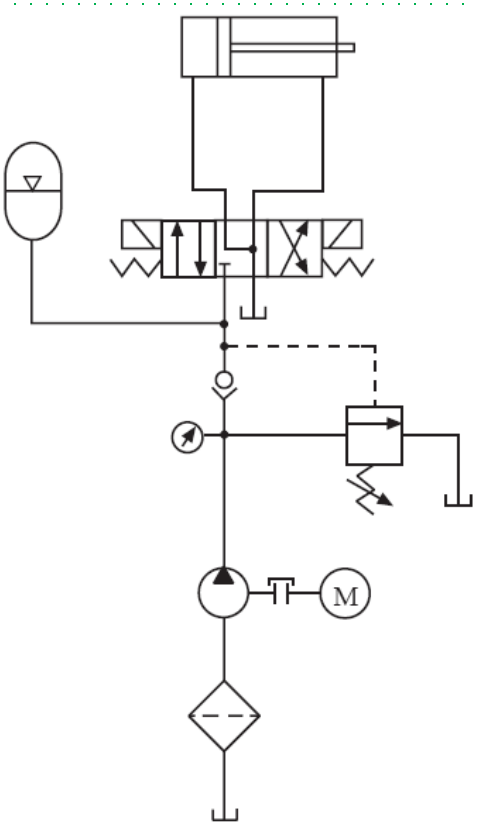
- Válvulas de Alivio.



# 4. Válvulas

## Controle de pressão

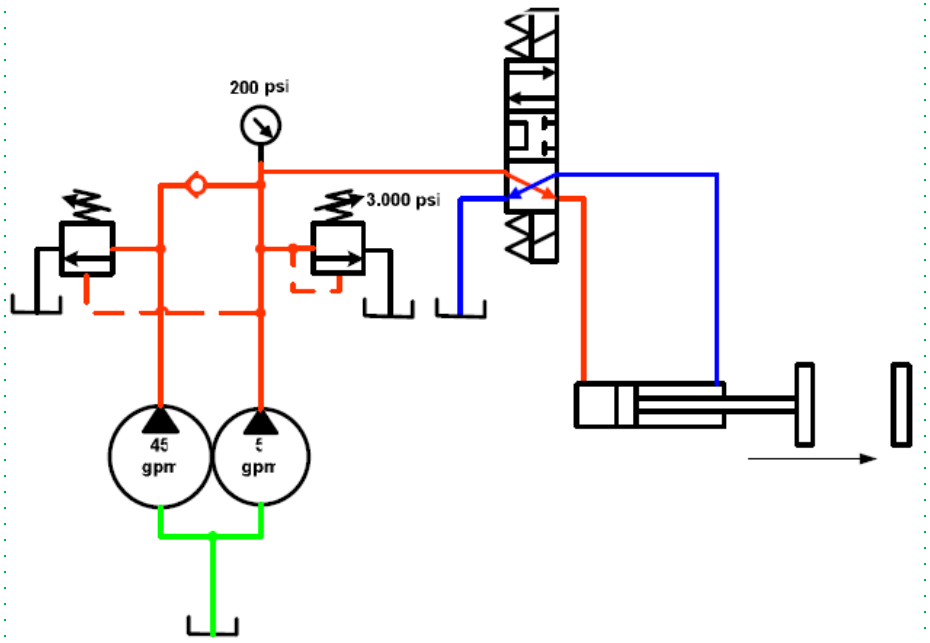
- Válvulas de descarga

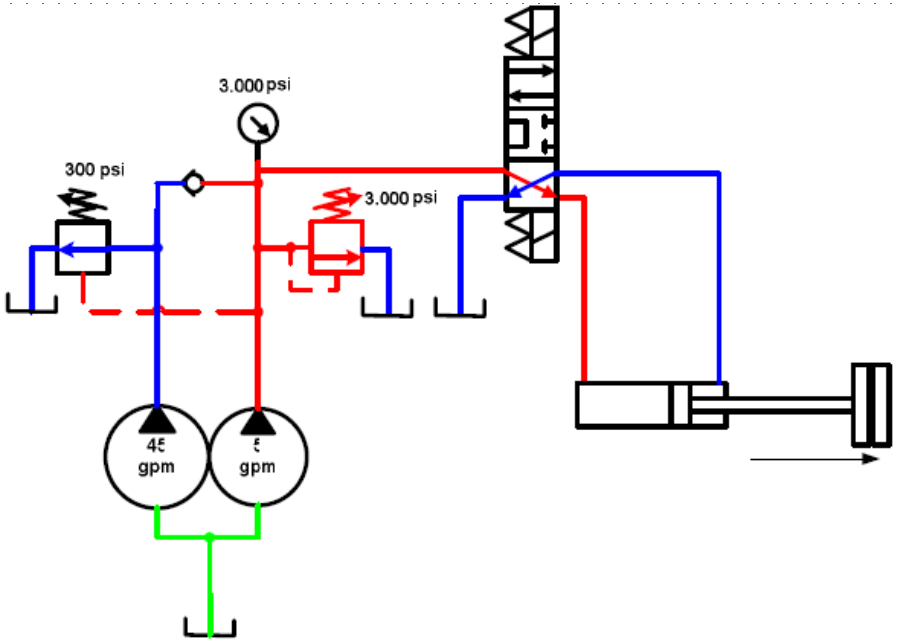


# 4. Válvulas

## Controle de pressão

- Válvulas de descarga

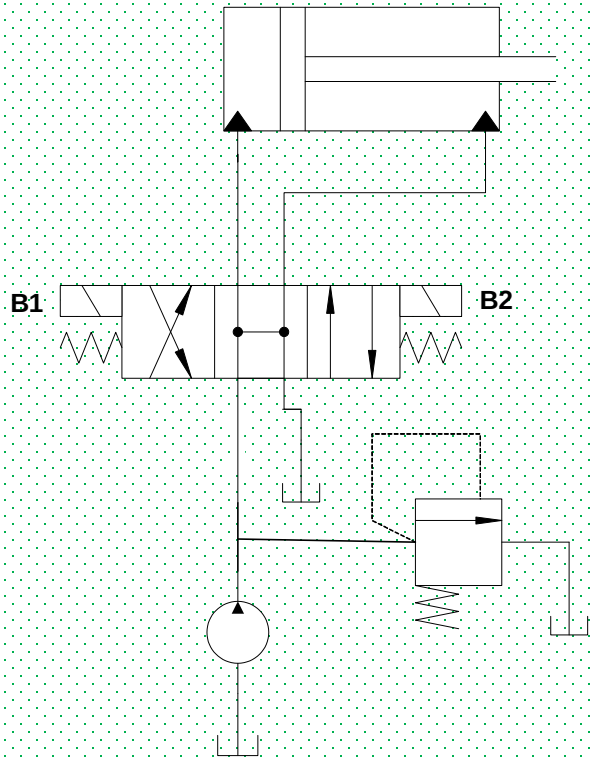


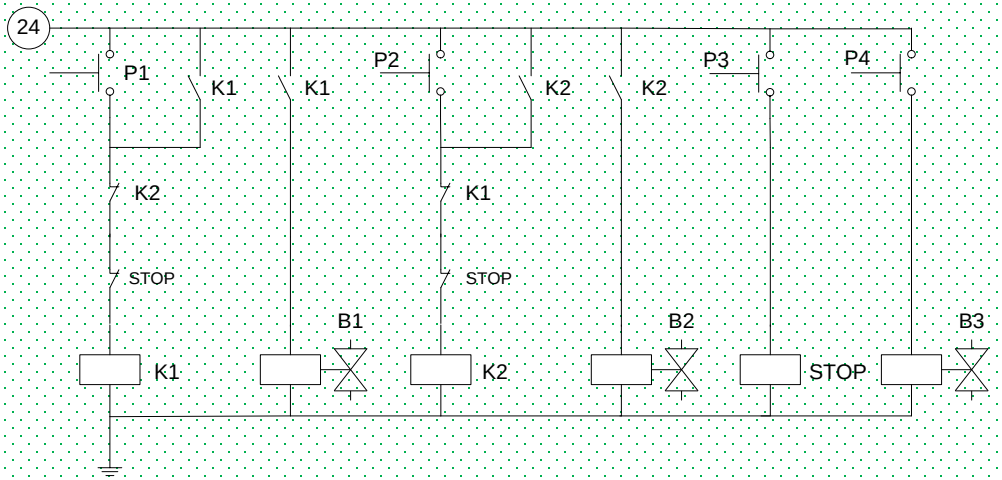



# 4. Válvulas

## Controle de pressão

- Válvulas de Alivio. Circuito de aplicação



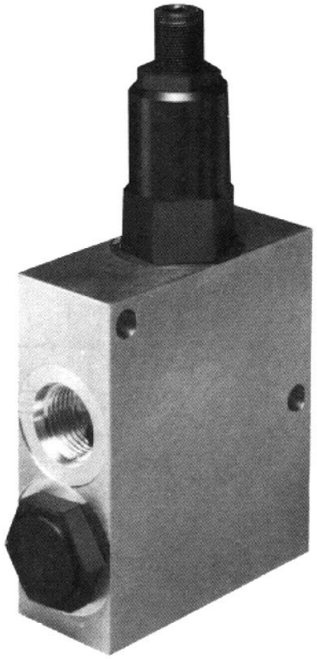



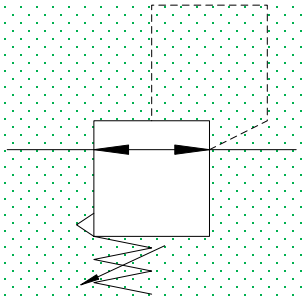
# 4. Válvulas

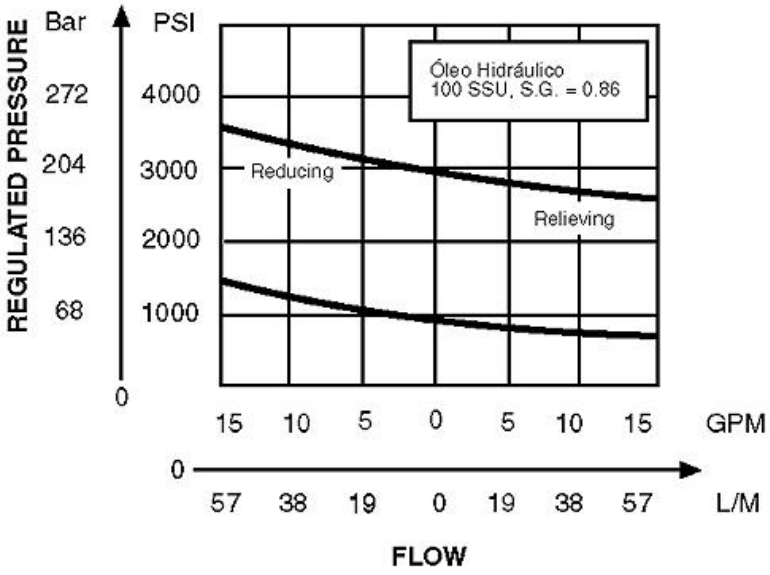
## Controle de pressão

- Válvulas redutoras de pressão

Uma válvula redutora de pressão é uma válvula de controle de pressão normalmente aberta. A válvula mede a pressão do fluido depois de sua via através da válvula. A pressão nestas condições é igual à pressão ajustada da válvula, e o carretel fica parcialmente fechado, restringindo o fluxo.



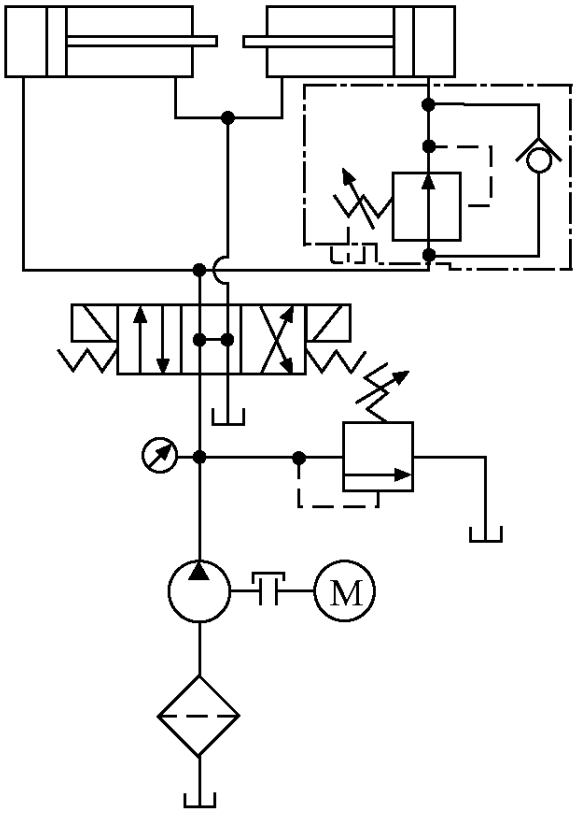




# 4. Válvulas

## Controle de pressão

- Válvulas redutoras de pressão

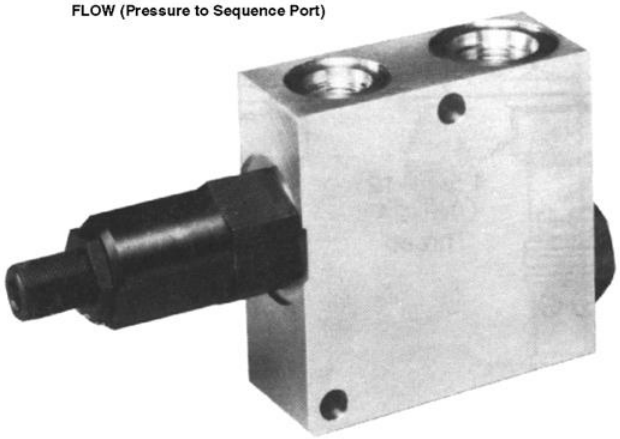


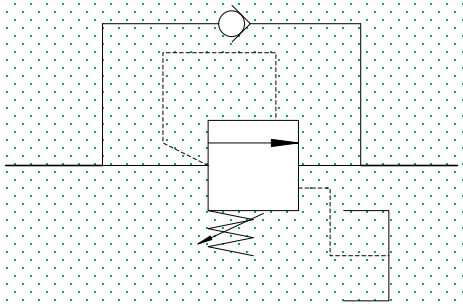
# 4. Válvulas

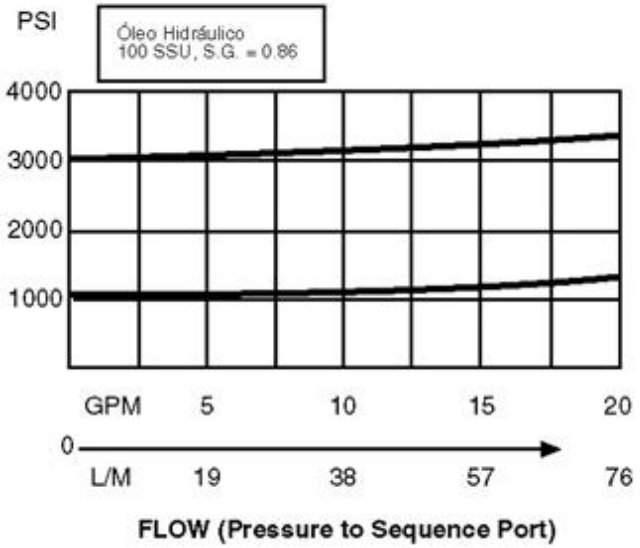
## Controle de pressão

- Válvulas de seqüência

  É uma válvula de controle de pressão normalmente fechada, utilizada para realizar operações menores de uma pressão desejada.



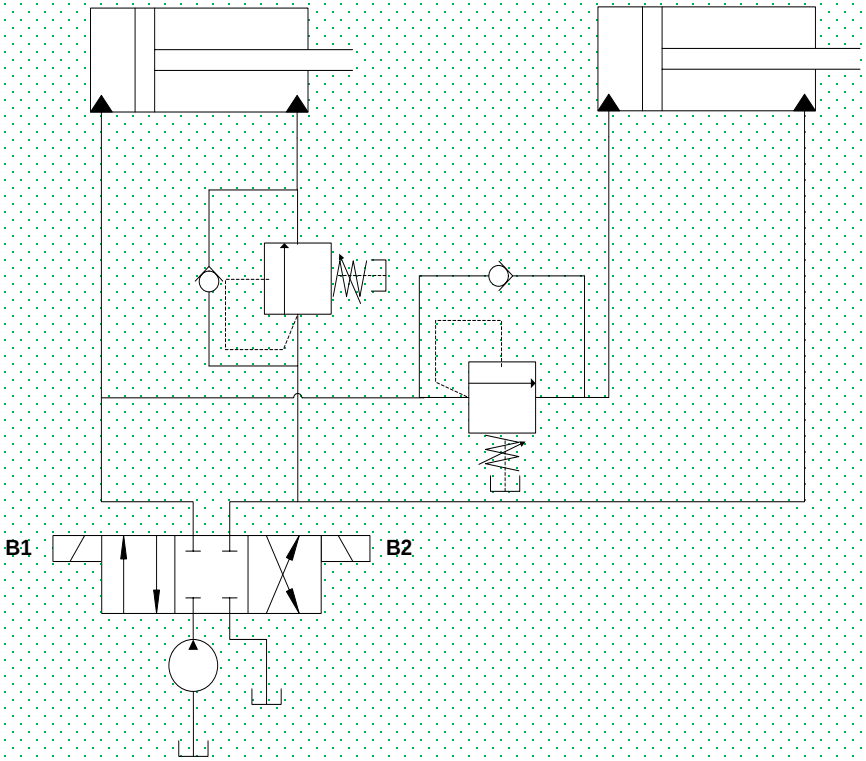





# 4. Válvulas

## Controle de pressão

- Válvulas de seqüência

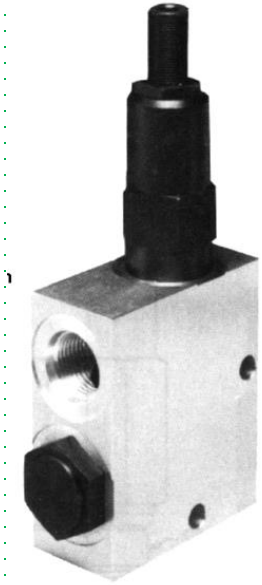


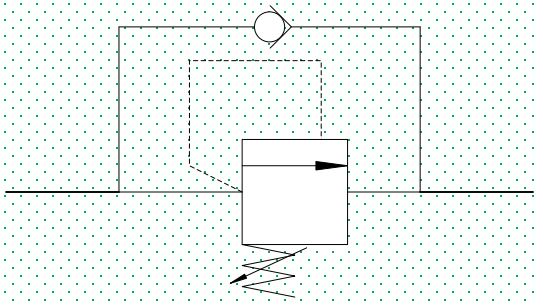
# 4. Válvulas

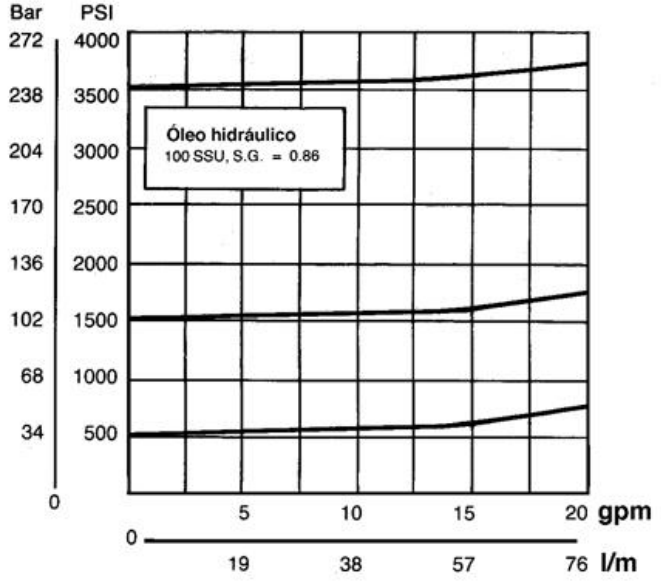
## Controle de pressão

- Válvulas de contrabalanço

Uma válvula de controle de pressão normalmente fechada pode ser usada para equilibrar ou contrabalancear um peso, tal como o da prensa a que nos referimos. Esta válvula é chamada de válvula de contrabalanço.



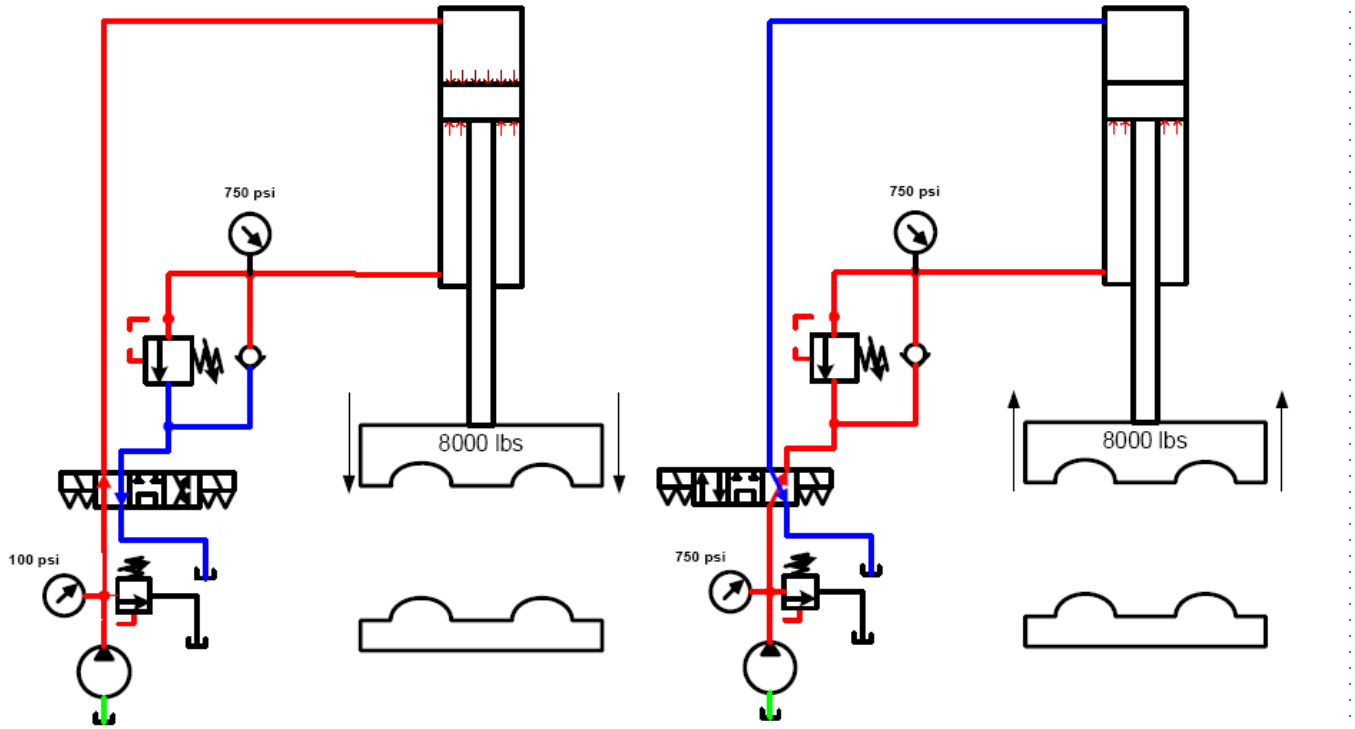




# 4. Válvulas

## Controle de pressão

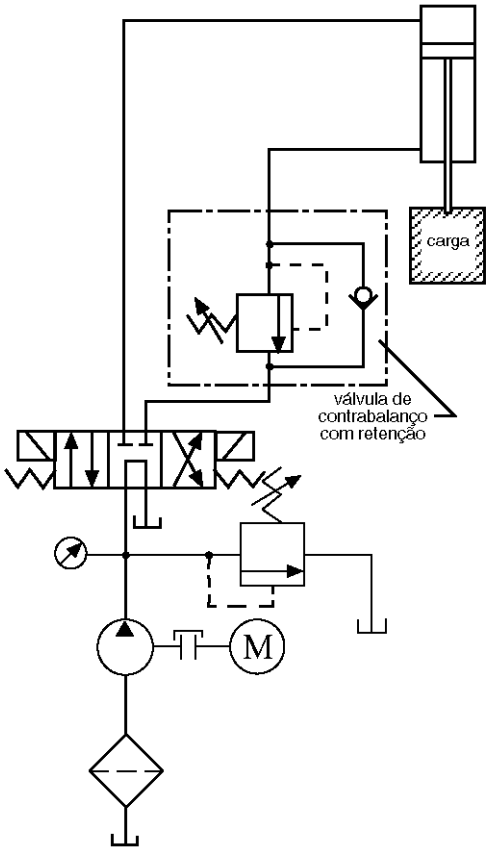
- Válvulas de contrabalanço

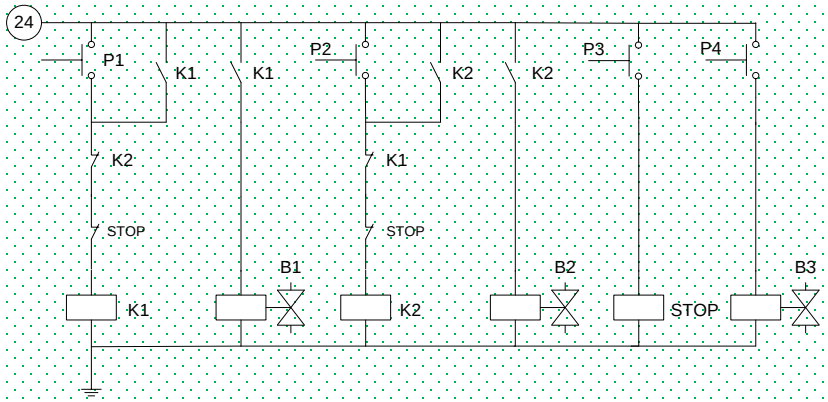


# 4. Válvulas

## Controle de pressão

- Válvulas de contrabalanço

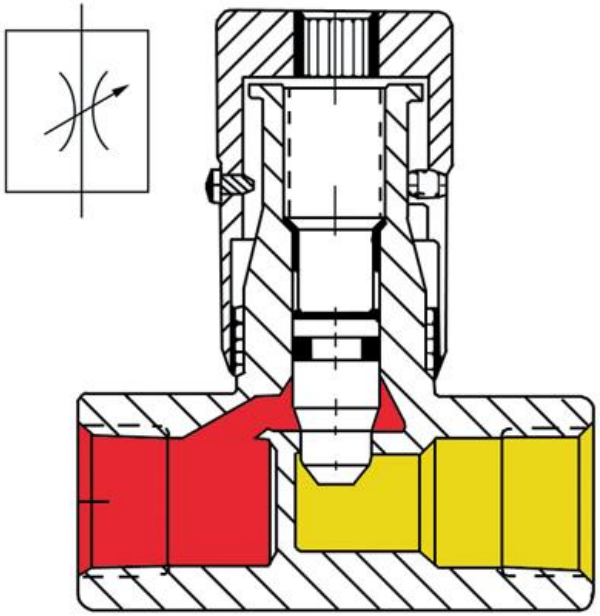


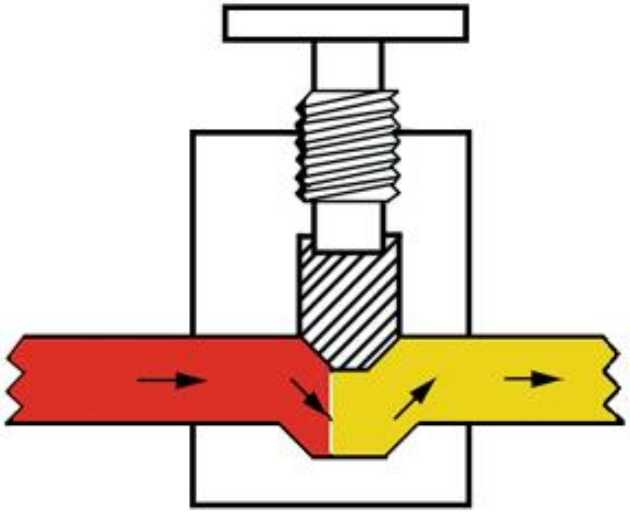



# 4. Válvulas

## Controle de vazão

- Não Compensados ou Simples

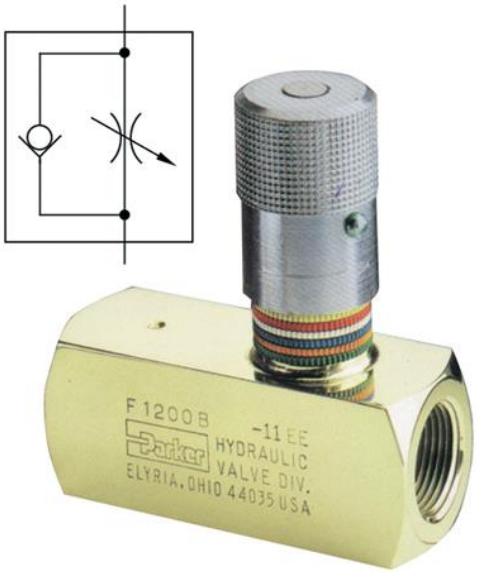


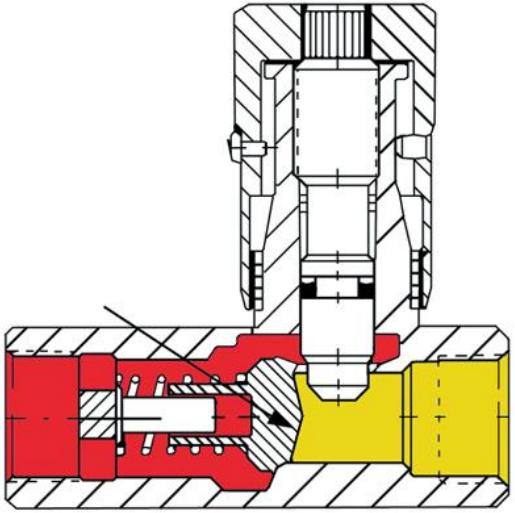


# 4. Válvulas

## Controle de vazão

- Não Compensados ou Simples

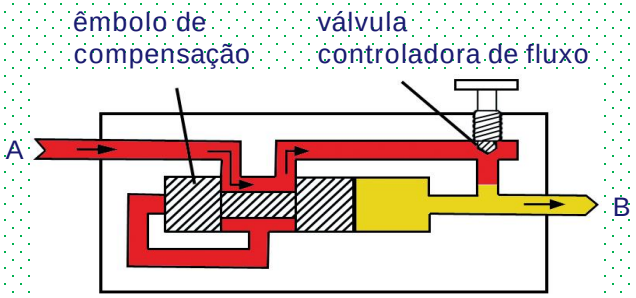


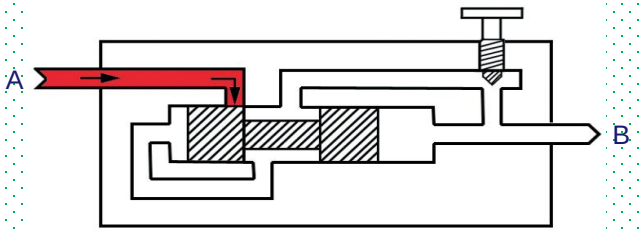



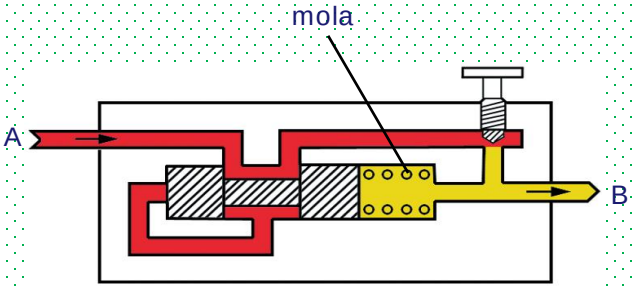
# 4. Válvulas

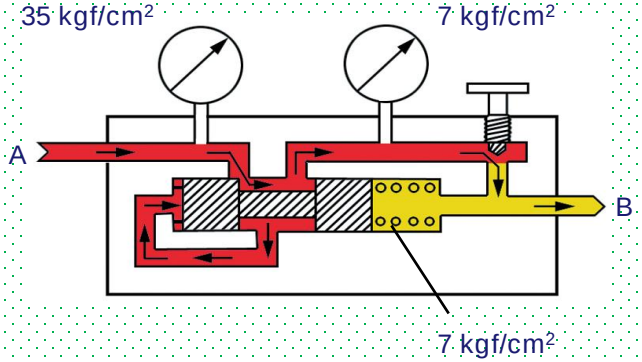
## Controle de vazão

- Válvulas compensadas por pressão



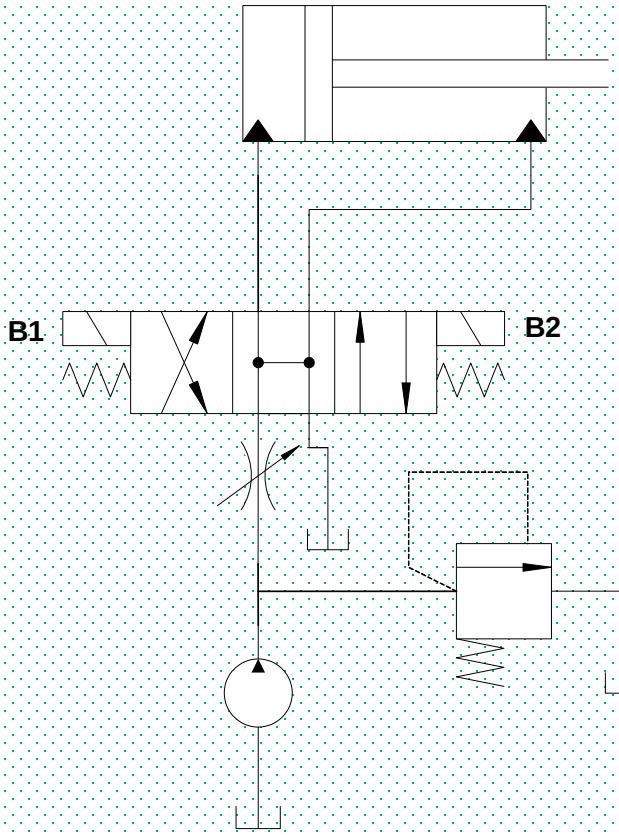



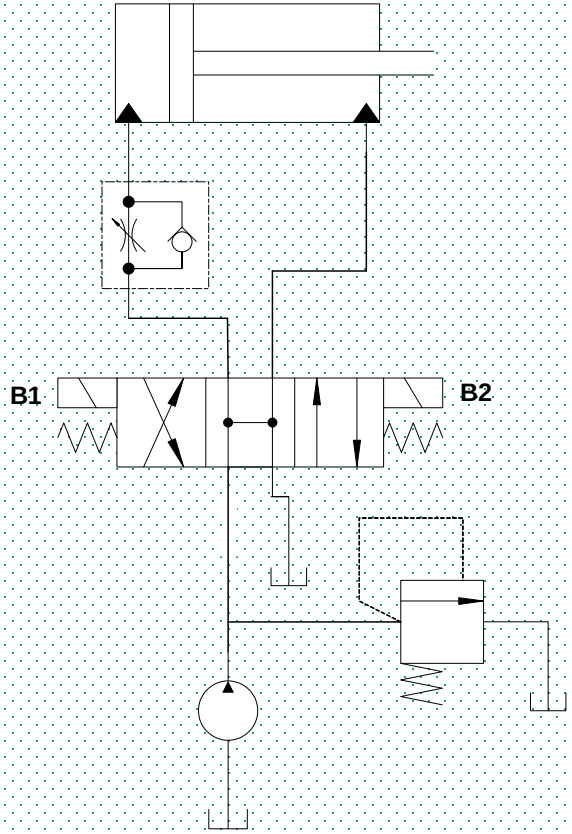



# 4. Válvulas

## Controle de vazão

- Circuitos de controle de vazão

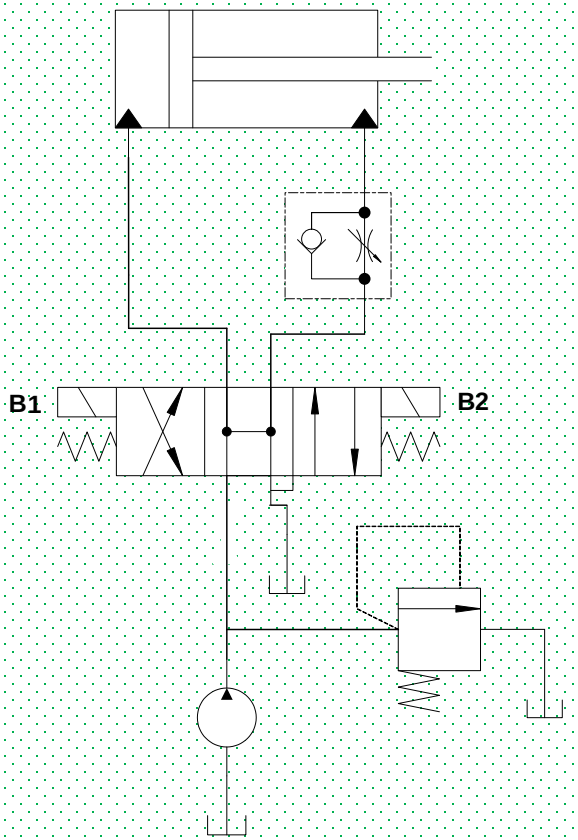


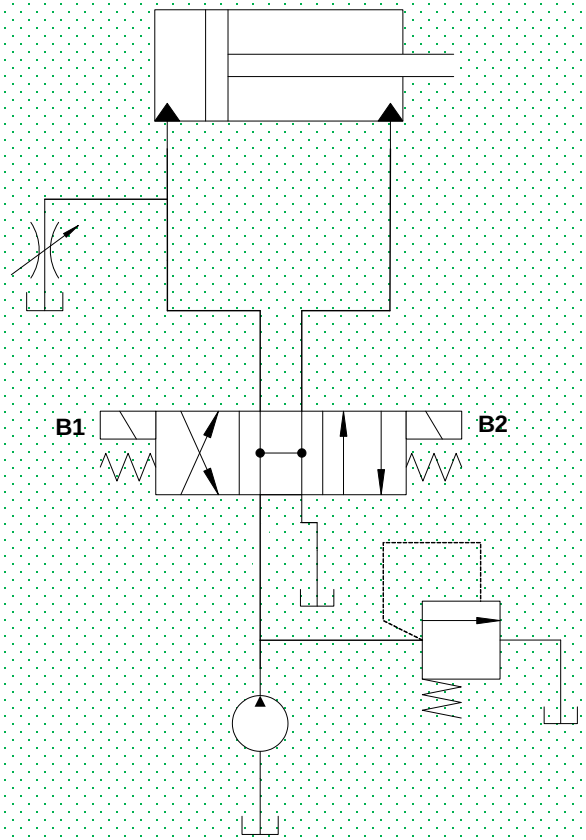



# 4. Válvulas

## Controle de vazão

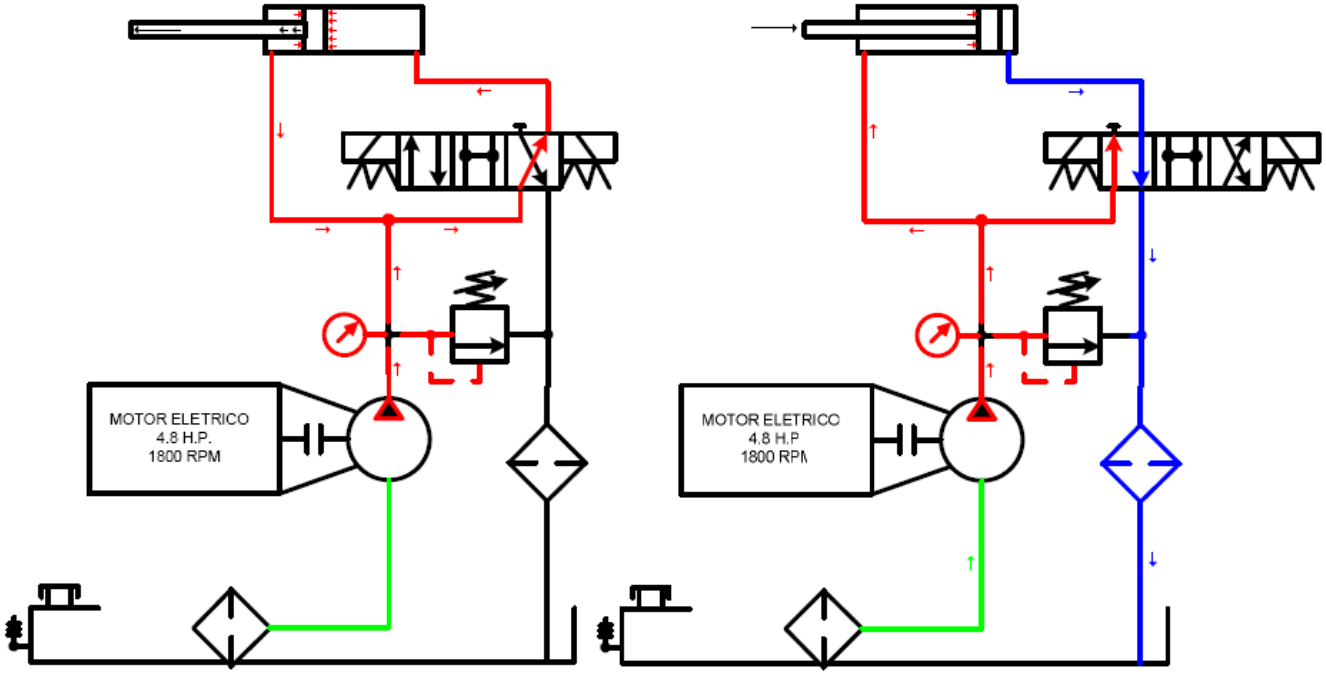
- Circuitos de controle de vazão



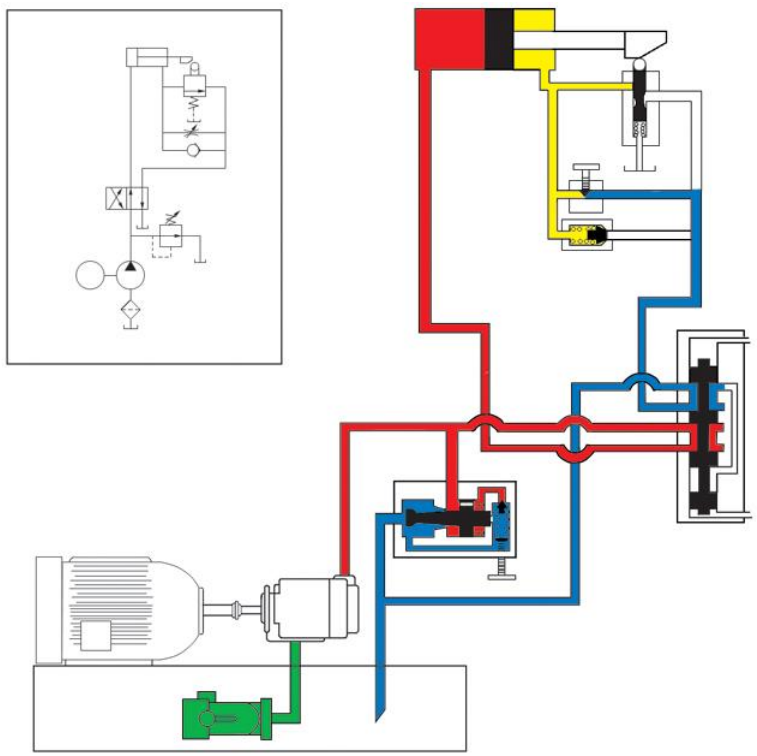
# 4. Circuitos

- **Circuitos óleo-hidráulicos.**
  - **Circuito regenerativo**



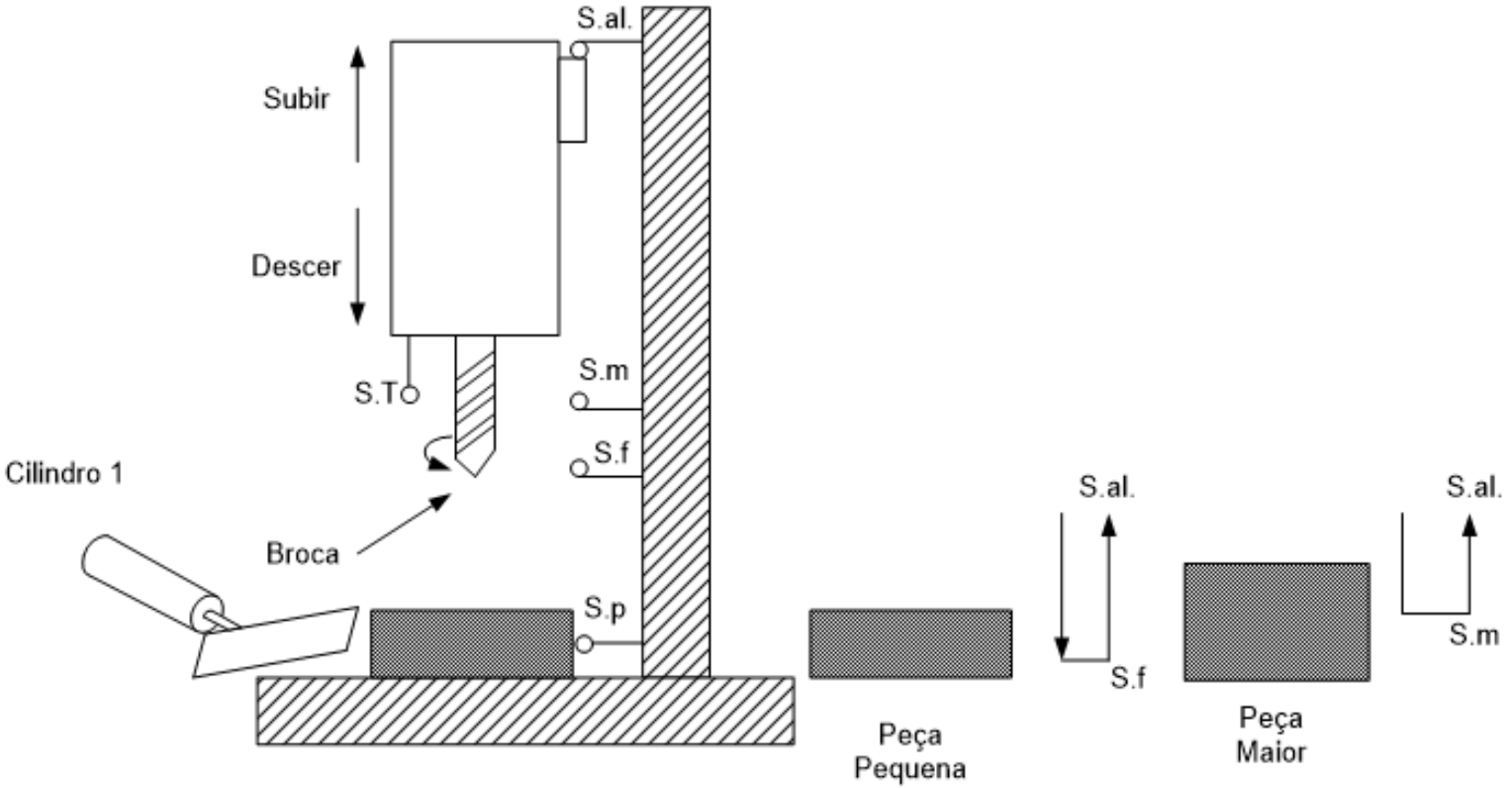
# 4. Circuitos

- **Circuitos óleo-hidráulicos.**
  - **Circuito com Aproximação Rápida e Avanço Controlado**



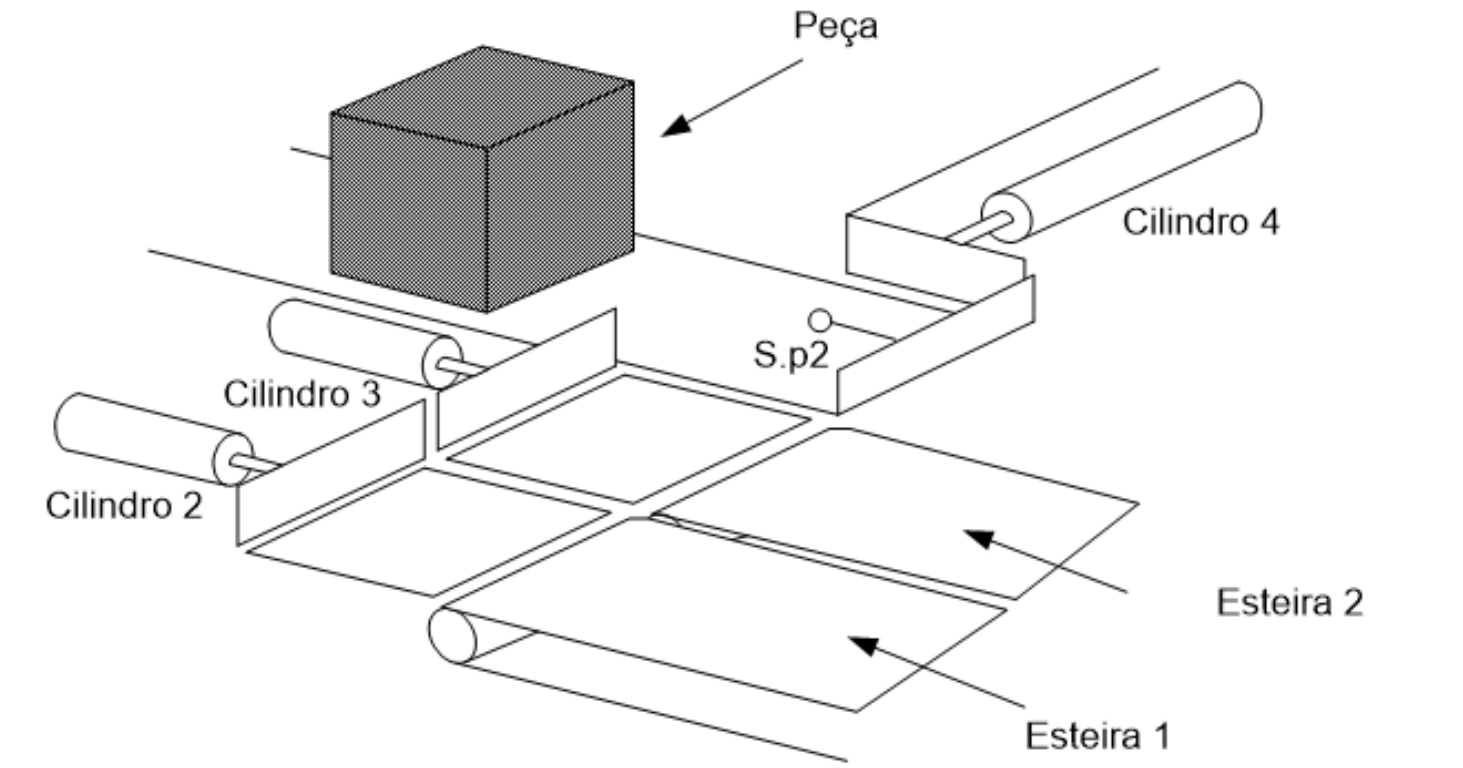
# Sistema de estudo

- Primeira Etapa.



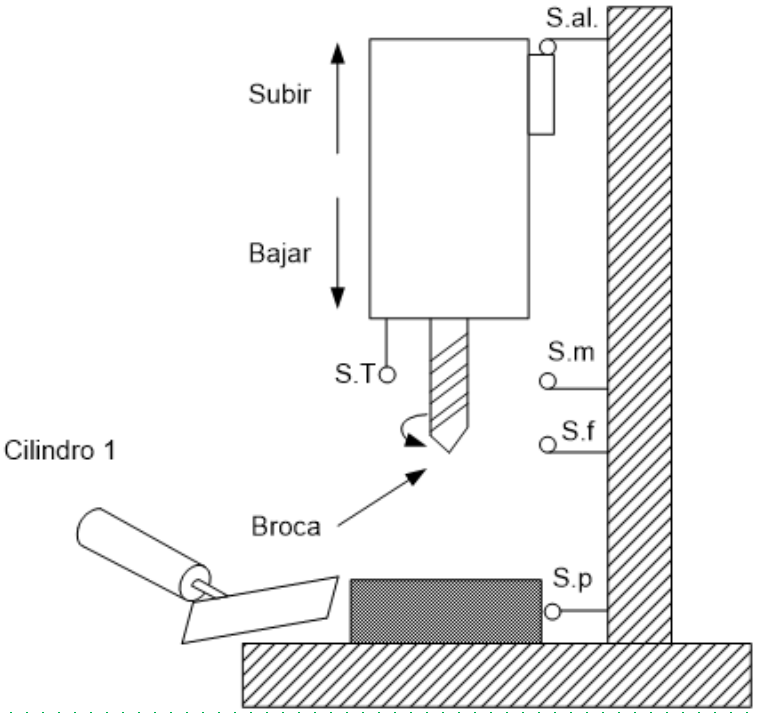
# Sistema de estudo

- Segunda Etapa.



# Sistema de estudo

- Primeira Etapa.



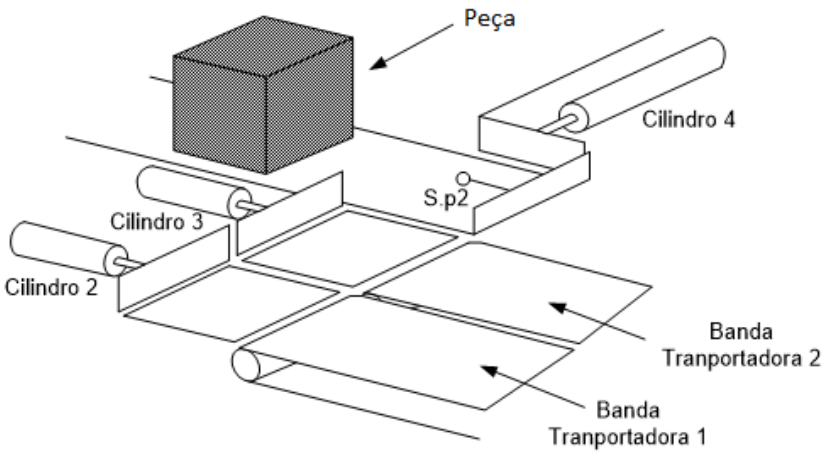

- Condições.

1- Peça pequena:Sp,Sf
Sai com SP(sensor presença).
Retorna com SF(sensor final)

2- Peça alta: SP, SM, ST
Sai com SP(sensor presença).
Ativa o ST(sensor de tamanho).
Retorna com SM(sensor meio).

# Automatización con PLC

- Segunda Etapa.



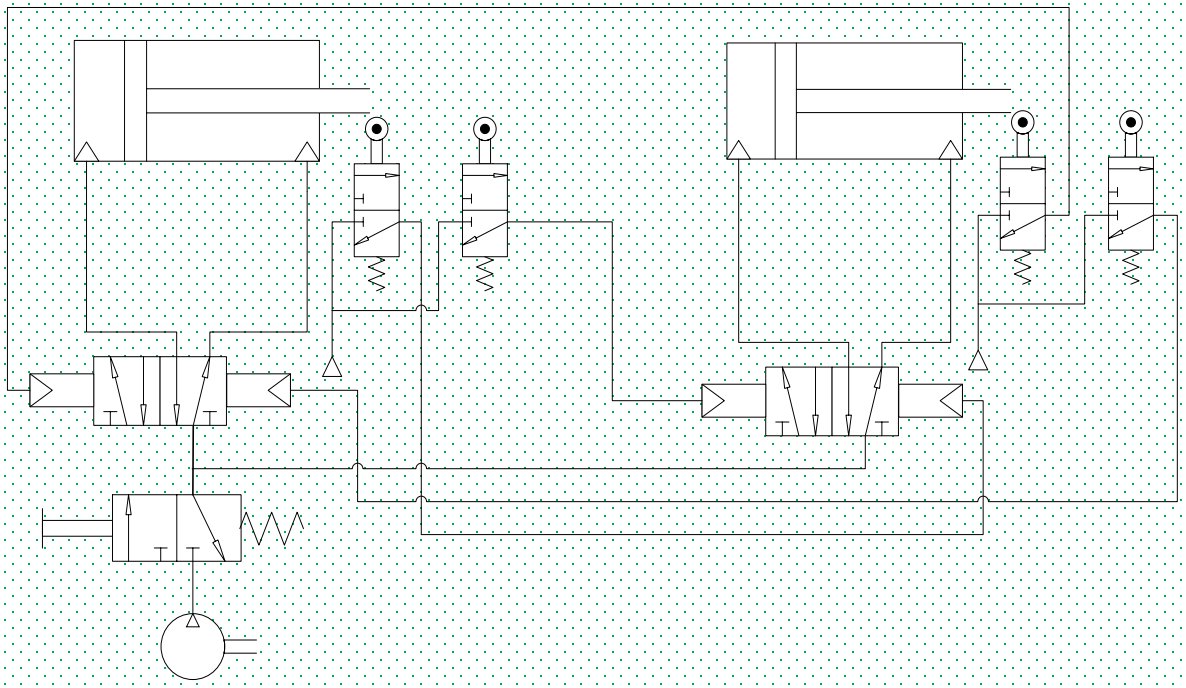

- Condições

1- Peça baixa: Sp, ST
Cilindro 4 coloca a peça na posição do cilindro 2.
Cilindros 2 envía a peça para banda transportadora 1.

2- Peça alta: SP, ST
Cilindro 4, coloca a peça na posição do cilindro 3.
Cilindro 3, envía a peça para a banda transportadora 2.

# Pneumática

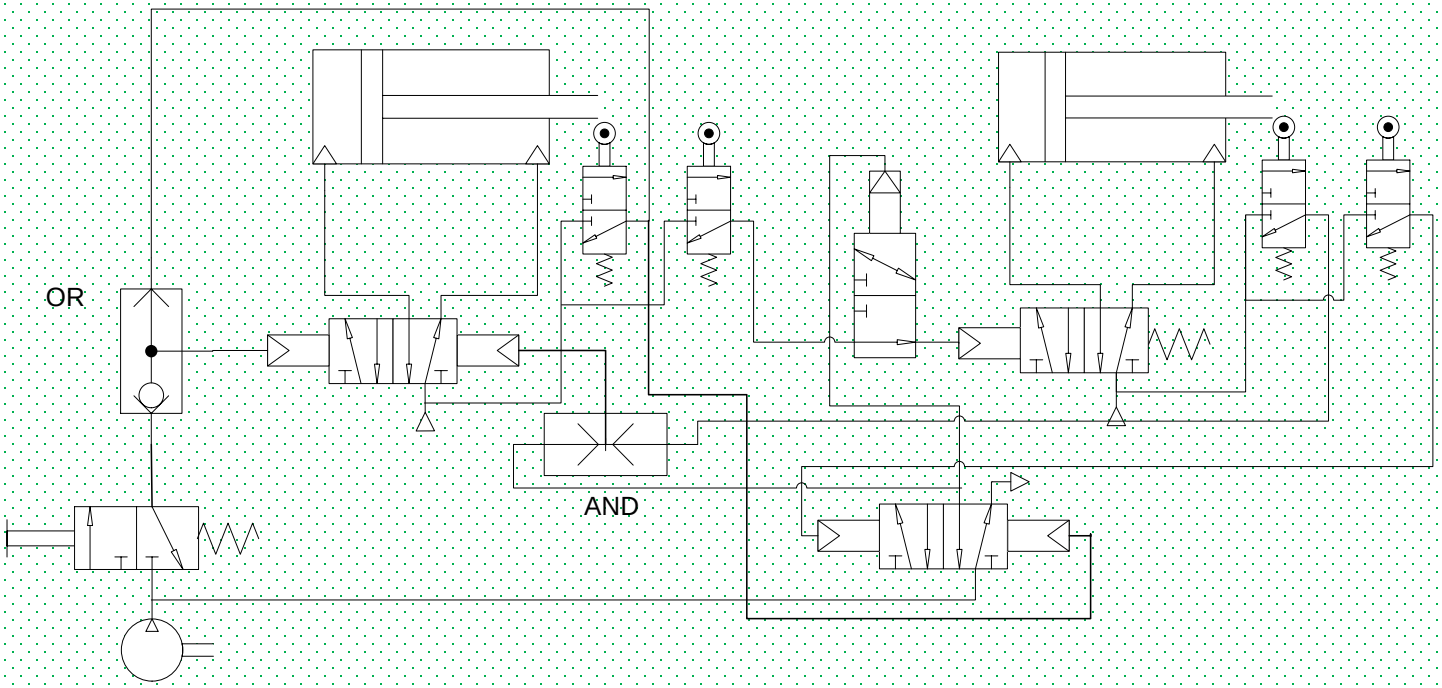
- **Circuitos pneumática**
  - **Válvulas com memória A+,B+,A-,B-**



# Pneumática

## Circuitos pneumática

- Válvulas com memória, A+,B+,B-,A-



# Dúvidas ou perguntas?