

# **MATERIAIS E COMPONENTES**

**26 - abril - 2016**

**USP - INSTITUTO DE FÍSICA**

# **MATERIAIS MAIS UTILIZADOS**

## **1 - METAIS**

### **PRÉ-VÁCUO:**

**COBRE**

**LATÃO**

**AÇO**

**FERRO**

**BRONZE**

**ALUMÍNIO LAMINADO**

**AÇO INOXIDÁVEL**

# 1 - METAIS

## ALTO-VÁCUO

**AÇO INOXIDÁVEL**  
**COBRE**  
**ALUMÍNIO LAMINADO**  
**DURALUMÍNIO**

**LIGAS ESPECIAIS (KOVAR)**  
**TITÂNIO (SUBLIMADORES)**  
**TUNGSTÊNIO (FILAMENTOS)**  
**MOLIBDÊNIO (FILAMENTOS)**  
**ÍNDIO (CRIOGENIA)**  
**NIÓBIO**  
**TÂNTALO**

## **2 - ISOLANTES**

**VIDRO (PYREX)**

**CERÂMICAS (ESTEATITA, ALUMINA)**

**EPÓXI (PASSADORES)**

**TEFLON**

**KEL-F**

**KAPTON**

**NYLON**

**ACRÍLICO (LUCITE)**

**TYGON**

**ELASTÔMEROS (O'RINGS)**

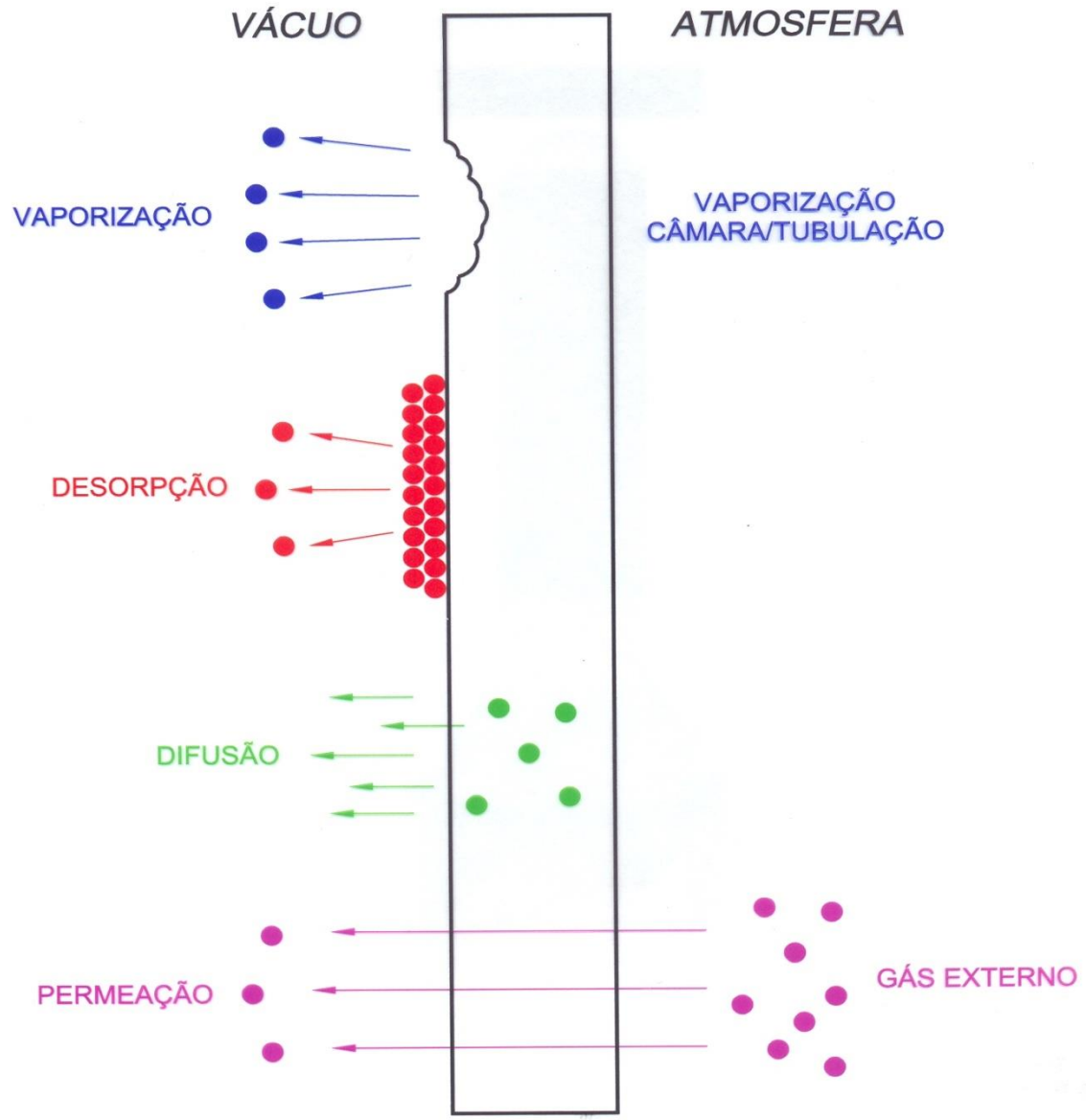
**BUNA-N (BORRACHA NITRÍLICA)**

**NEOPRENE**

**ISOPRENE (BORRACHA NATURAL)**

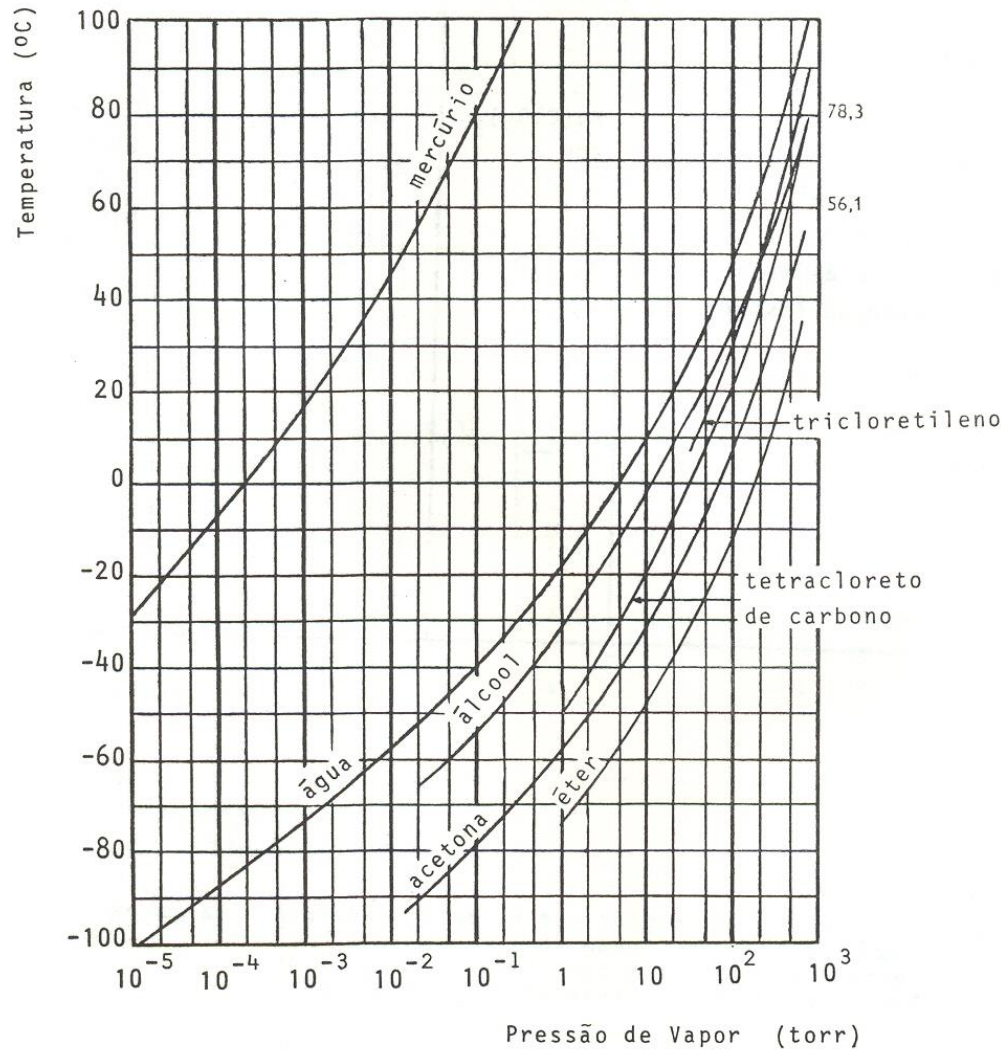
**VITON**

# DEGASIFICAÇÃO



ALGUNS DADOS DO AR À TEMPERATURA AMBIENTE

|  | PRESSÃO (TORR)           |                            |  |  |  |   |   |
|--|--------------------------|----------------------------|--|--|--|---|---|
|  | 760                      | $10^{-3}$                  | $10^{-8}$  | $10^{-10}$   | $10^{-12}$   | $10^{-14}$  | $10^{-16}$  |
| Caminho livre médio  | $10^{-5}$ cm             | 7 cm                       | 7 km   | 700 km   | $7 \times 10^5$ km                                 | $7 \times 10^6$ km                                    | $7 \times 10^8$ km                                      |
| Número de moléculas por cm                                 | $2,5 \times 10^{19}$     | $3,3 \times 10^{13}$       | $3,3 \times 10^8$                                    | $3,3 \times 10^6$                                      | $3,3 \times 10^4$                                  | $3,3 \times 10^2$                                     | 3,3   |
| Número de moléculas batendo em $1 \text{ cm}^2/\text{s}$ . | $3 \times 10^{23}$       | $3,5 \times 10^{17}$       | $3,5 \times 10^{12}$                                 | $3,5 \times 10^{10}$                                   | $3,5 \times 10^8$                                  | $3,5 \times 10^6$                                     | $3,5 \times 10^4$                                       |
| Taxa média de colisões entre moléculas                     | $5 \times 10^9/\text{s}$ | $6,5 \times 10^3/\text{s}$ | $6,5 \times 10^{-2}/\text{s}$<br>1 a cada<br>15,4 s. | $6,5 \times 10^{-4}/\text{s}$<br>1 a cada<br>25,5 min. | $6,5 \times 10^{-6}/\text{s}$<br>1 a cada<br>45 h. | $6,5 \times 10^{-8}/\text{s}$<br>1 a cada<br>188 dias | $6,5 \times 10^{-10}/\text{s}$<br>1 a cada<br>51,5 anos |



PRESSÃO DE VAPOR DE ALGUNS MATERIAIS

|                     | Pressão de vapor a 20 °C<br>(torr) | Ponto de fusão<br>(°C) |
|---------------------|------------------------------------|------------------------|
| Graxa Apiezon L     | $< 10^{-10}$                       | 47                     |
| Graxa Apiezon M     | $< 10^{-8}$                        | 44                     |
| Graxa Apiezon N     | $< 10^{-9}$                        | 43                     |
| Graxa Apiezon T     | $10^{-8}$                          | 125                    |
| Graxa Apiezon AP100 | $< 10^{-10}$                       | 47                     |
| Graxa Apiezon AP101 | $< 10^{-5}$                        | (*)                    |
| Celvacene "light"   | $10^{-6}$                          | 90                     |
| Celvacene "medium"  | $< 10^{-6}$                        | 120                    |
| Celvacene "heavy"   | $< 10^{-6}$                        | 130                    |
| Vacuseal "light"    | $10^{-5}$                          | 50                     |
| Vacuseal "heavy"    | $10^{-5}$                          | 60                     |
| Graxa de Silicone   | $< 10^{-6}$                        | 215                    |
| Graxa Lubriseal     | $< 10^{-5}$                        | 40                     |
| Araldite            | $< 10^{-6}$ (+)                    | 60                     |
| Glyptal             | $2 \times 10^{-4}$ (+)             | 100                    |

(\*) Em temperaturas elevadas não chega a fundir

(+) A 25 °C



PROPRIEDADES DE SOLVENTES MAIS COMUNS

|                           | Fórmula        | Pressão de vapor à temperatura ambiente<br>(torr) | Ponto de ebulição<br>(°C) | Toxidez: máxima concentração permitida<br>(ppm) |
|---------------------------|----------------|---|---------------------------|---|
| Tricloretileno            | $C_2HCl_3$     | 60  | 87                        | 100   |
| Tetracloreto de carbono   | $CCl_4$        | 88  | 77                        | 10  |
| Clorofórmio               | $CHCl_3$       | 180   | 61                        | 50  |
| Benzeno                   | $C_6H_6$       | 80  | 80                        | 25  |
| Tolueno                   | $C_7H_8$       | 23  | 110                       | 200   |
| Xilol                     | $C_8H_{10}$    | 5   | 140                       | 200   |
| Éter etílico              | $C_4H_{10}O$   | 440   | 35                        | 400   |
| Acetona                   | $C_3H_6O$      | 180   | 56                        | 1000  |
| Metil-etil-cetona         | $C_4H_8O$      | 71  | 80                        | 250   |
| Alcool metílico (metanol) | $CH_4O$        | 98  | 65                        | 200   |
| Alcool etílico            | $C_2H_6O$      | 46  | 78                        | 1000  |
| Alcool isopropílico       | $C_3H_8O$      | 38  | 82                        | 400   |
| Freon MF                  | $CCl_3F$       | 700   | 24                        | 1000  |
| Freon TF                  | $CCl_2FCClF_2$ | 284   | 48                        | 1000  |
| Freon BF                  | $CCl_2FCCl_2F$ | 57  | 93                        | 1000  |
| Água                      | $H_2O$         | 17,535  | 100                       | -   |
| Mercúrio                  | Hg             | $1,2 \times 10^{-3}$                              | 356,6                     | 0,05mg/m <sup>3</sup>                           |

# ÓLEOS PARA BOMBAS DE DIFUSÃO

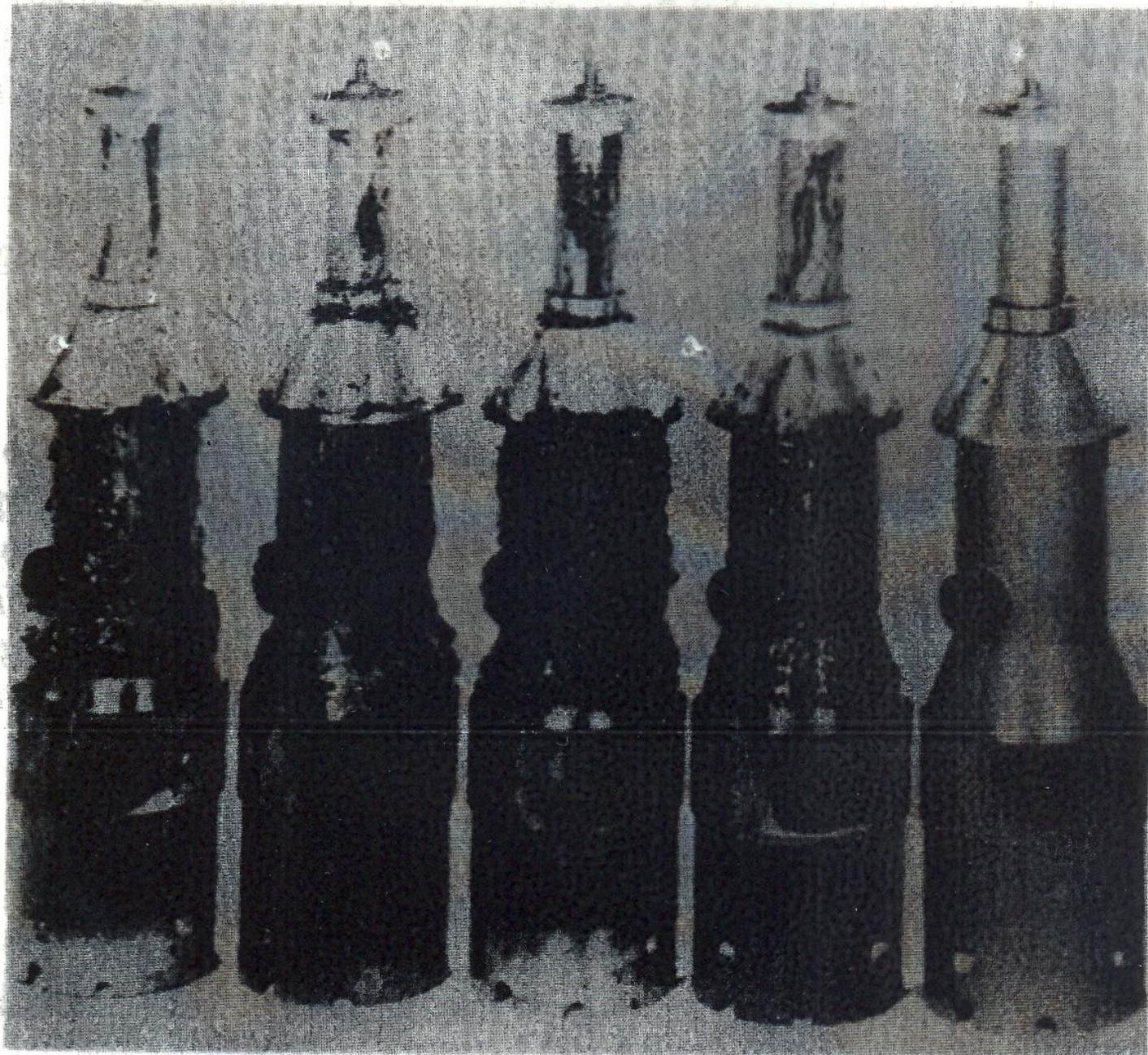
| ÓLEO            | COMPOSIÇÃO QUÍMICA                | PONTO DE EBUL. (°C) | PESO MOLECULAR | PRESSÃO FINAL (Torr) | VISCOSIDADE A (cSt) |       |
|-----------------|-----------------------------------|---------------------|----------------|----------------------|---------------------|-------|
|                 |                                   |                     |                |                      | 20°C                | 150°C |
| APIEZON C       | Hidrocarboneto de petróleo        | 255                 | 479            | 1.0 E 10-7           | 283                 | 4,0   |
| SILICONE DC-702 | Metil polisiloxano                | 185                 | 530            | 4.9 E 10-6           | 55                  | 2,4   |
| SILICONE DC-704 | Tetrafenil tetrametil trisiloxano | 223                 | 484            | 4.9 E 10-8           | 47                  | 2,2   |
| SILICONE DC-705 | Pentafenil trimetil trisiloxano   | 254                 | 546            | 1.0 E 10-9           | 240                 | 3,3   |
| SANTOVAC 5      | Éter polifenílico                 | 295                 | 446            | 1.0 E 10-9           | 2400                | 4,5   |
| FOMBLIN         | Poliéter perfluorado              | 240                 | 2650           | 2.0 E 10-8           | 190                 | 9 a   |
| NEOVAC SY       | Éter mono-N-alquildifenílico      | 220                 | 406            | 1.0 E 10-8           | 25 b                | 17 c  |
| ALCATEL 214     | Tetrafenil tetrametil trisiloxano | 185                 | 484            | 8.0 E 10-8           | 45                  | -     |
| ALCATEL 220     | Elcosil naftaleno                 | 250                 | 408            | 2.3 E 10-10          | 50                  | -     |
| CONVOIL 20      | Hidrocarboneto de petróleo        | 190                 | 400            | 8.0 E 10-6           | 80                  | 23 d  |
| MERCÚRIO        | (elemento químico)                | 127                 | 201            | -                    | 1,15                | -     |

(a) 100°C

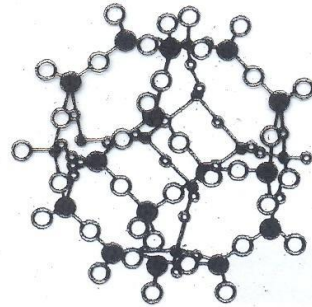
(b) 40°C

(c) 50°C

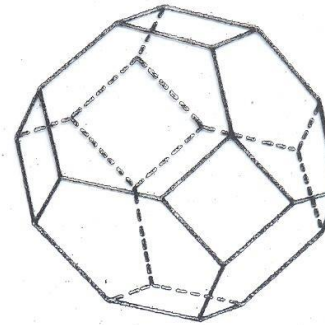
(d) 54°C



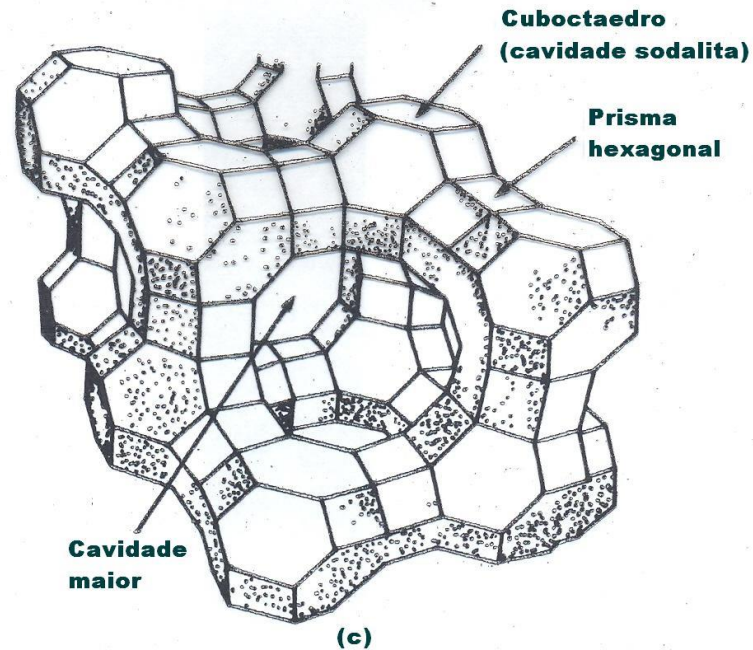
# ZEÓLITA



(a)



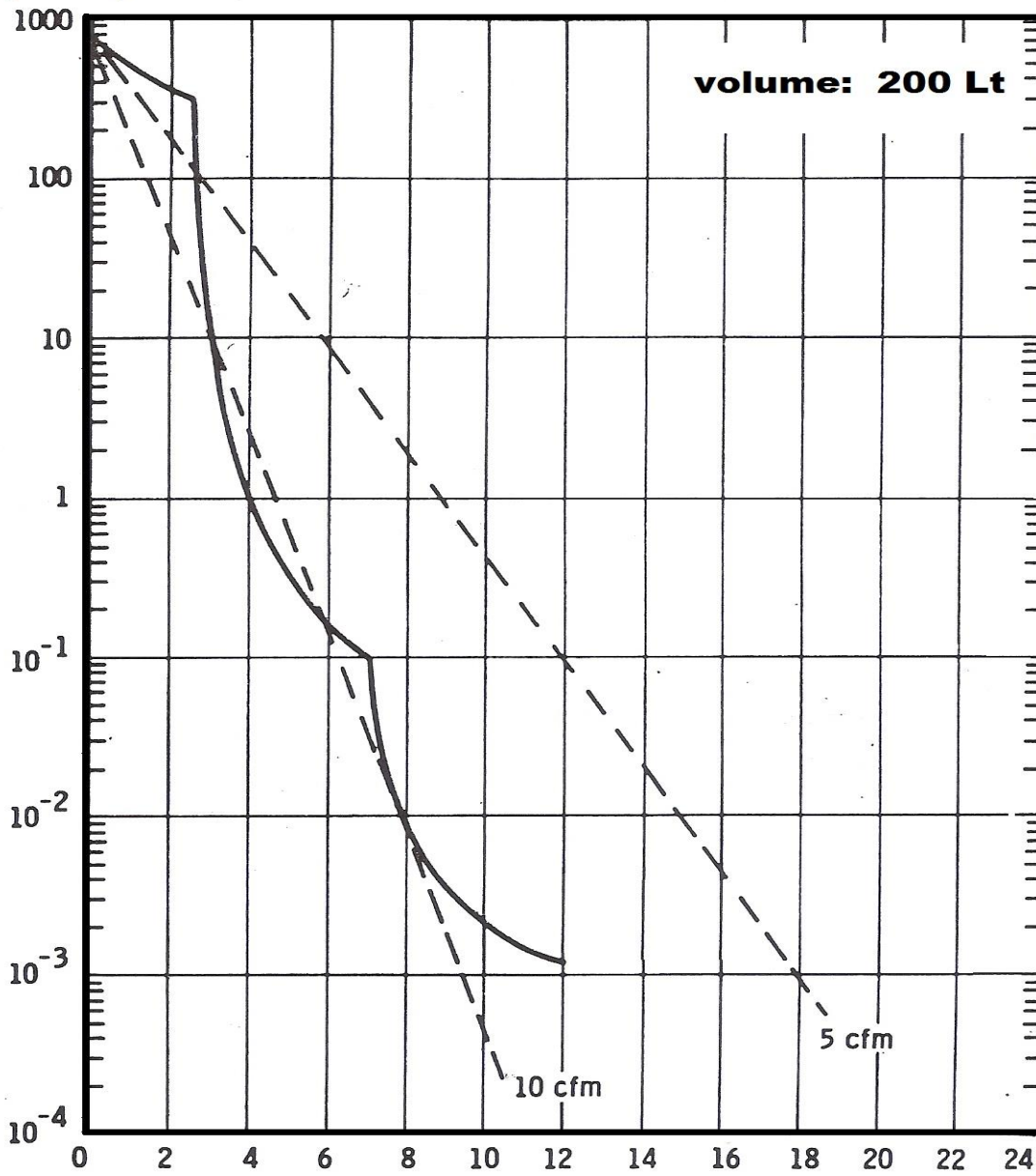
(b)



(c)













**Estrutura de uma zeólita. (b) Representação simplificada do cuboctaedro (a), onde aparecem os átomos de oxigênio [o] e os de alumínio ou silício [•]. Estes cuboctaedros unidos formam a zeólita (c).**

**P (Torr)**



**t (min)**

## AGENTES DE SORPÇÃO

| PROPRIEDADE                           | ZEOLITAS  | CARVÃO ATIVADO  |
|---------------------------------------|---|---|
| CAPACIDADE DE SORPÇÃO                 |    |    |
| CONDUTIVIDADE TÉRMICA                 |    |    |
| PRODUÇÃO DE PÓ                        |    |    |
| FACILIDADE DE REGENERAÇÃO             |   |   |
| PERIGO DE EXPLOSÃO COM O <sub>2</sub> |  |  |
| CUSTO                                 |  |  |

# PROPRIEDADES DE ELASTÔMEROS

| <b>ELASTÔMERO</b>                            | <b>BUNA-N</b> | <b>NEOPRENE</b> | <b>VITON</b> | <b>ISOPRENO</b> | <b>SILICONE</b> |
|--|---------------|-----------------|--------------|-----------------|-----------------|
| TIPO DE ELASTÔMERO                           | <b>NBR</b>    | <b>CR</b>       | <b>FPM</b>   | <b>IR</b>       | <b>SI</b>       |
| MÁXIMA TEMPERATURA DE TRABALHO CONTÍNUO (°C) | <b>121</b>    | <b>93</b>       | <b>260</b>   | <b>107</b>      | <b>260</b>      |
| RESILIÊNCIA (VOLTA AO NORMAL)                | <b>R-B</b>    | <b>MB</b>       | <b>MB</b>    | <b>B</b>        | <b>B</b>        |
| RESISTÊNCIA À ABRASÃO                        | <b>MB</b>     | <b>MB</b>       | <b>B</b>     | <b>E</b>        | <b>M</b>        |
| RESISTÊNCIA A SOLVENTES                      | <b>M</b>      | <b>M</b>        | <b>R-B</b>   | <b>M</b>        | <b>M</b>        |
| RESISTÊNCIA A ÓLEO                           | <b>R-B</b>    | <b>R-B</b>      | <b>MB</b>    | <b>M</b>        | <b>M</b>        |
| RESISTÊNCIA A ÁGUA                           | <b>R-B</b>    | <b>R</b>        | <b>R-B</b>   | <b>R-B</b>      | <b>R-B</b>      |

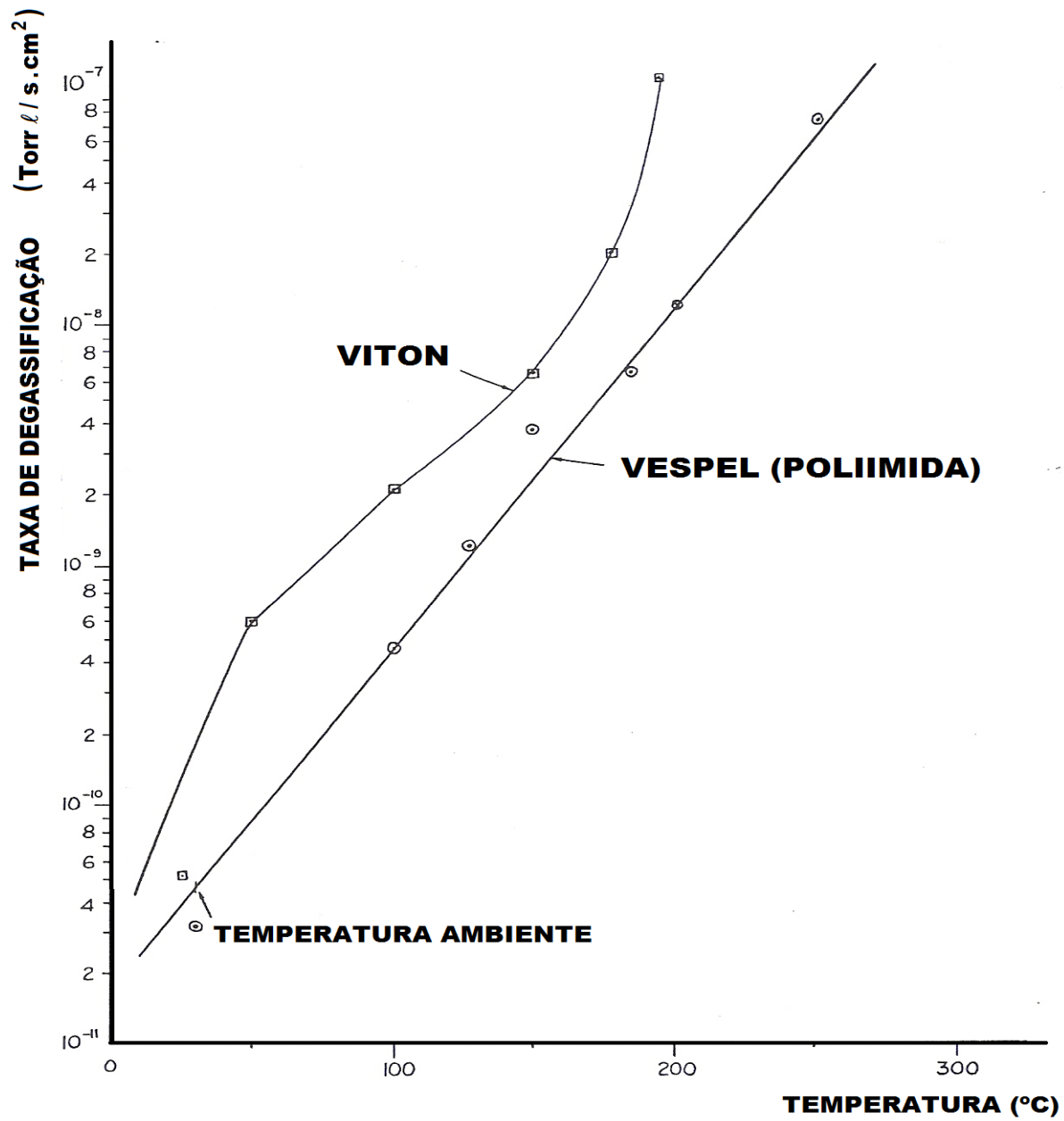
M = Mau

R = Regular

B = Bom

MB = Muito Bom

E = Excelente





# COMPONENTES

- ◆ TUBOS, CONEXÕES
- ◆ FLANGES COM O'RINGS  
VEDAÇÃO METÁLICA
- CANAL  
KF (ANEL E ABRAÇADEIRA)  
CONFLAT (COBRE OFHC)  
METAL MOLE (ALUMÍNIO)
- ◆ ABRAÇADEIRAS (PARA O'RINGS)
- ◆ CONEXÕES FLEXÍVEIS - BELLOWS
- ◆ MANGUEIRAS (BORRACHA, PVC, METÁLICAS)
- ◆ VÁLVULAS COM BELLOWS  
GAVETA  
ESFERA  
BORBOLETA  
DIAFRAGMA  
VEDAÇÃO METÁLICA (FACA, DISCO)  
AGULHA (AJUSTE FINO)
- ◆ ABAFADORES - BAFFLES
- ◆ ARMADILHAS - TRAPS  
GELO SECO E ÁLCOOL  
NITROGÊNIO LÍQUIDO
- ◆ PASSADORES
- ◆ VISORES
- ◆ MANIPULADORES
- ◆ CAMPÂNULAS (VIDRO, METÁLICAS)
- ◆ FILTROS

**VÁLVULA  
PNEUMÁTICA**

**TUBO FLEXÍVEL**

**PIRANI**

**MAGNETRON  
INVERTIDO**

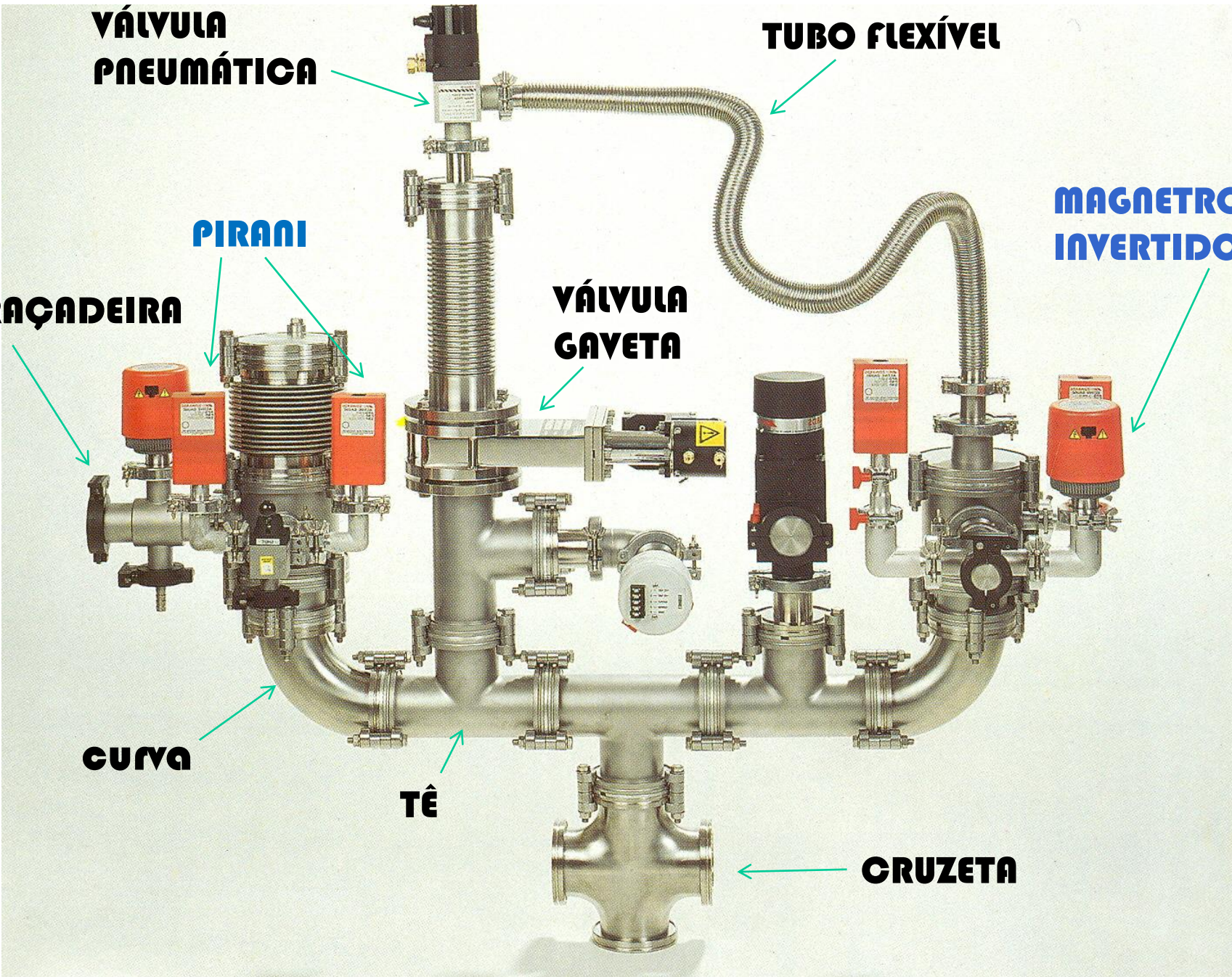
**ABRAÇADEIRA**

**VÁLVULA  
GAVETA**

**CURVA**

**TÊ**

**CRUZETA**



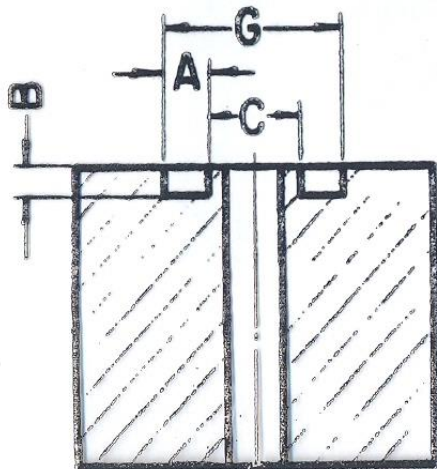
# CANAL DE O'RING



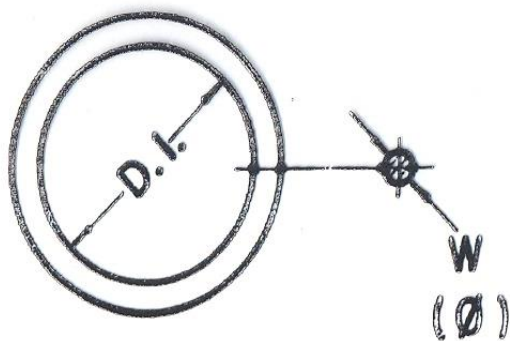
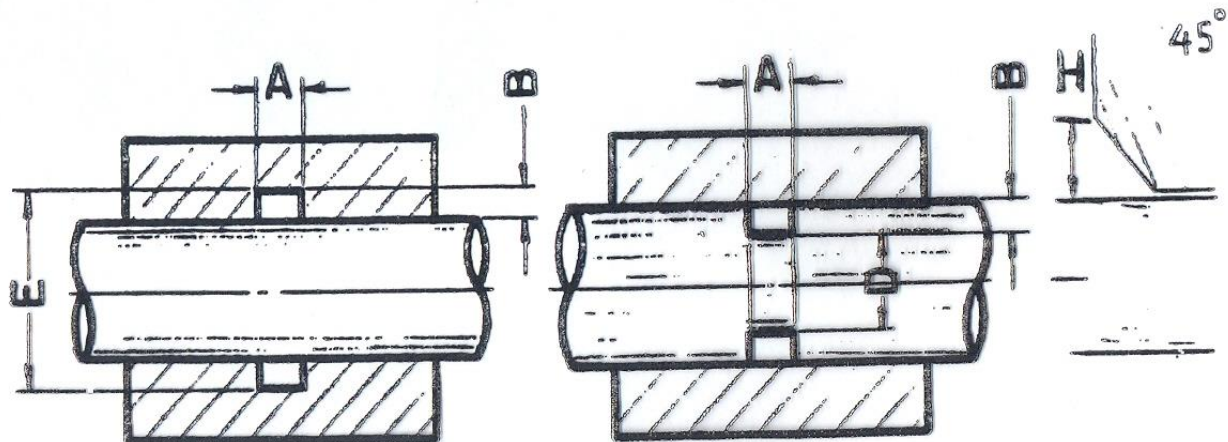
332 Low-Profile  
Water-Cooled Baffle  
300 ℓ/s Conductance

# O - RINGS

## APLICAÇÃO ESTÁTICA

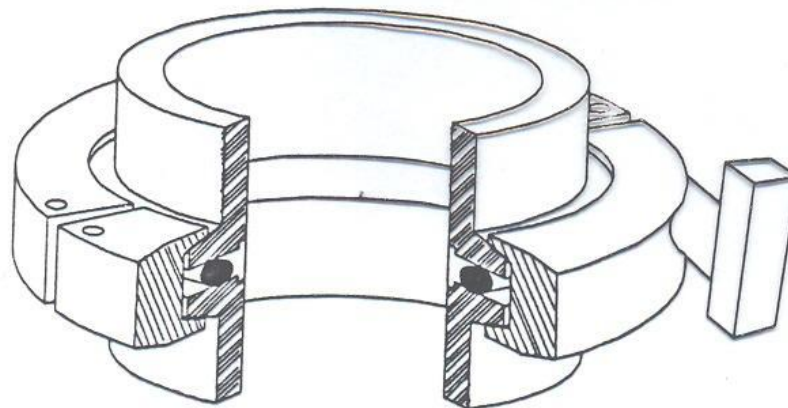
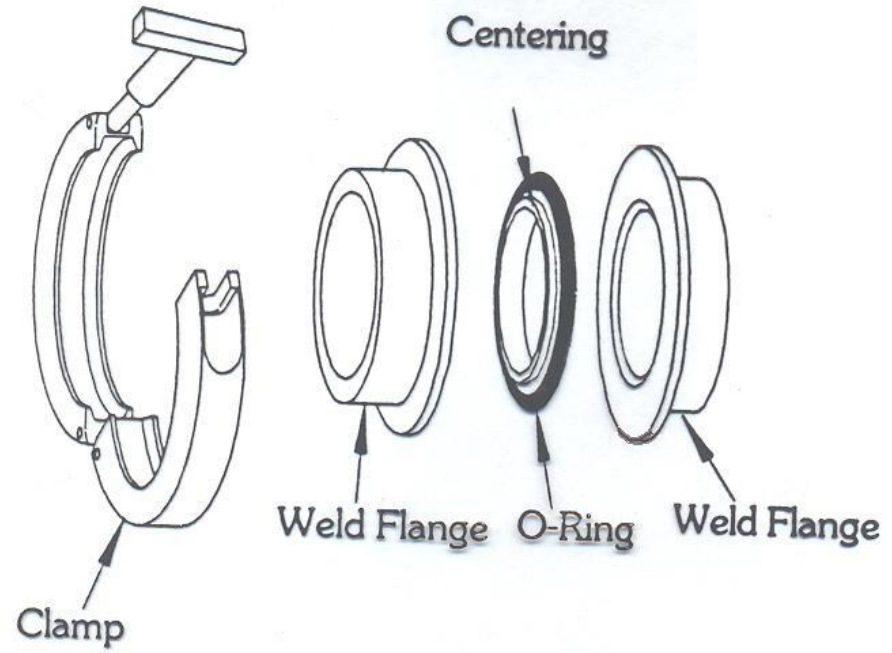


## APLICAÇÃO DINÂMICA



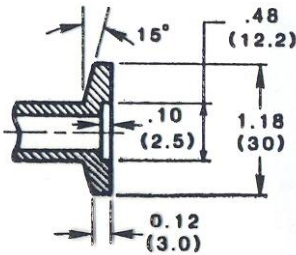
| W    | Ø    | EST. |     | DIN. |     | H   |
|------|------|------|-----|------|-----|-----|
|      |      | A    | B   | A    | B   |     |
| 1/16 | 1,78 | 2,4  | 1,4 | 2,3  | 1,3 | 2,3 |
| 3/32 | 2,62 | 3,6  | 2,3 | 3,2  | 2,1 | 3,4 |
| 1/8  | 3,53 | 4,8  | 3,1 | 4,2  | 2,9 | 4,6 |

# FLANGE KF

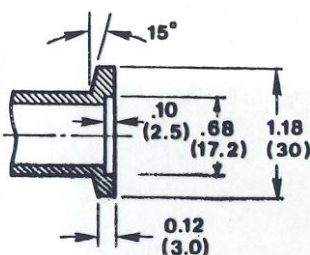




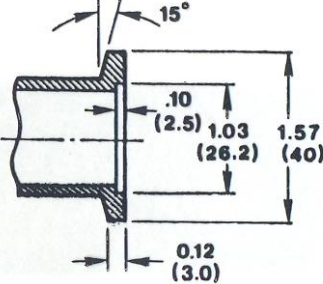
# THE ISO-KF SYSTEM



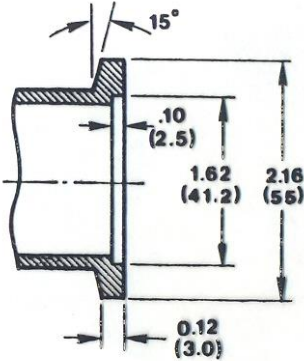
NW 10 ISO-KF



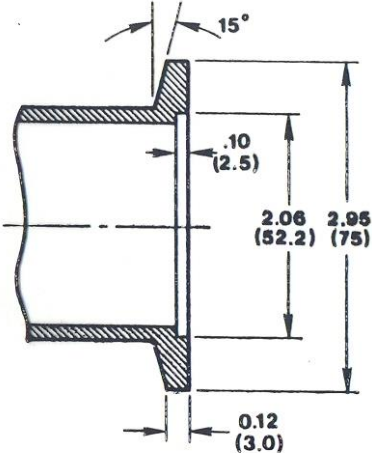
NW 16 ISO-KF



NW 25 ISO-KF



NW 40 ISO-KF



NW 50 ISO-KF

\* NW is from the German, *Nennweite* meaning nominal diameter. It is retained here by convention, not to specify flange type.

Figure 1  
Standard ISO-KF flange assembly

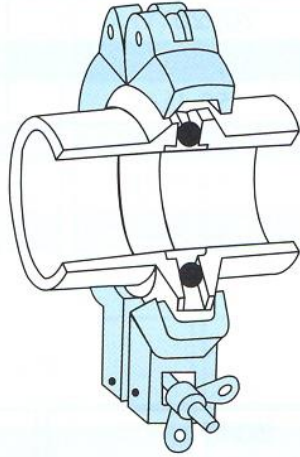


Figure 2  
Centering ring

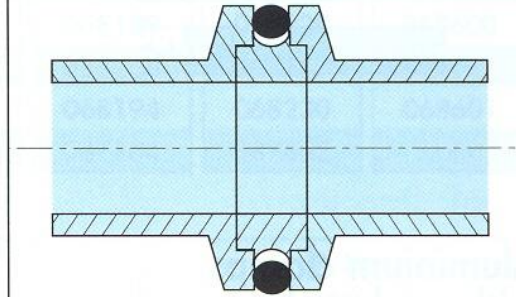


Figure 3  
Metal seal assembly

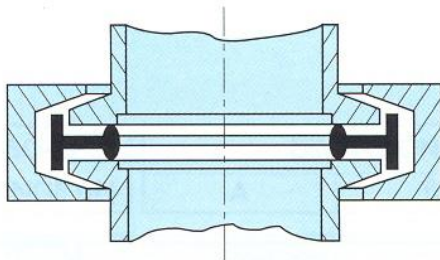


Figure 4  
Adapter centering ring

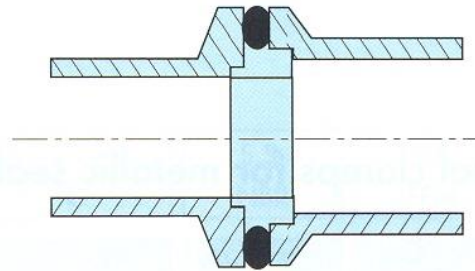




Figure 1  
Double claw clamp coupling

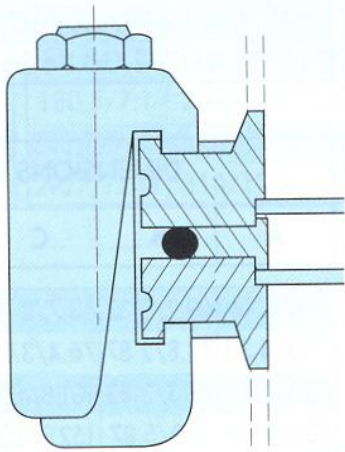


Figure 2  
Rotatable flange

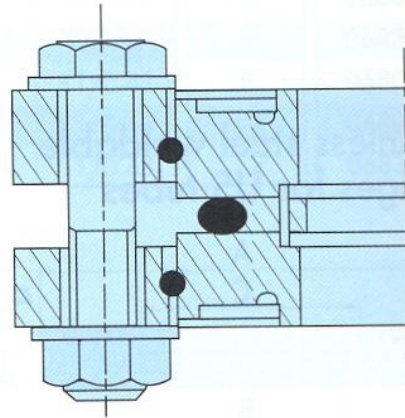


Figure 3  
ISO-F connection

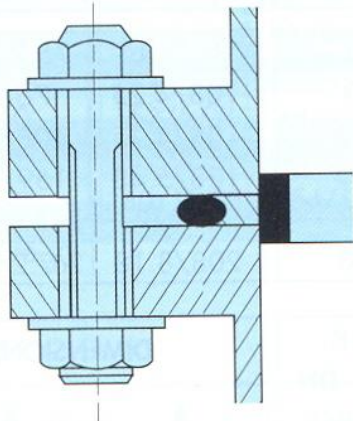
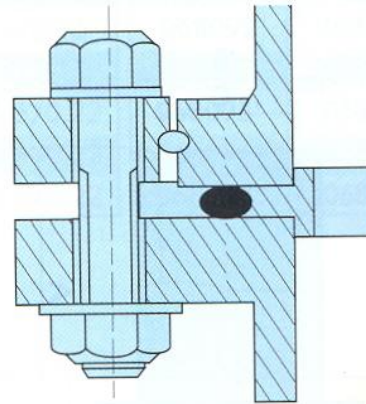


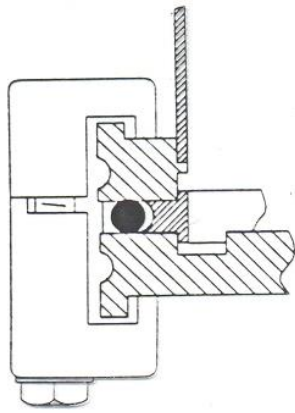
Figure 4  
ISO-K / ISO-F coupling



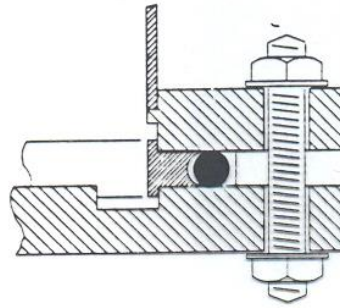
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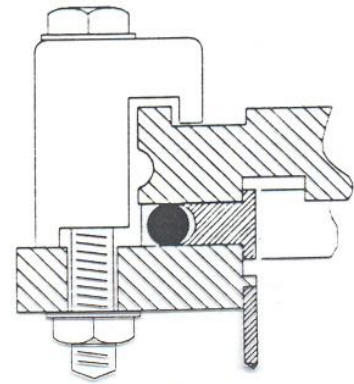
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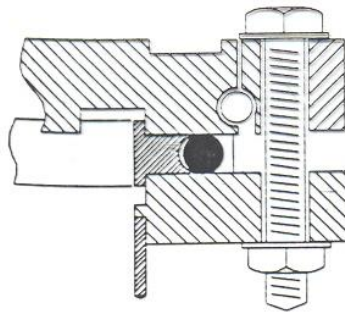
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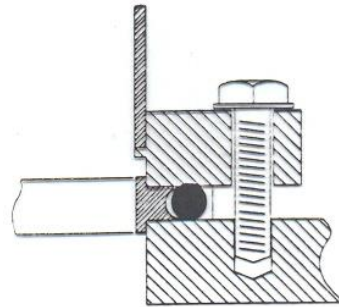
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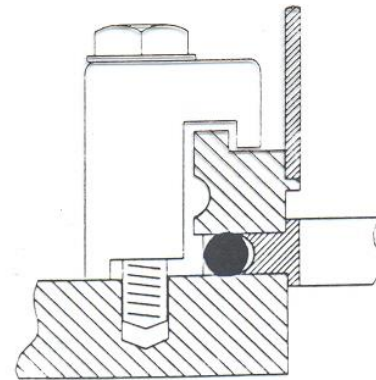
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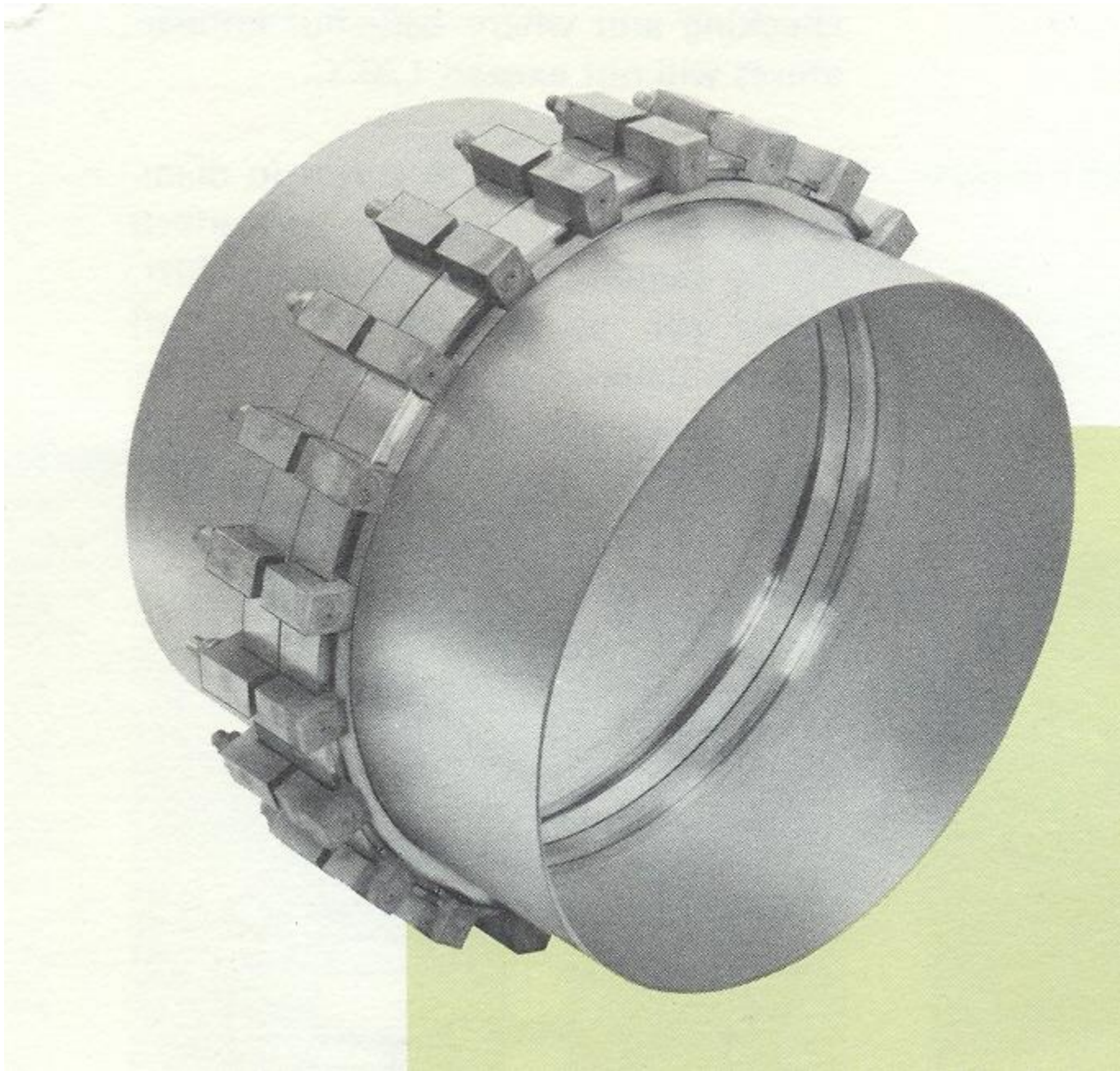
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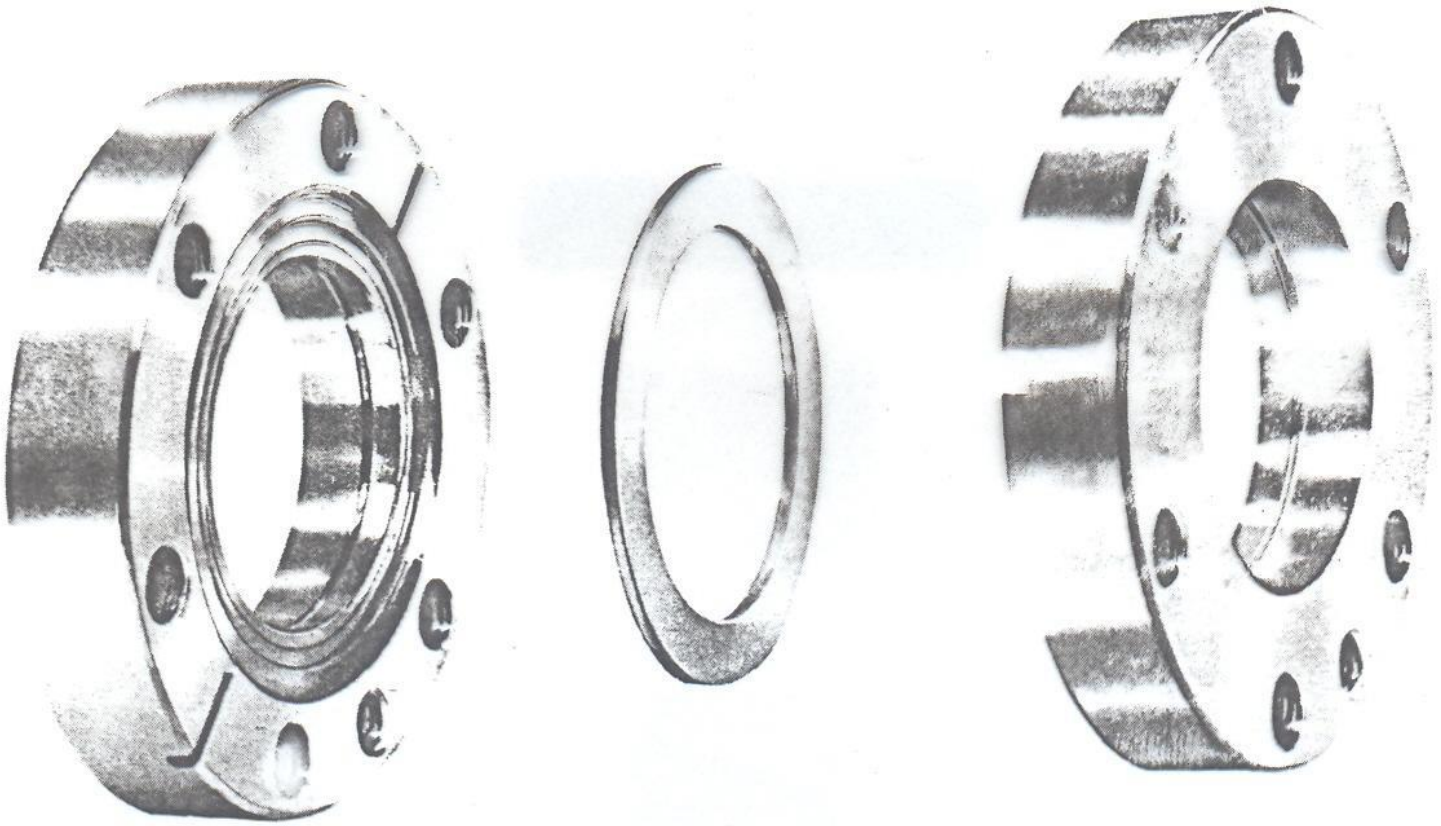


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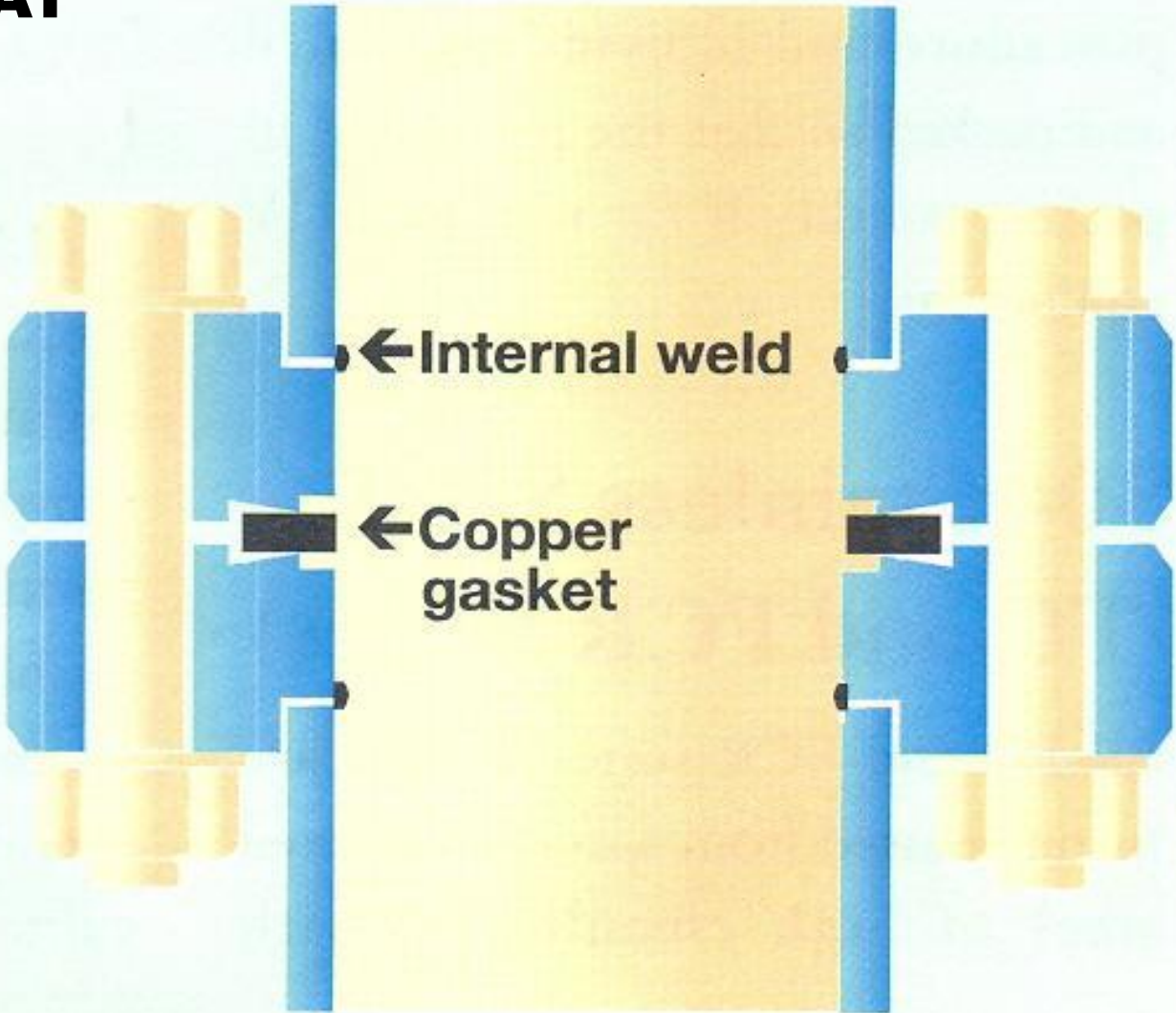
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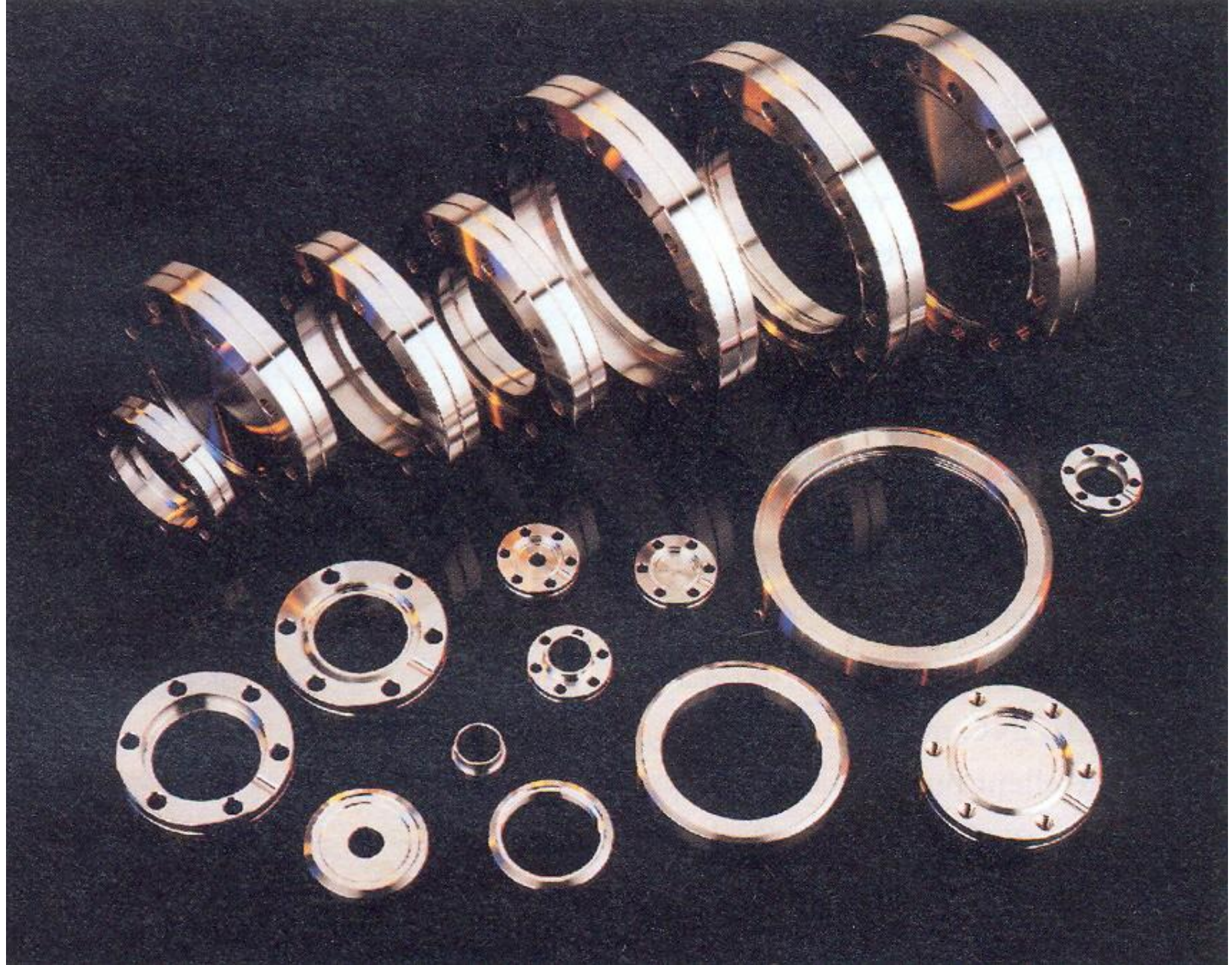




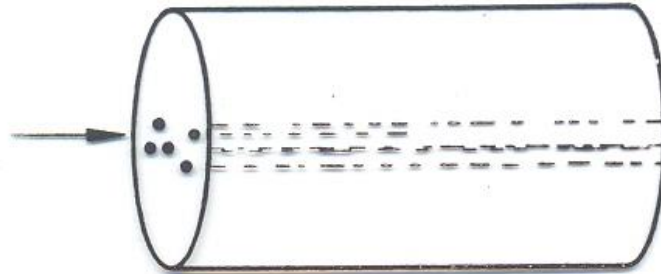
CF flange connection with copper gasket

# FLANGE CONFLAT

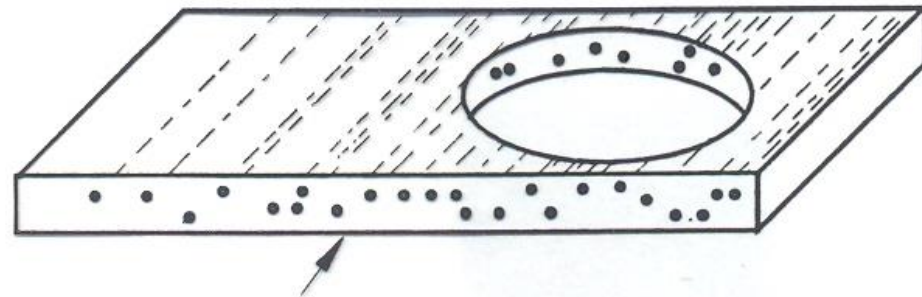




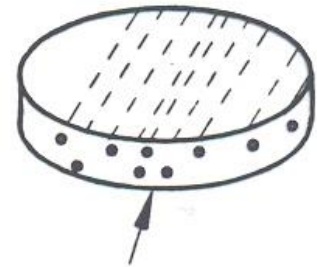
Axial voids in round bar stock



Porous flange

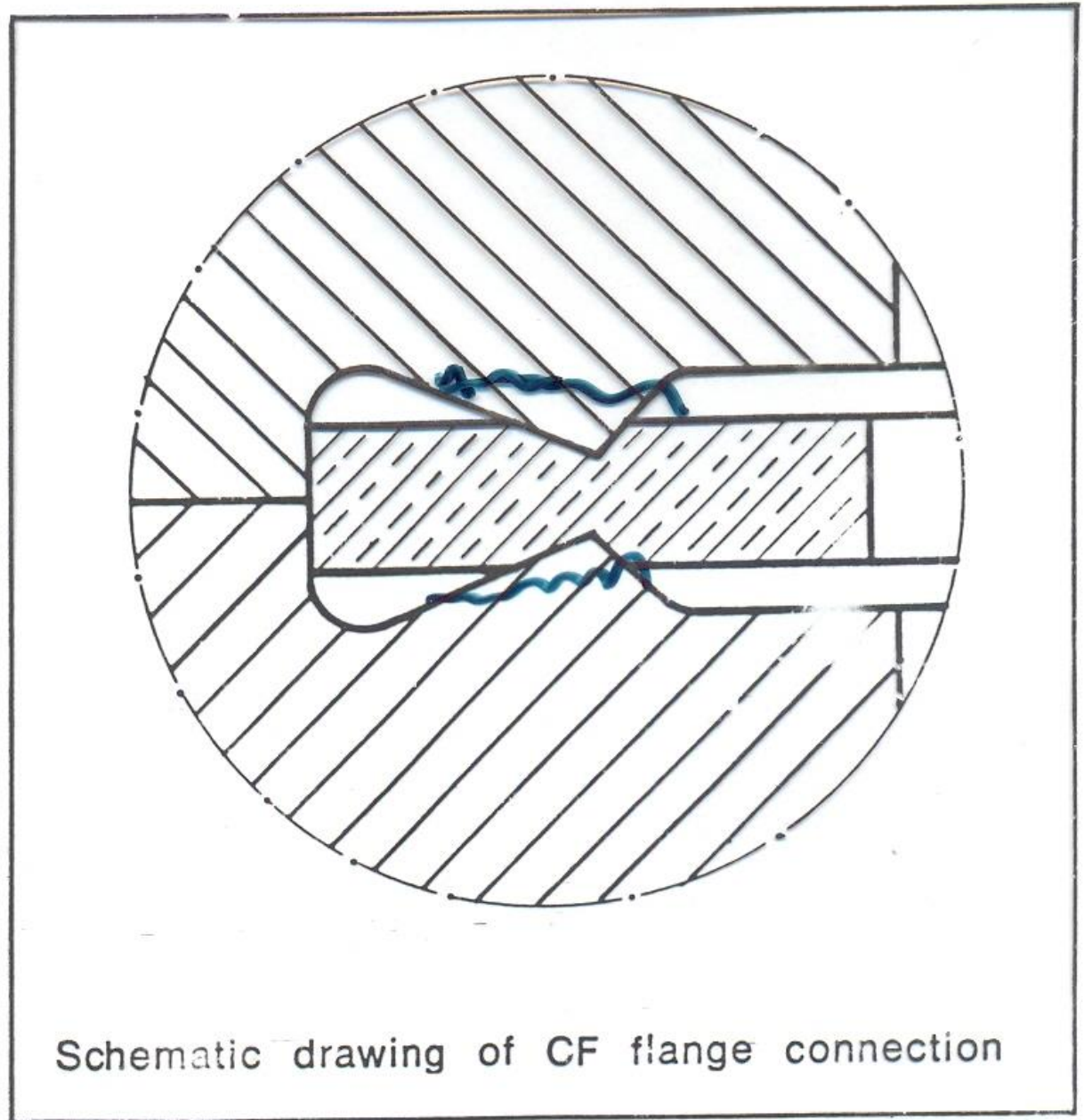


Longitudinal voids in rolled plate



Non porous flange

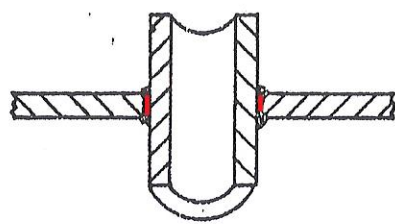
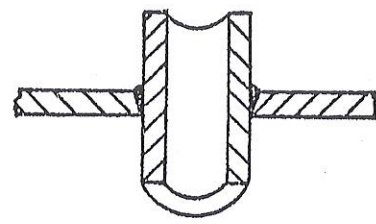
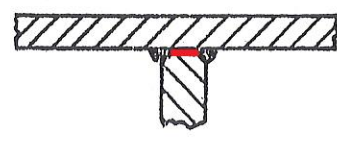
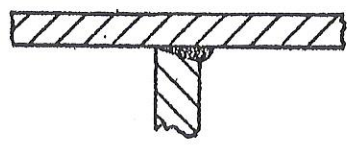
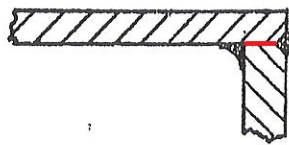
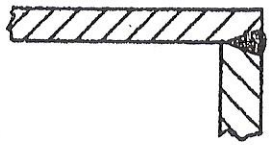
# FLANGE CONFLAT

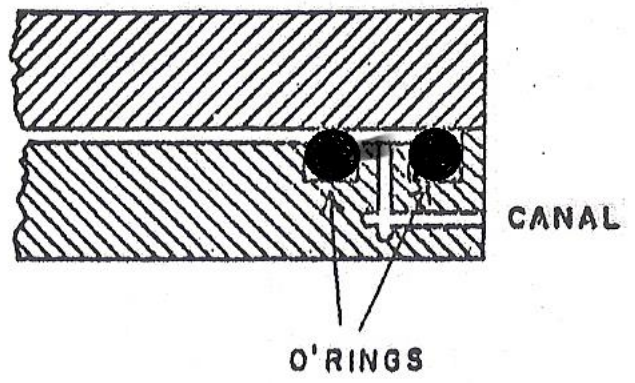
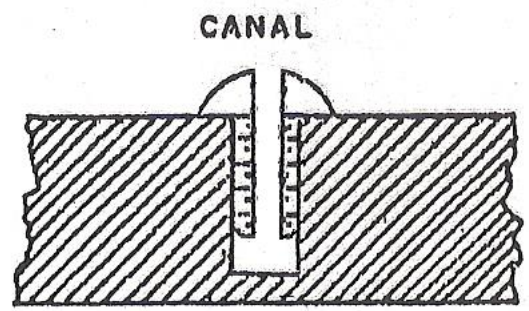
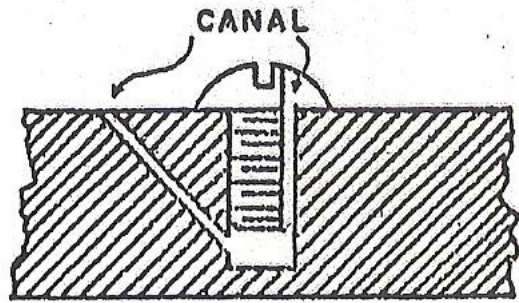


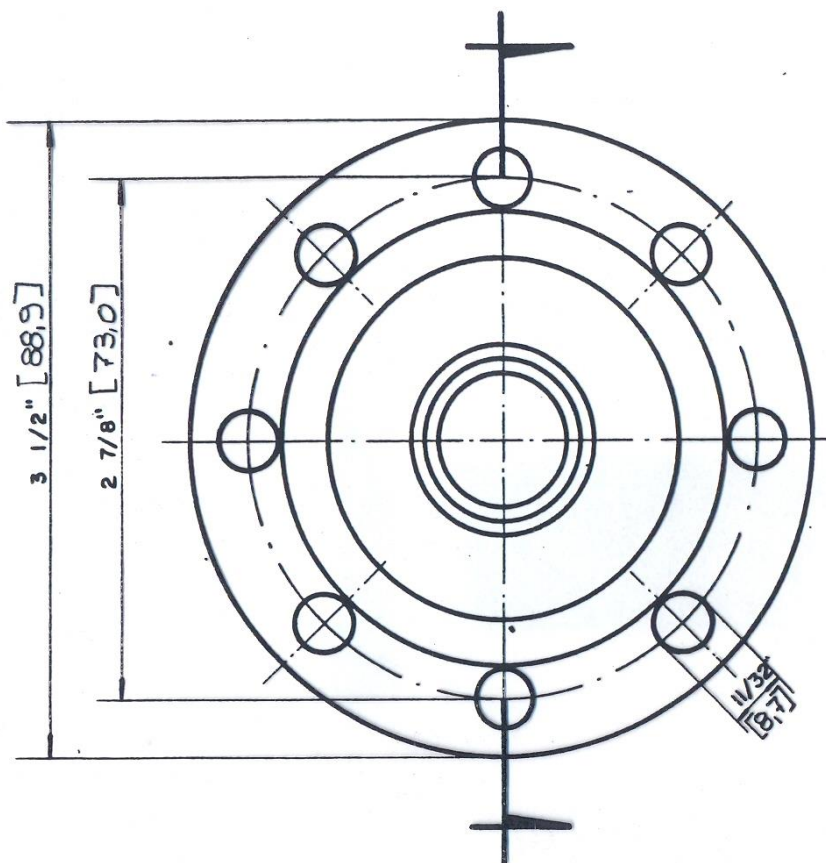


CORRETO

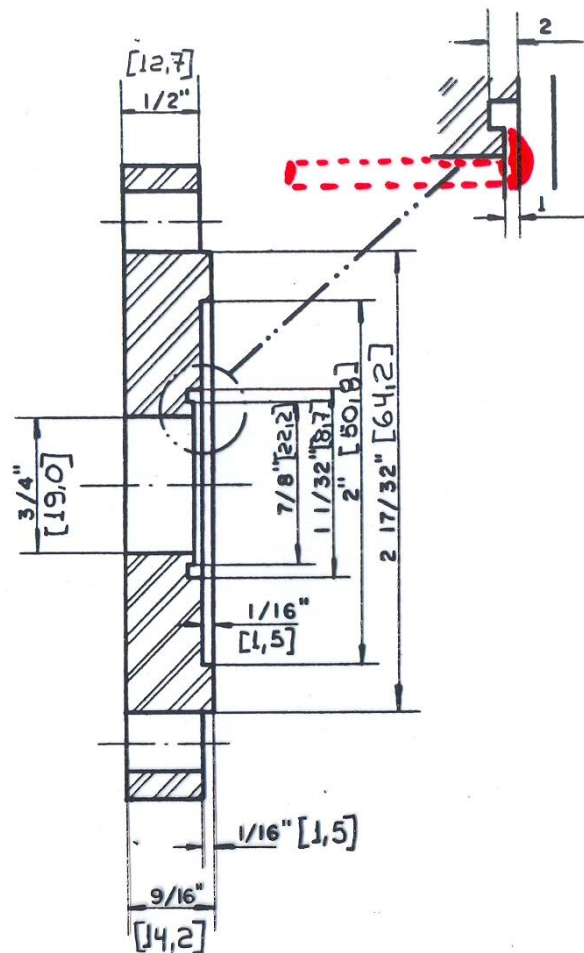
INCORRETO







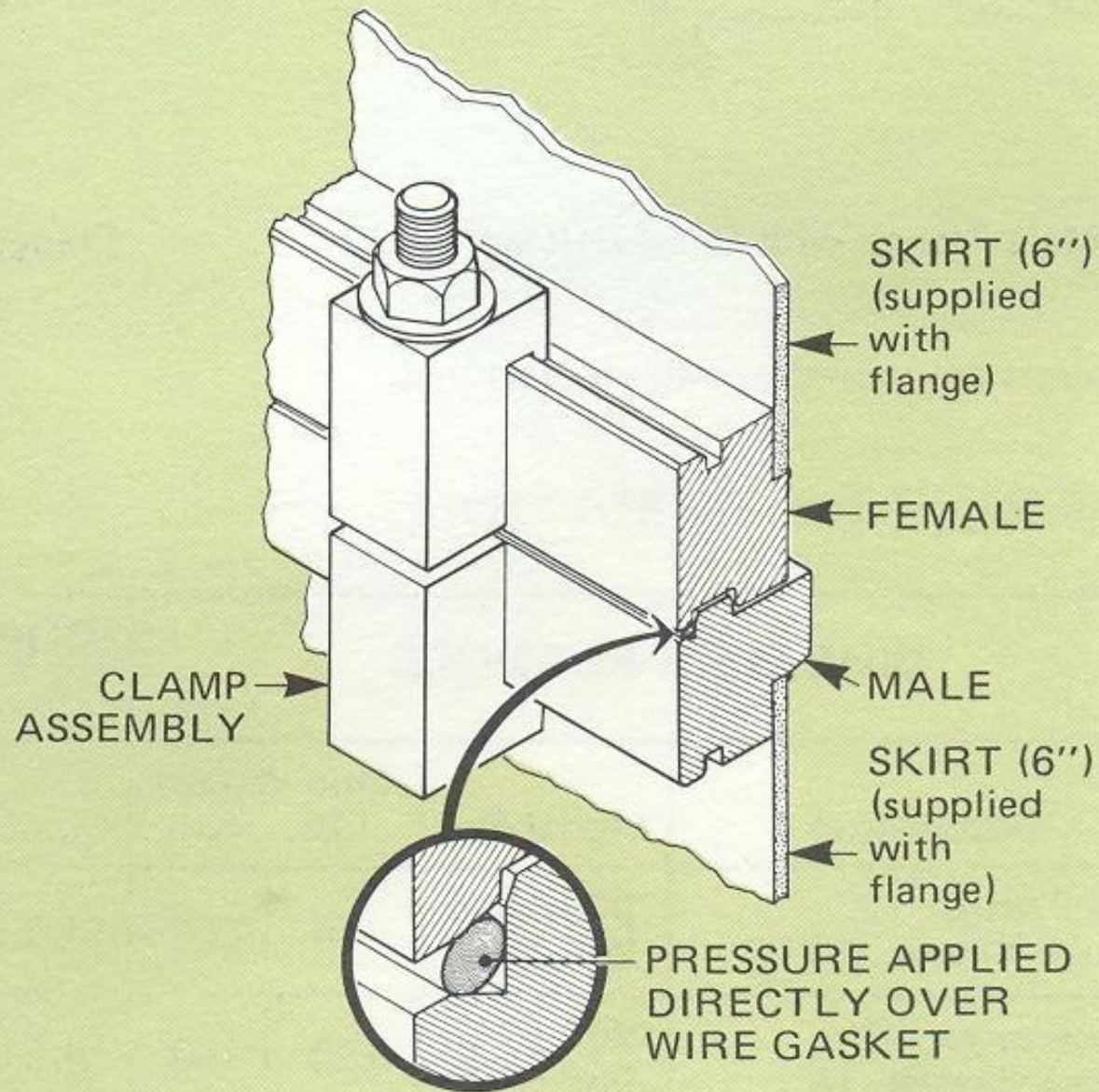
FLANGE PADRÃO PARA  
MEDIDORES DE IONIZAÇÃO  
3 1/2"



Nº 419  
GO-02  
RO-35  
GC-01  
PC-09

LAB. PELLETRON  
DES. Endo-19/11/73  
ESCALA - 1:1 - [ ] MILÍMETROS  
MATERIAL - AÇO INOX





# VÁLVULAS

- **COM “BELLOWS” (90°, 180°)**
- **AREJAMENTO**
- **DIAFRAGMA**
- **ESFERA**
- **AGULHA (AJUSTE FINO)**
- **BORBOLETA**
- **DISCO**
- **GAVETA**
- **VEDAÇÃO METÁLICA (FACA, DISCO CÔNICO)**

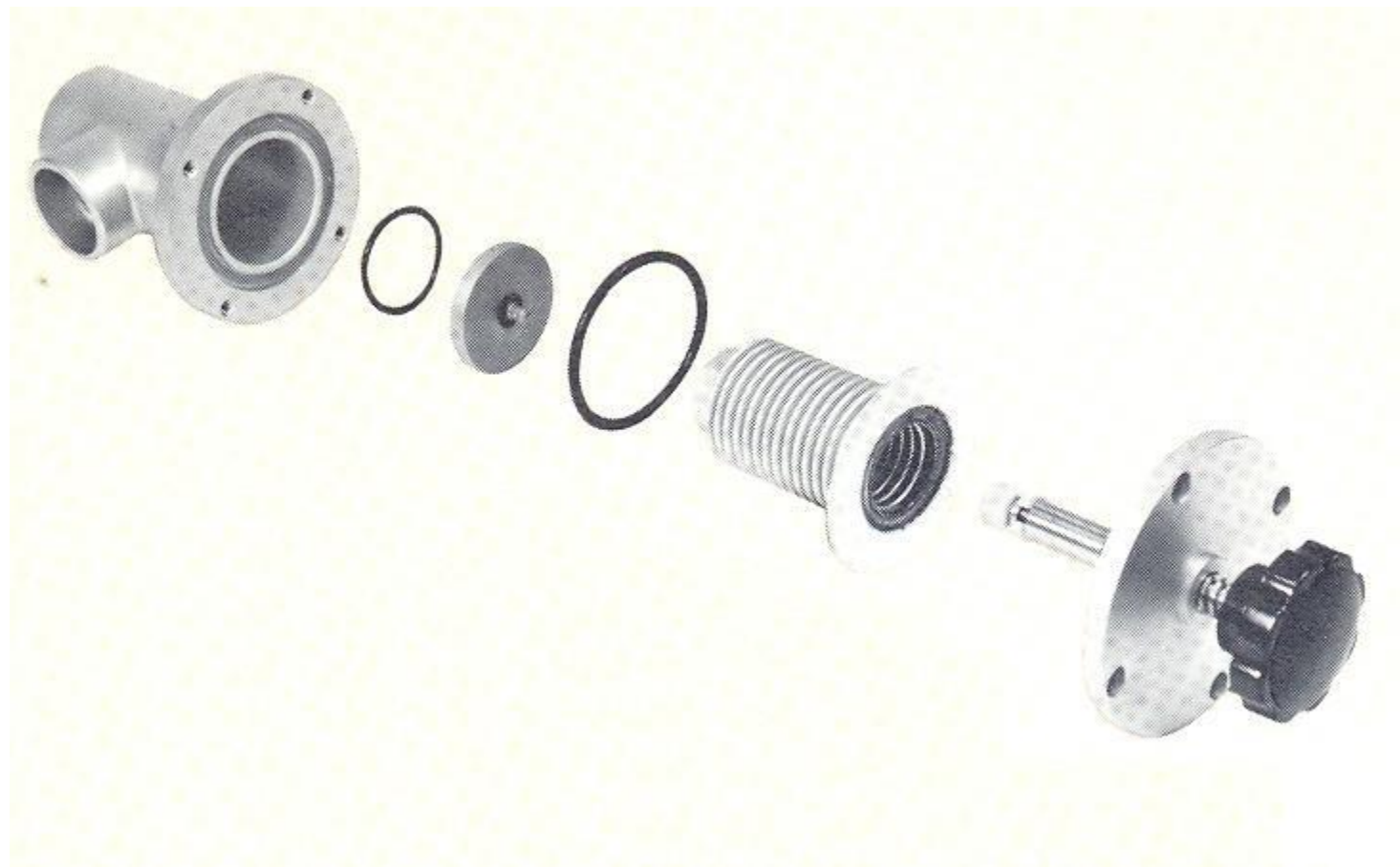




**Brass  
Vacuum Valves**



# VÁLVULA ANGULAR COM FOLE METÁLICO

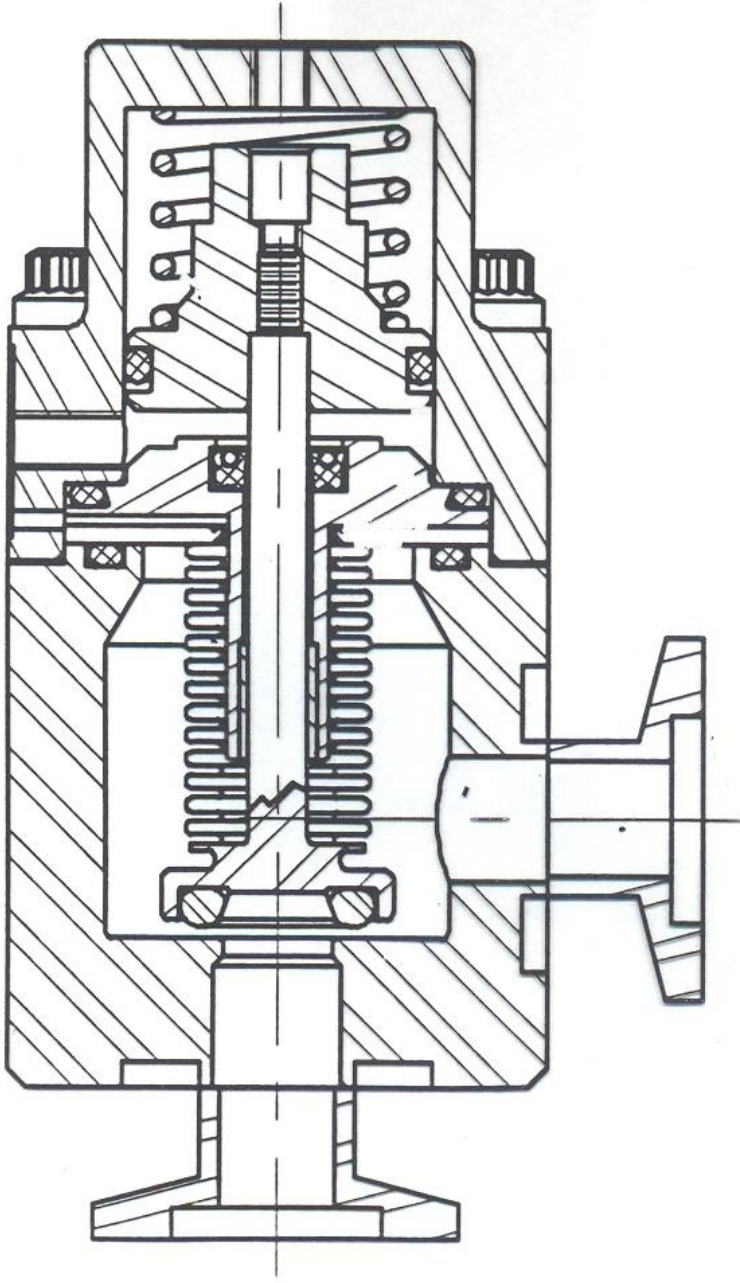




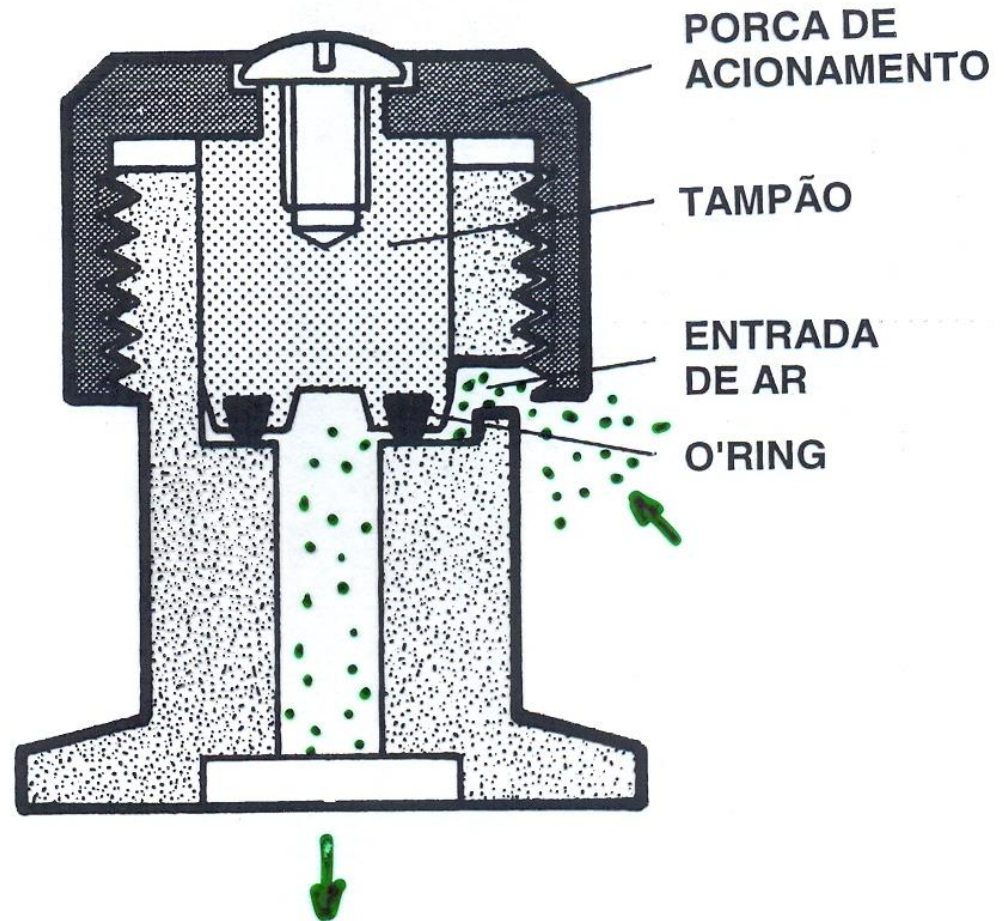


# VÁLVULA PNEUMÁTICA

**AR COMPRIMIDO**



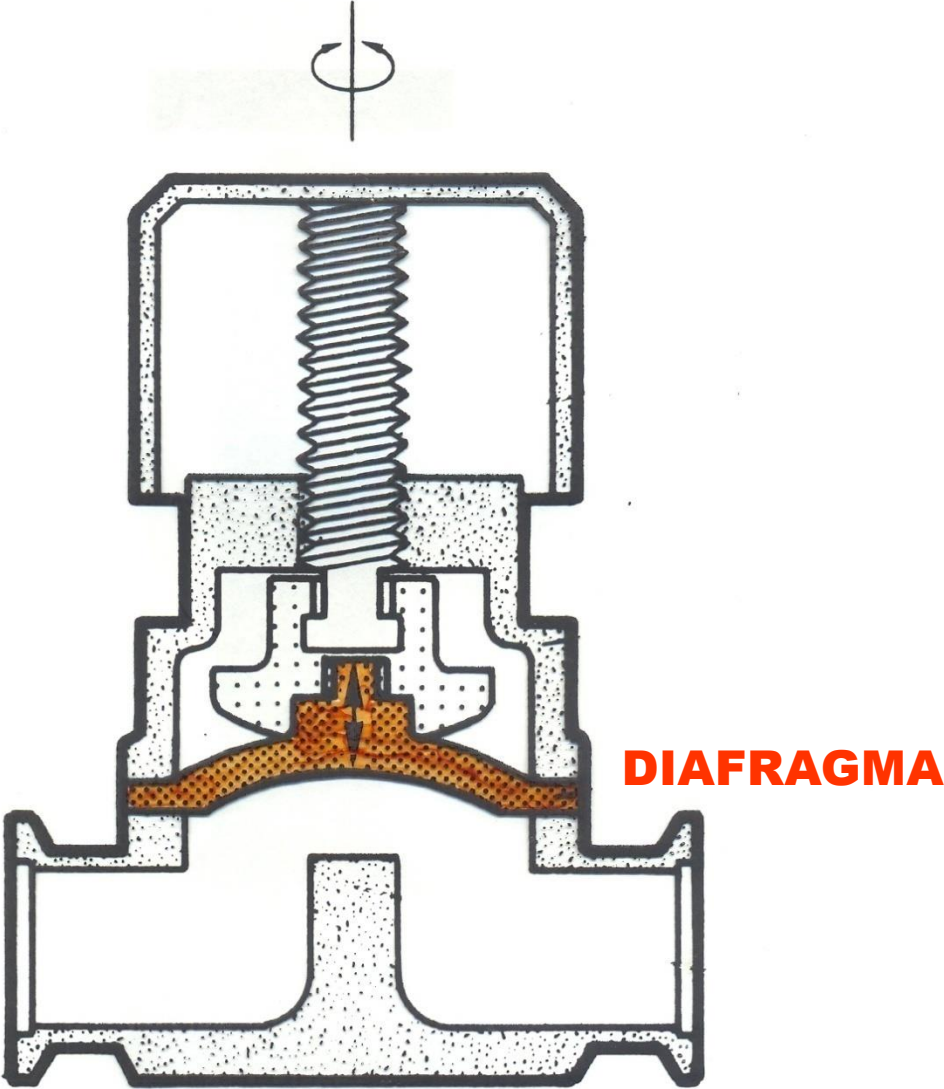
# VÁLVULA DE ENTRADA DE AR



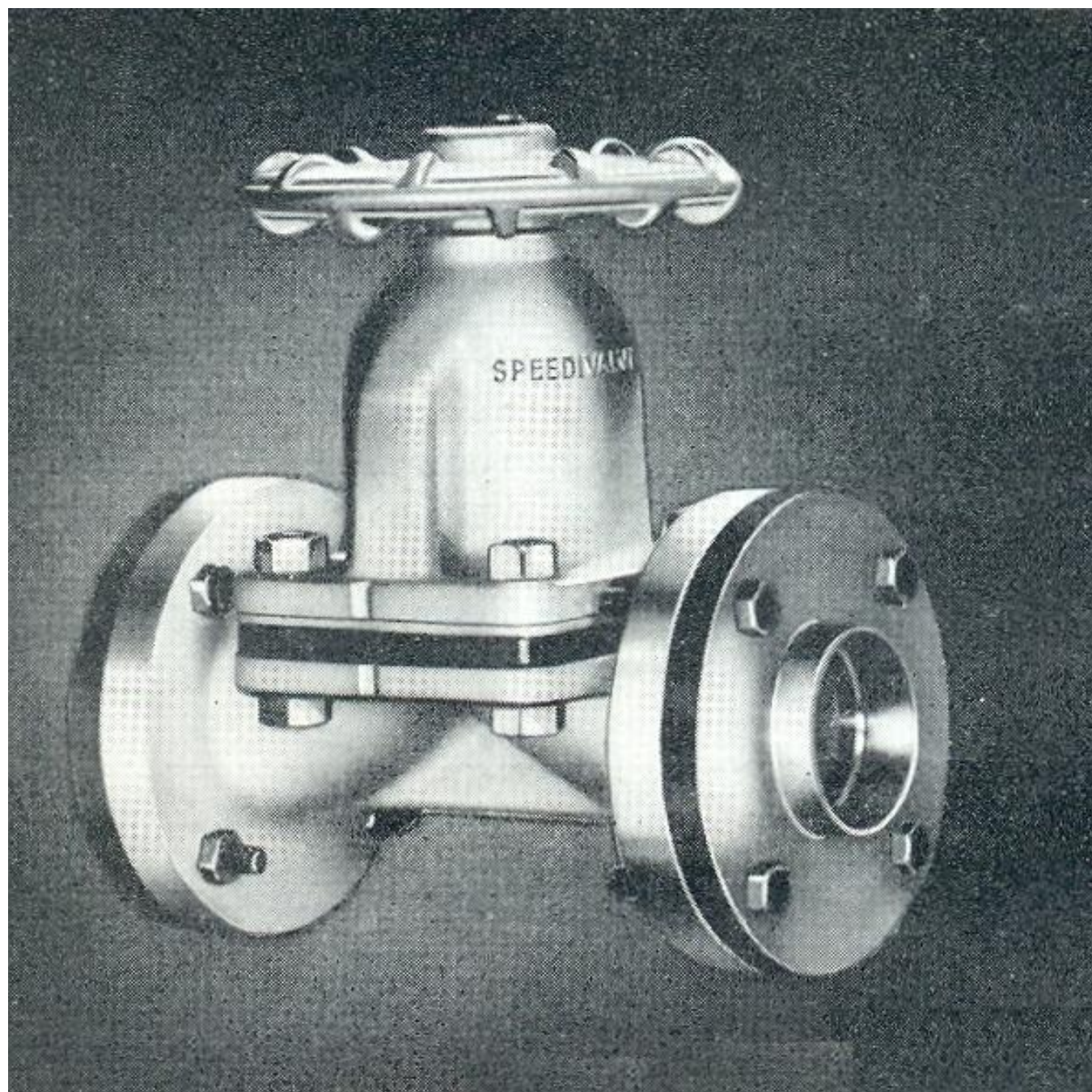




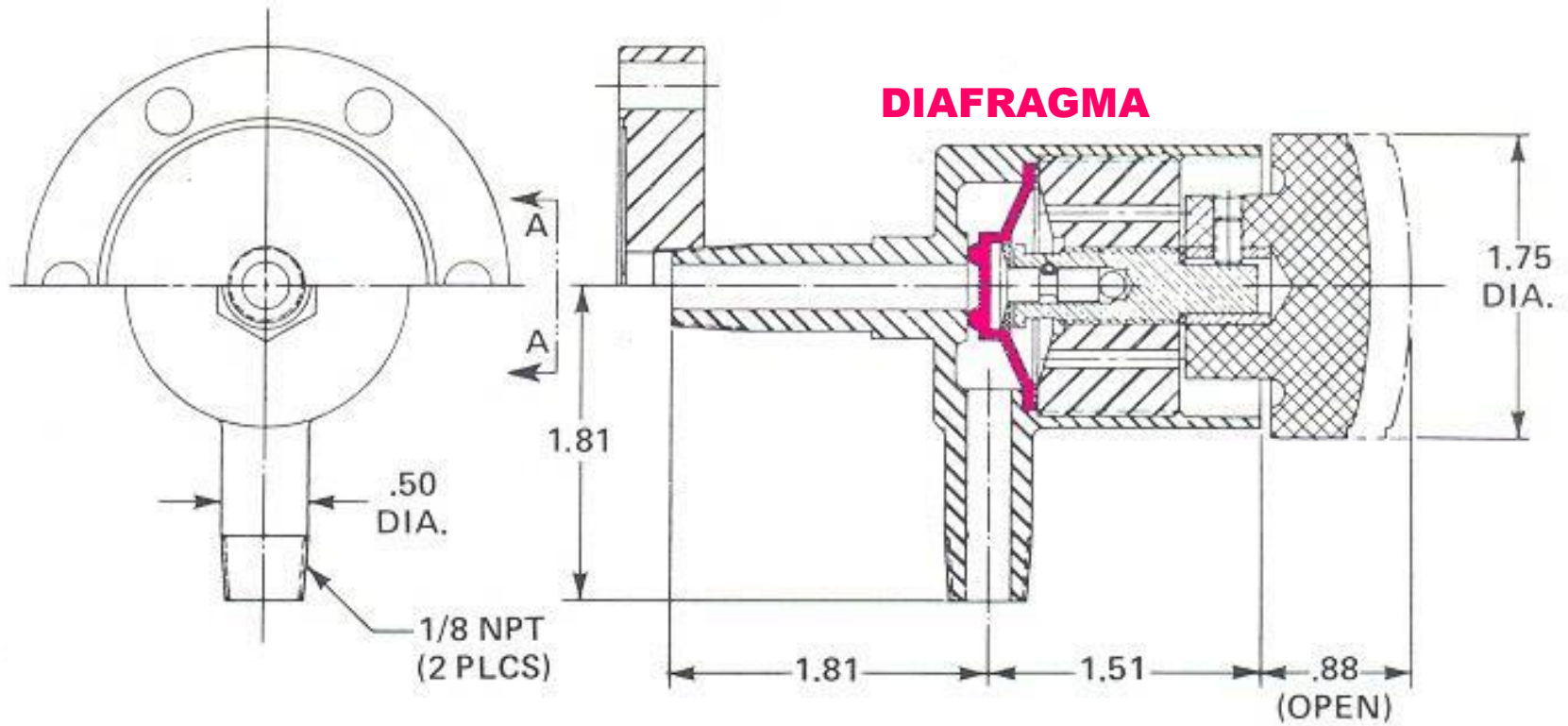
**VÁLVULA  
DIAFRAGMA**

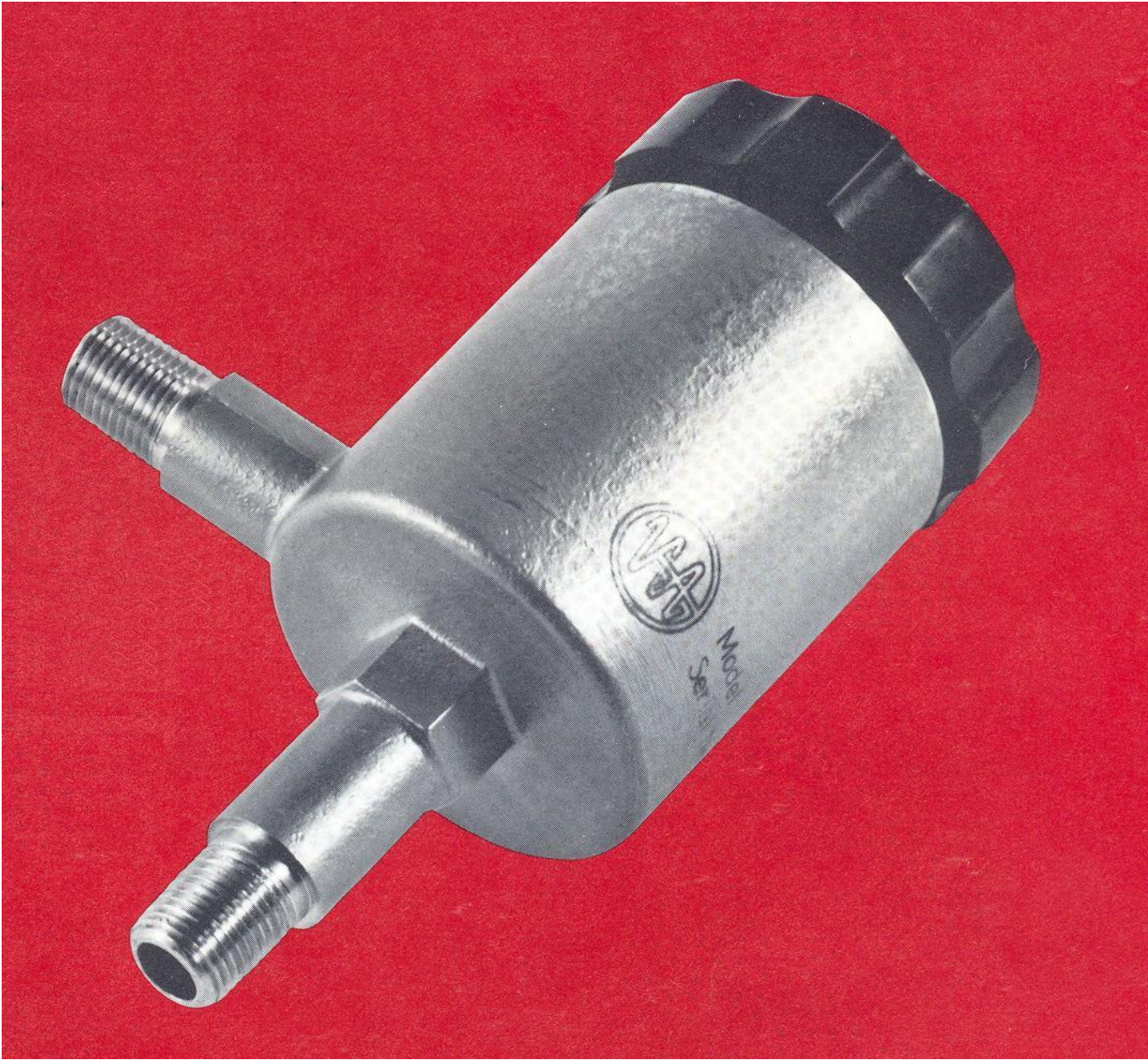






# VÁLVULA DIAFRAGMA





# VÁLVULA ESFERA



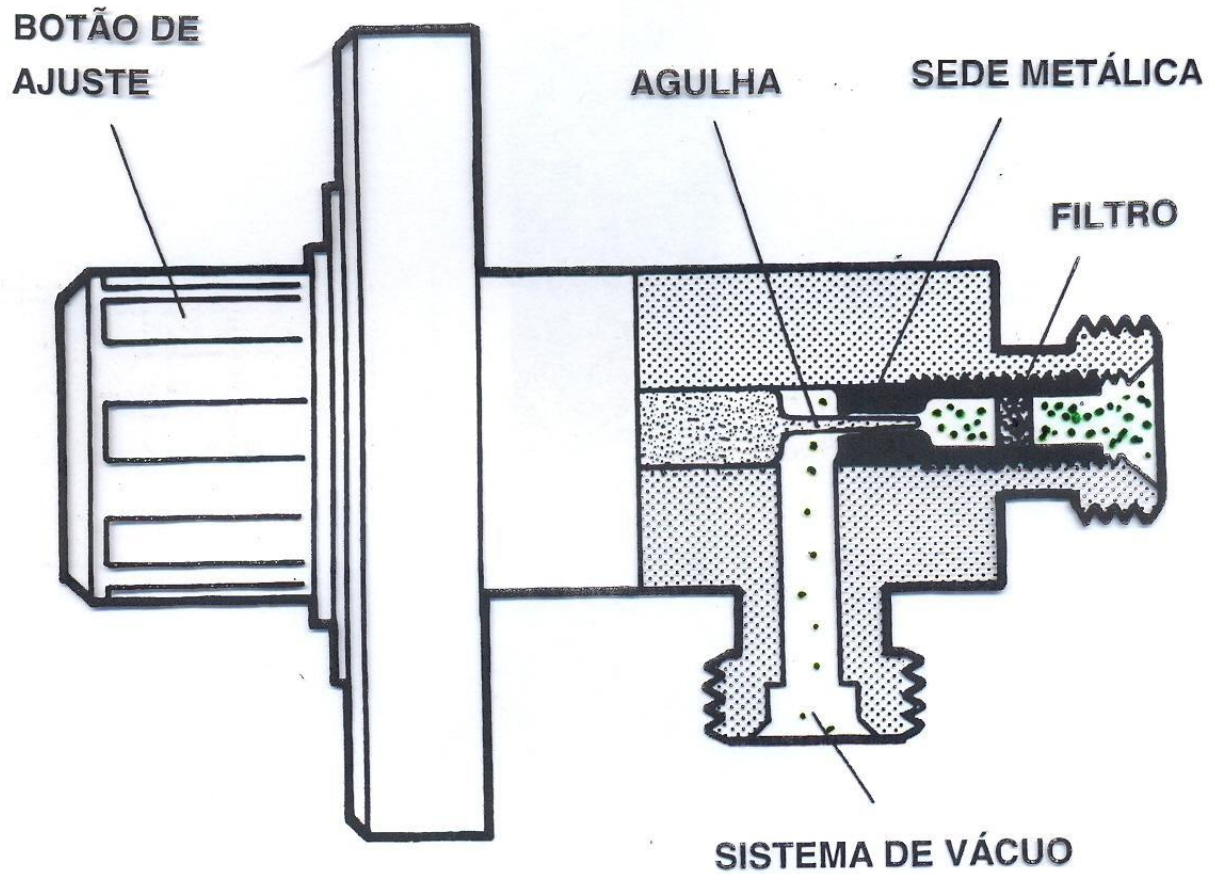
05/06/2007

# VÁLVULA ESFERA



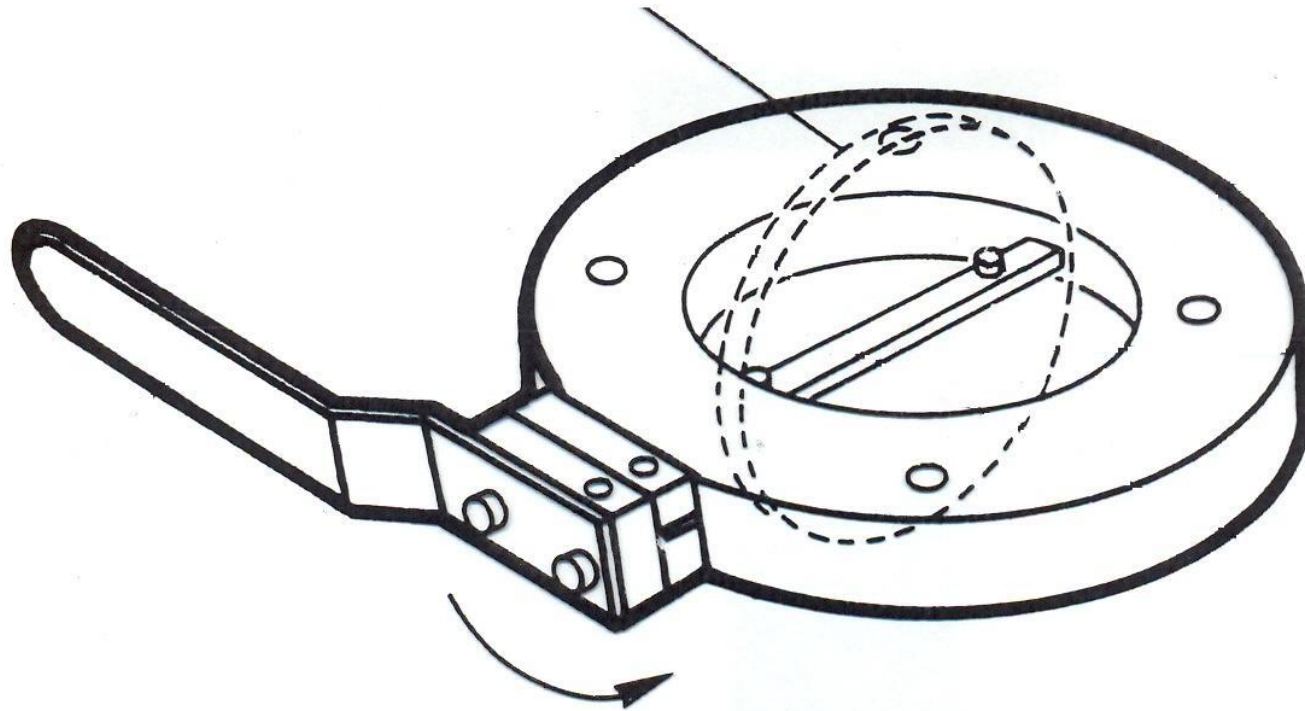
05/06/2007

# VÁLVULA AGULHA



# VÁLVULA BORBOLETA

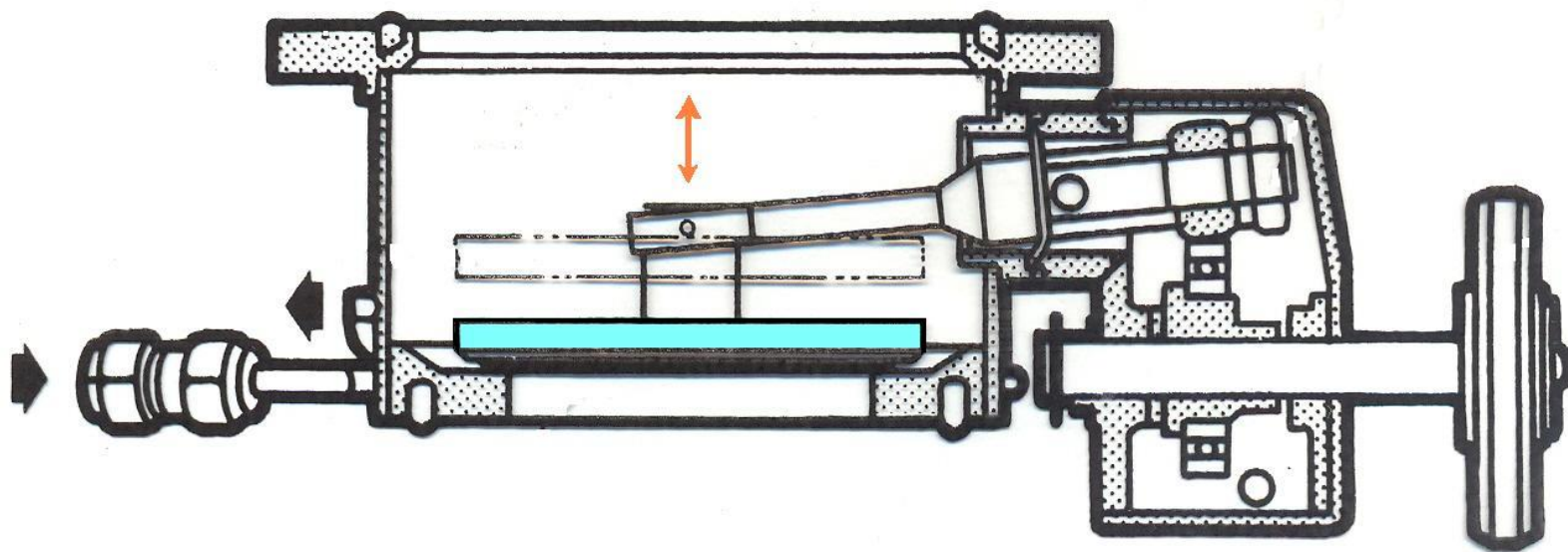
DISCO COM O'RING



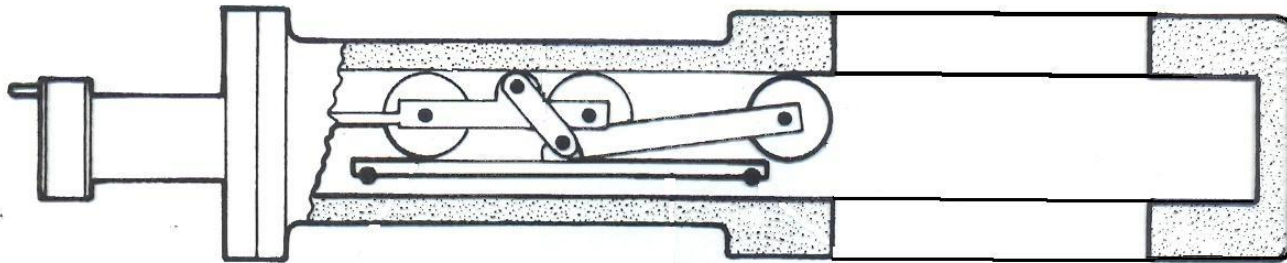
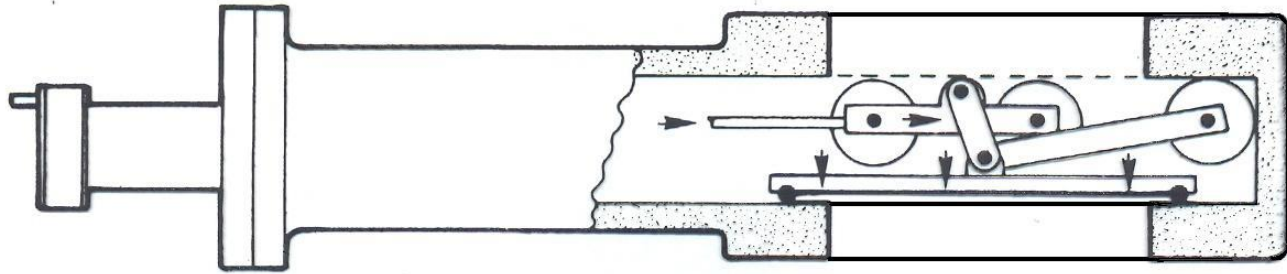




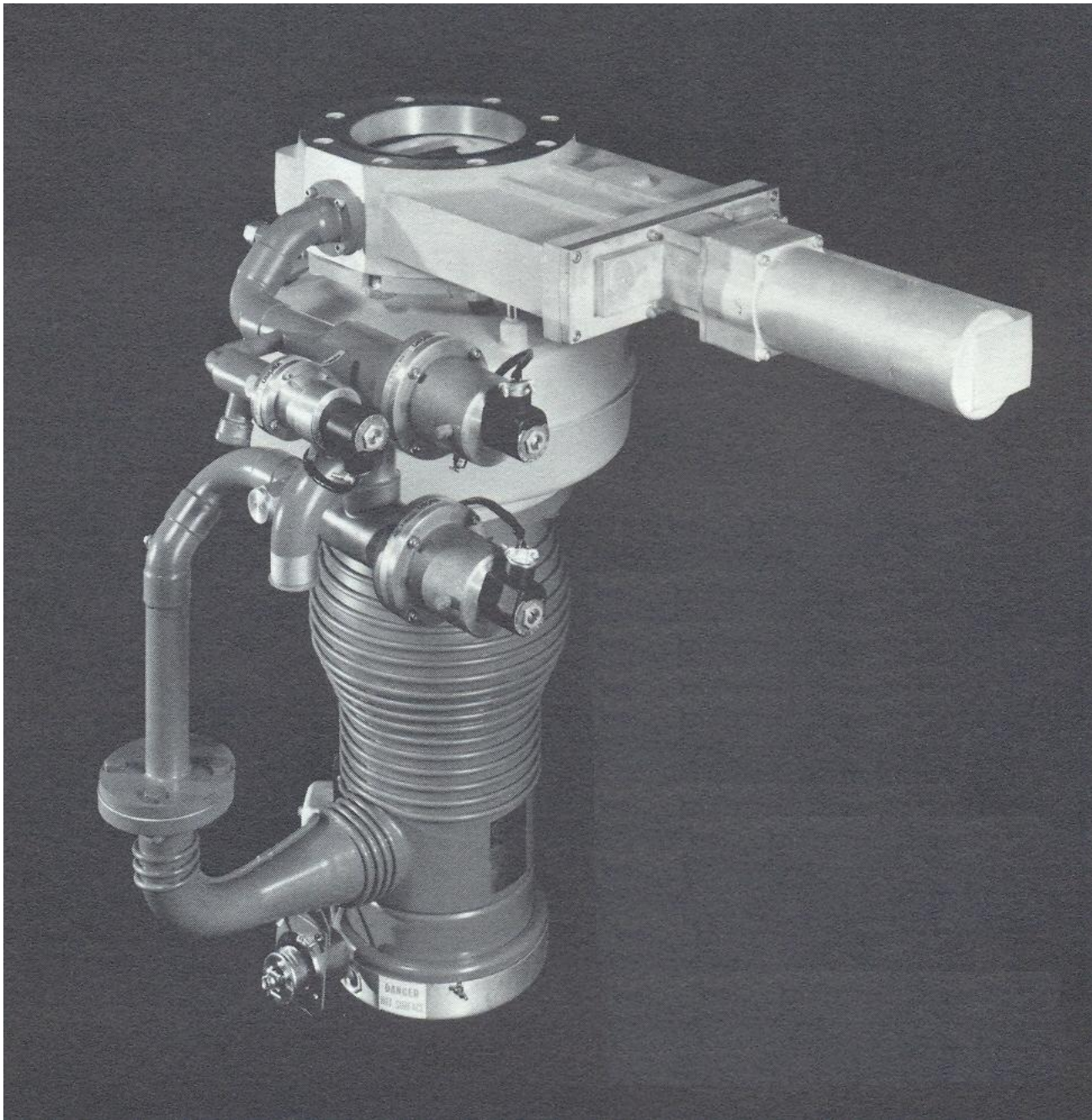
# VÁLVULA DISCO



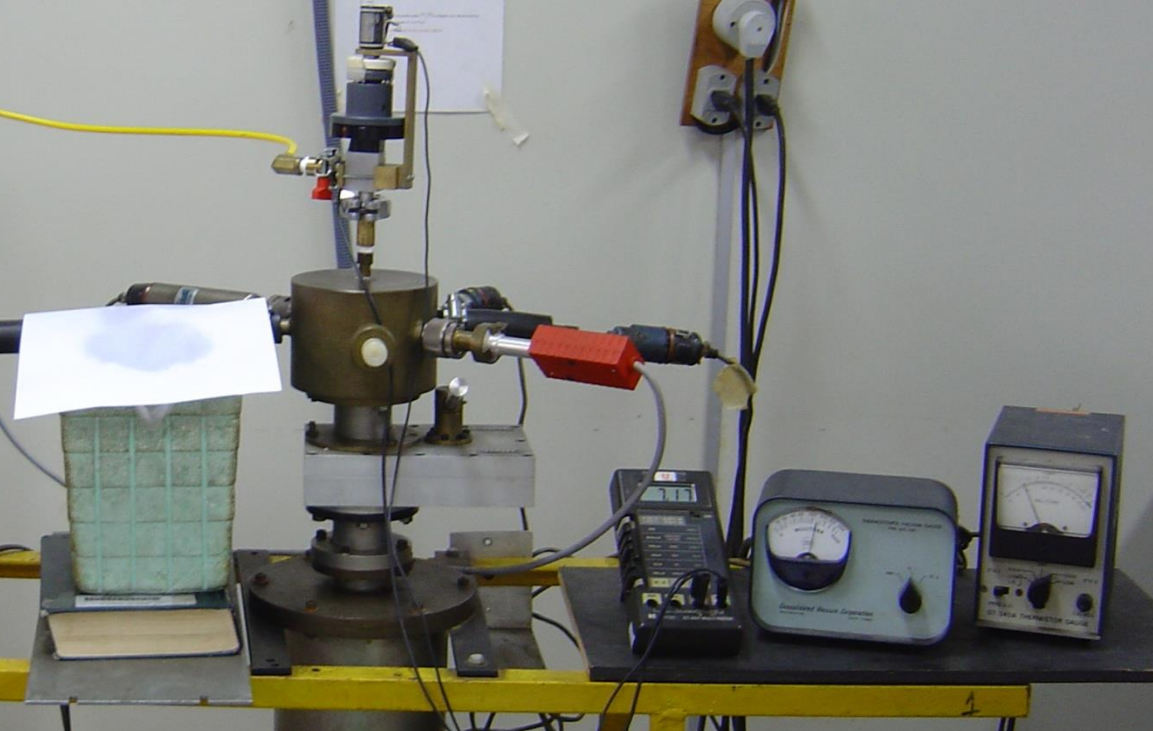
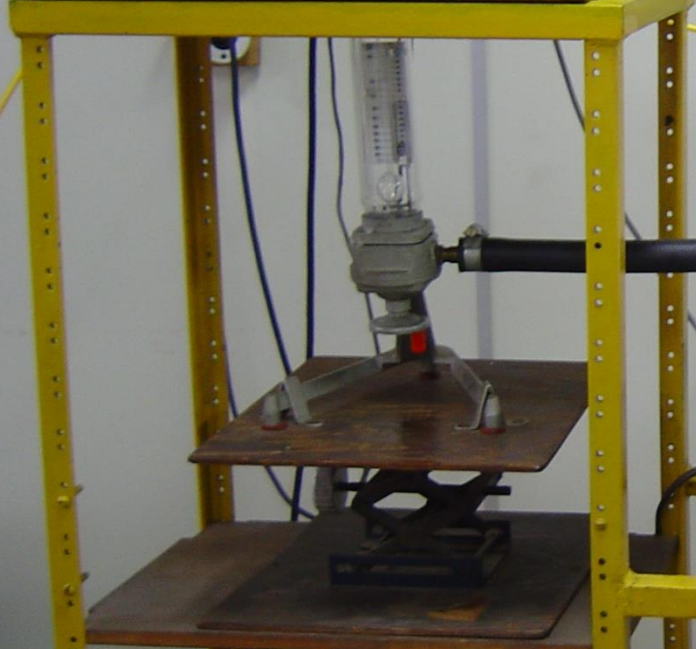
# VÁLVULA GAVETA



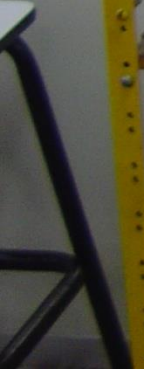




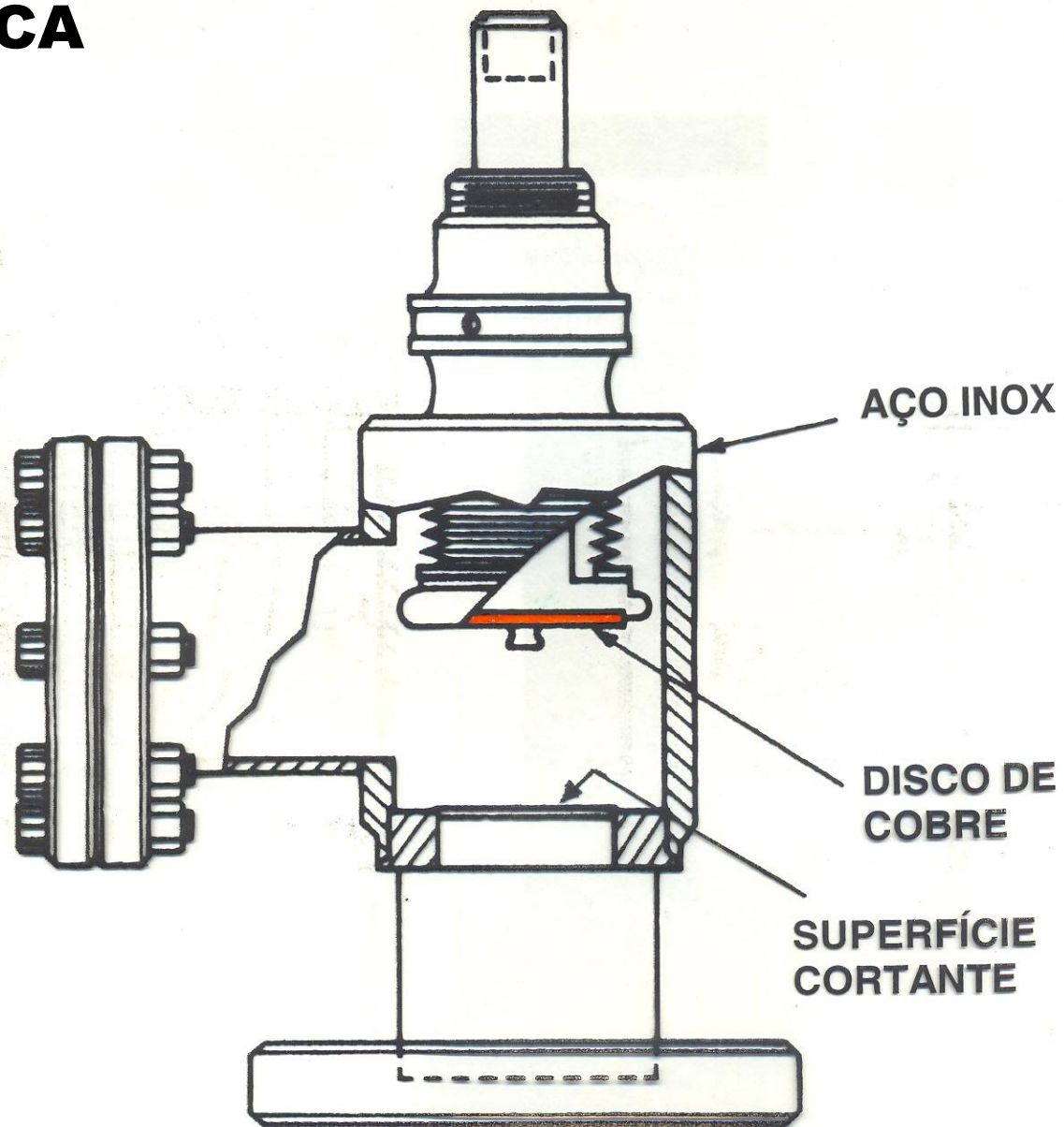
Escala Logarítmica



Diagrama

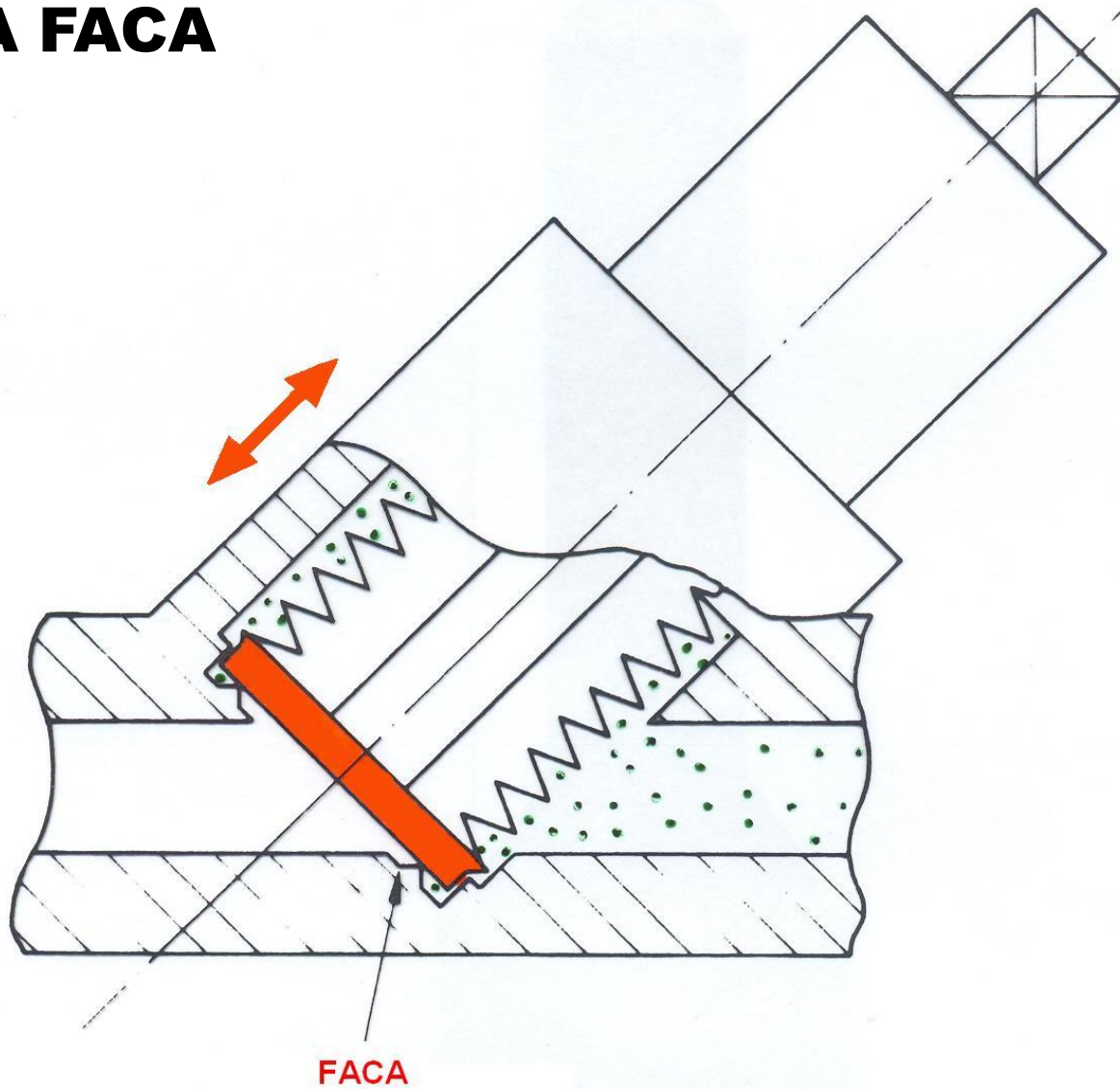


# VÁLVULA FACA



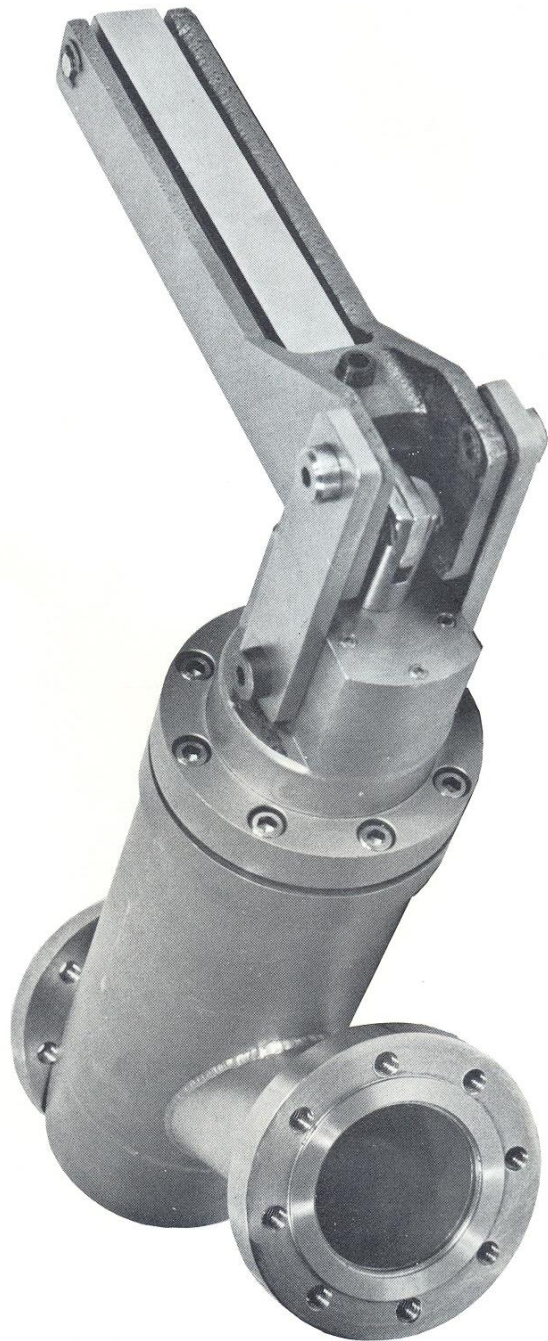


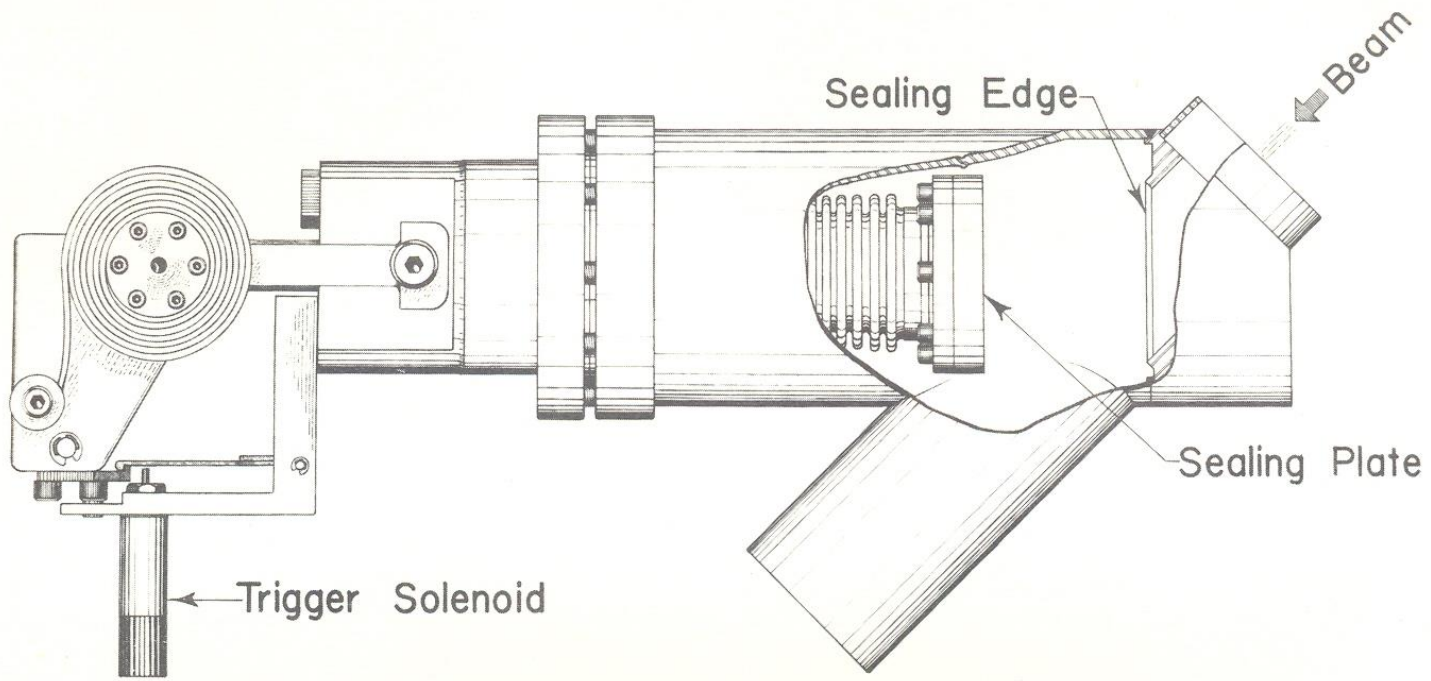
# VÁLVULA FACA

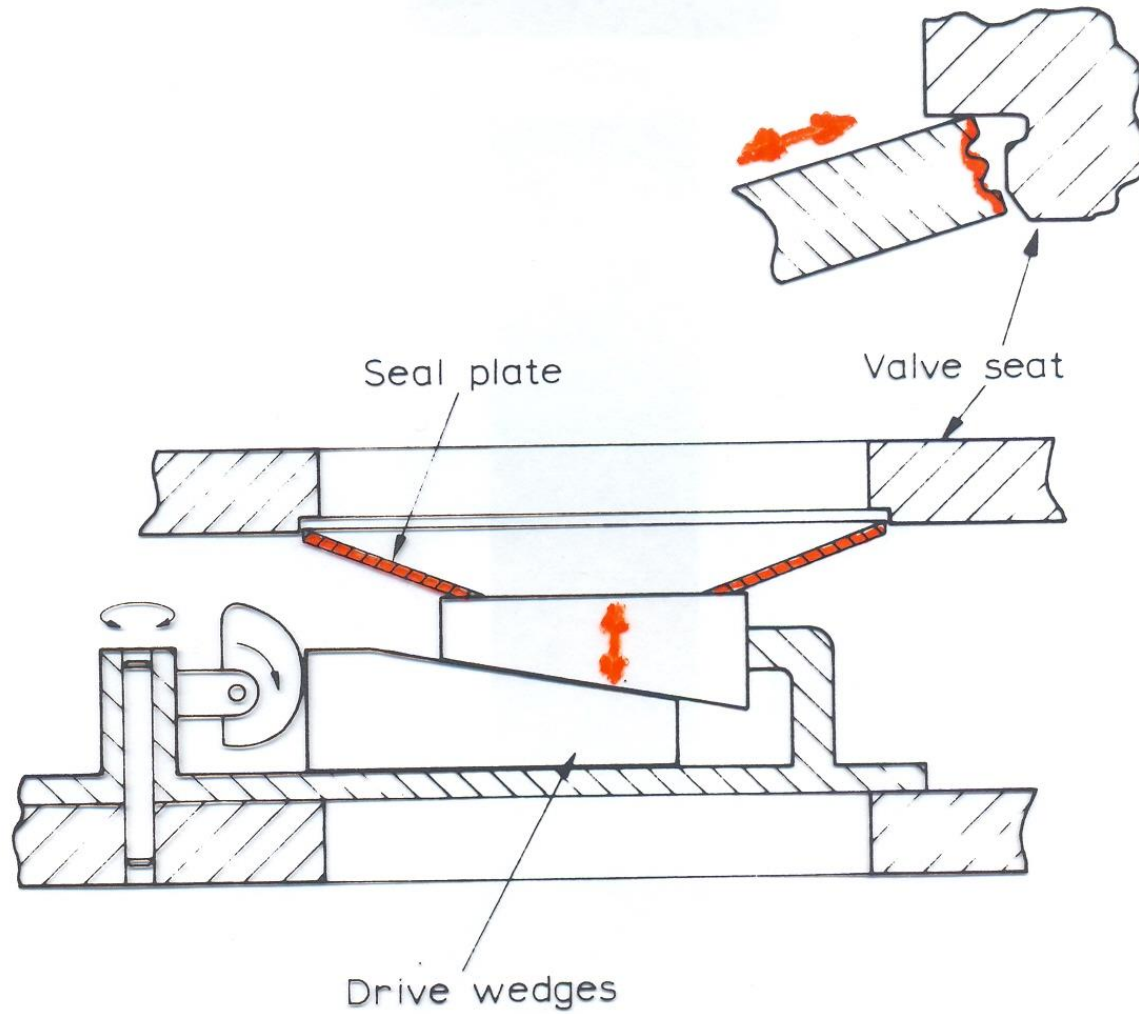




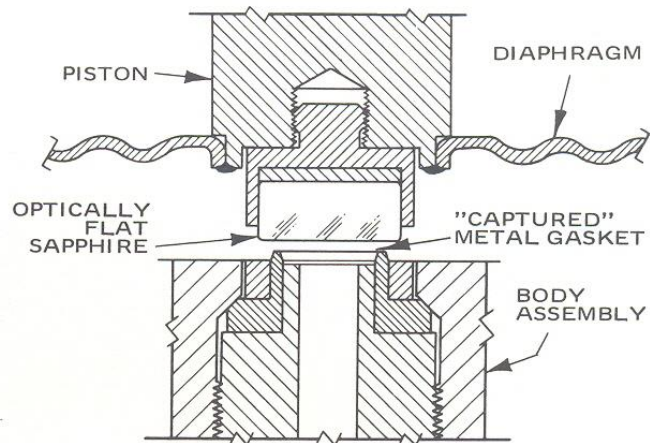
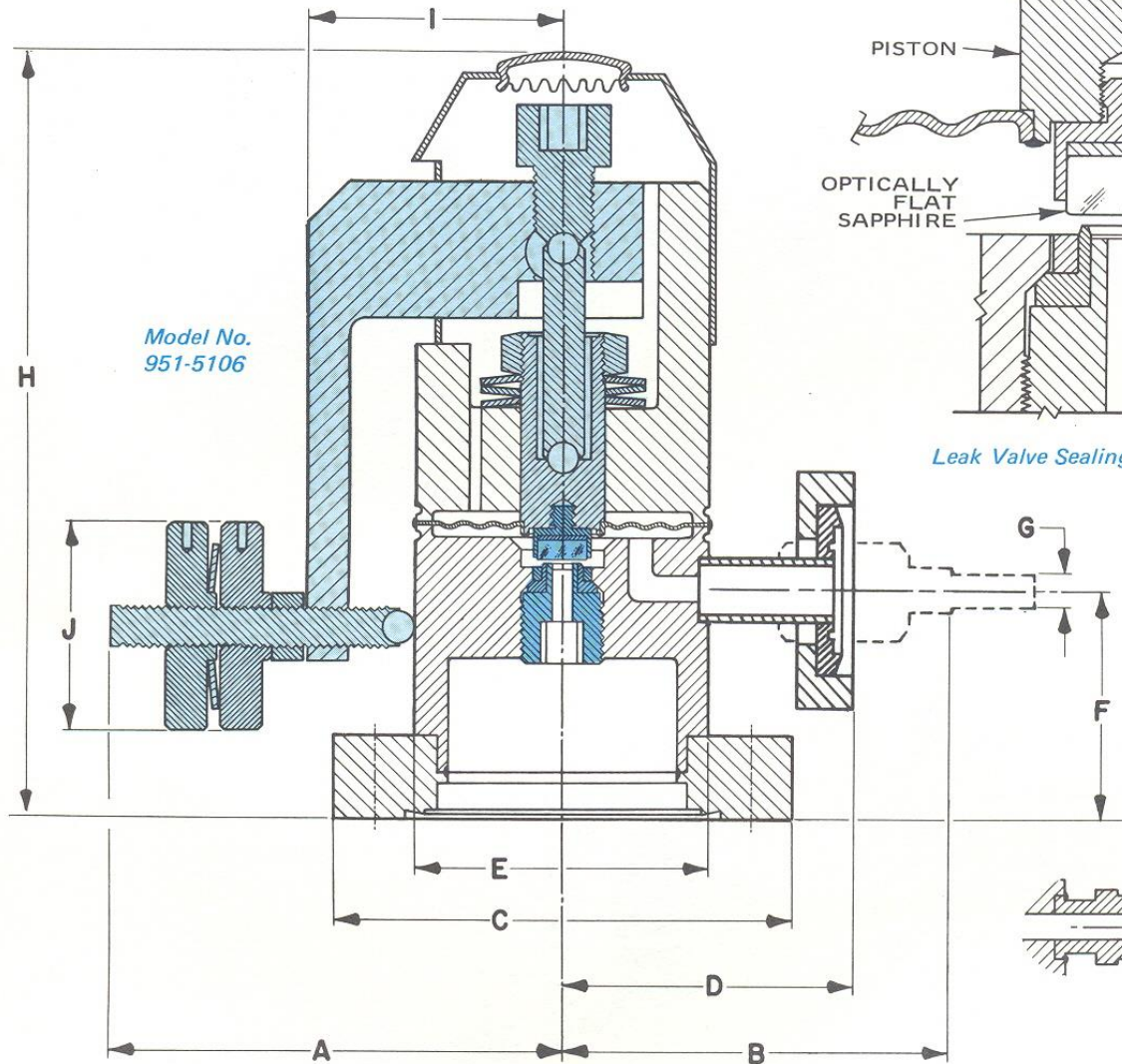






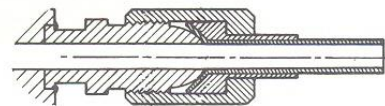


Gate valve design from Varian Associates



*Leak Valve Sealing Mechanism Detail*

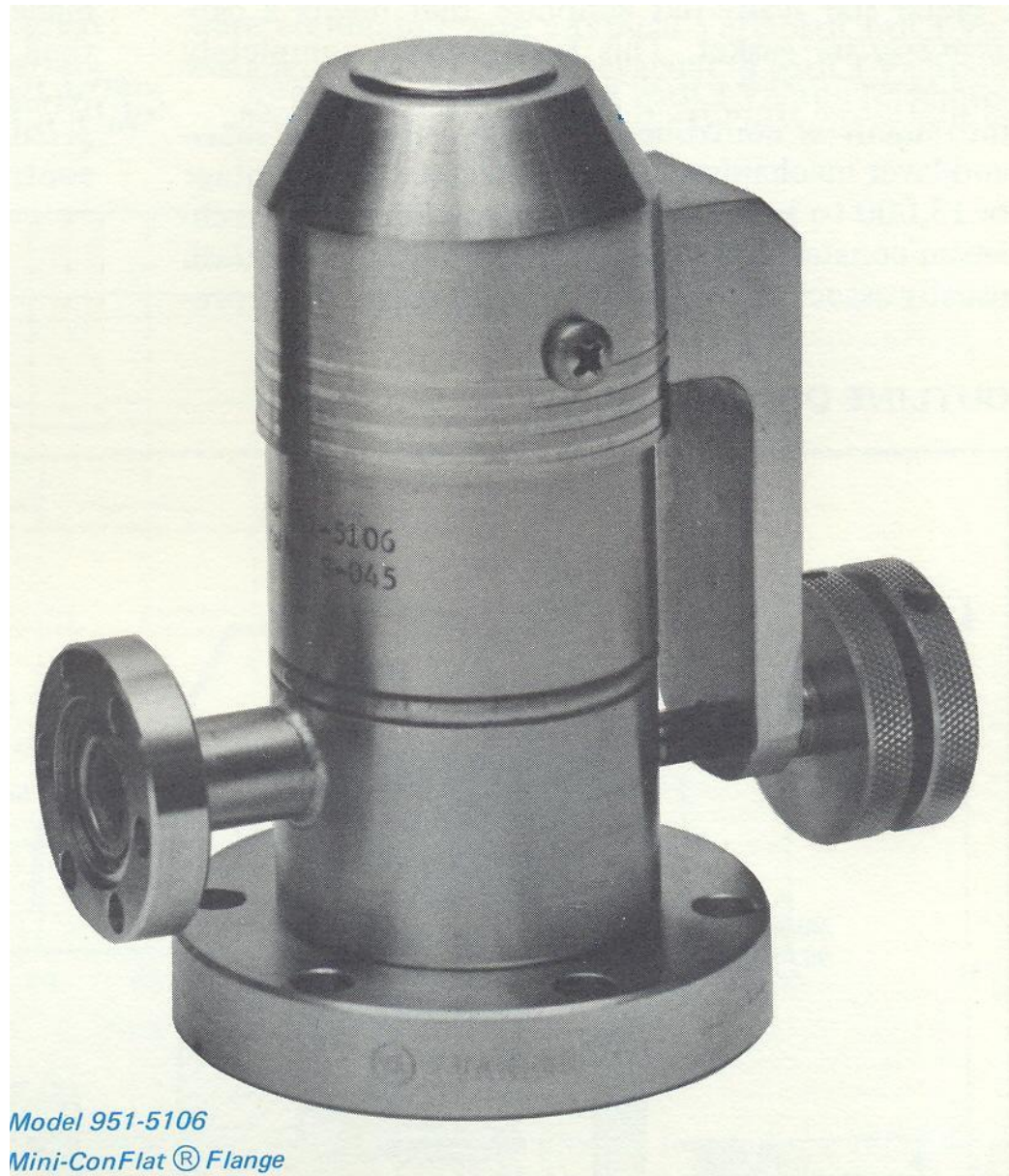
*1.33" O.D. Mini-ConFlat Flange or Flare Fitting For Gas Inlet Port*



*Gas Inlet Flare Fitting Detail For Model No. 951-5100*

 DRIVE MECHANISM

 SEALING COMPONENTS



*Model 951-5106  
Mini-ConFlat® Flange*

# **“BAFFLE” CHAPÉU MEXICANO**



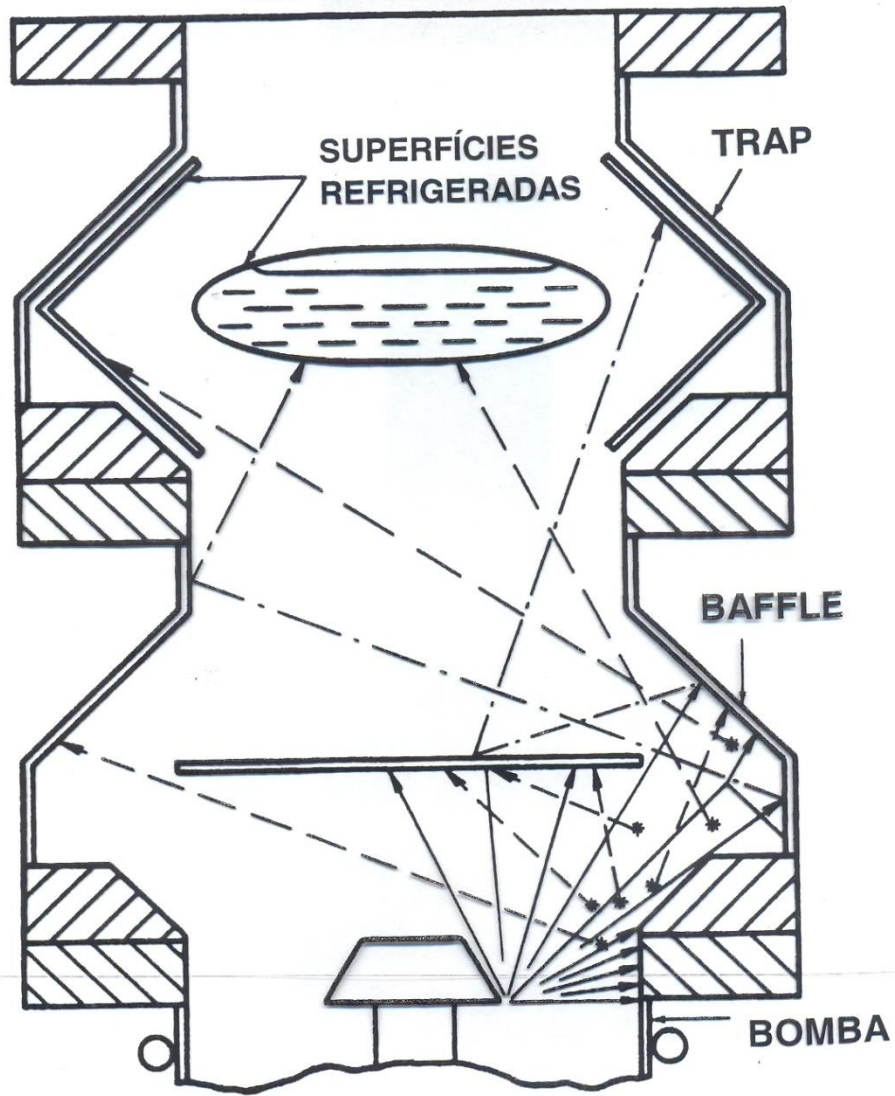


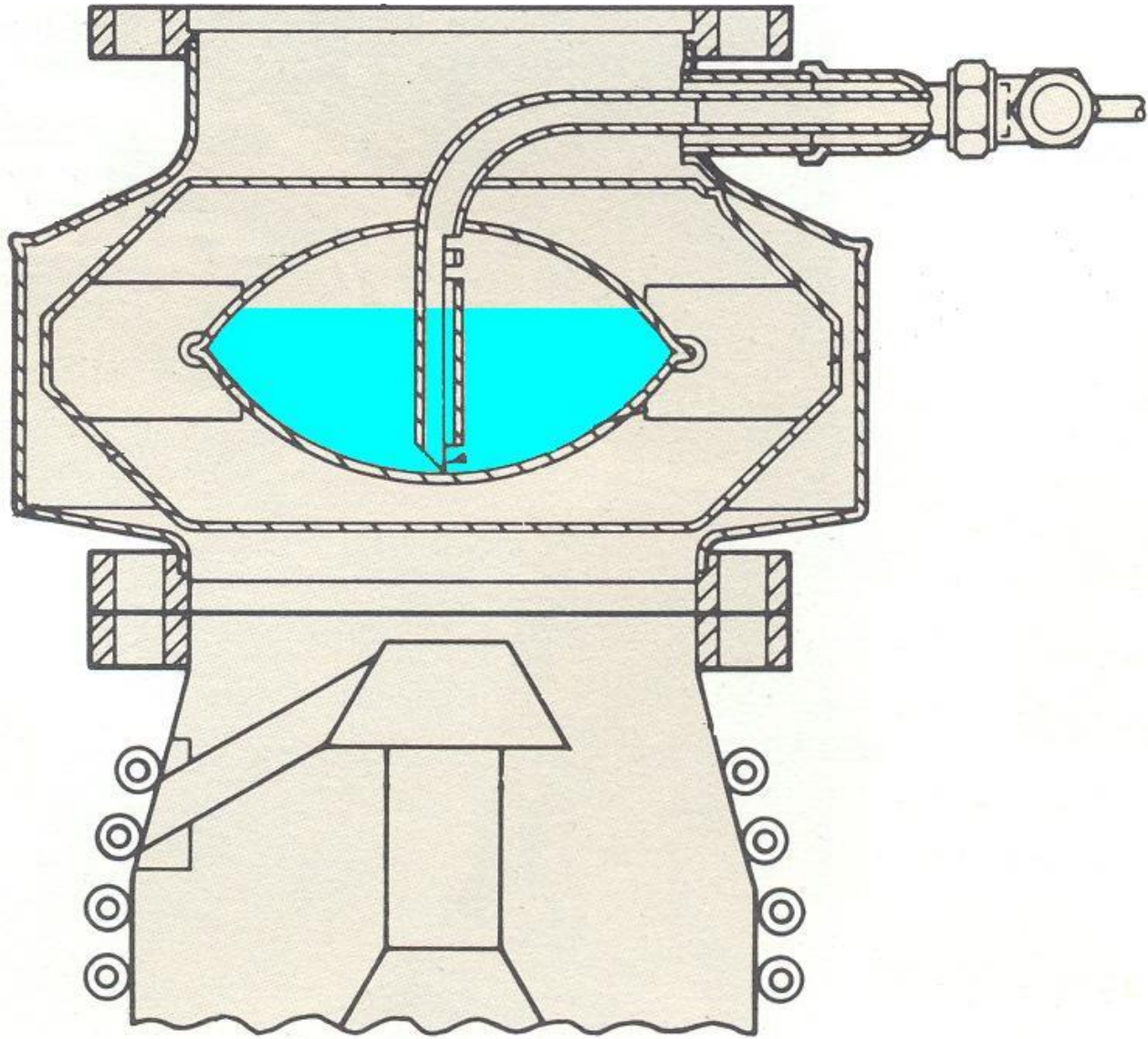
**332 Low-Profile  
Water-Cooled Baffle  
300 ℓ/s Conductance**

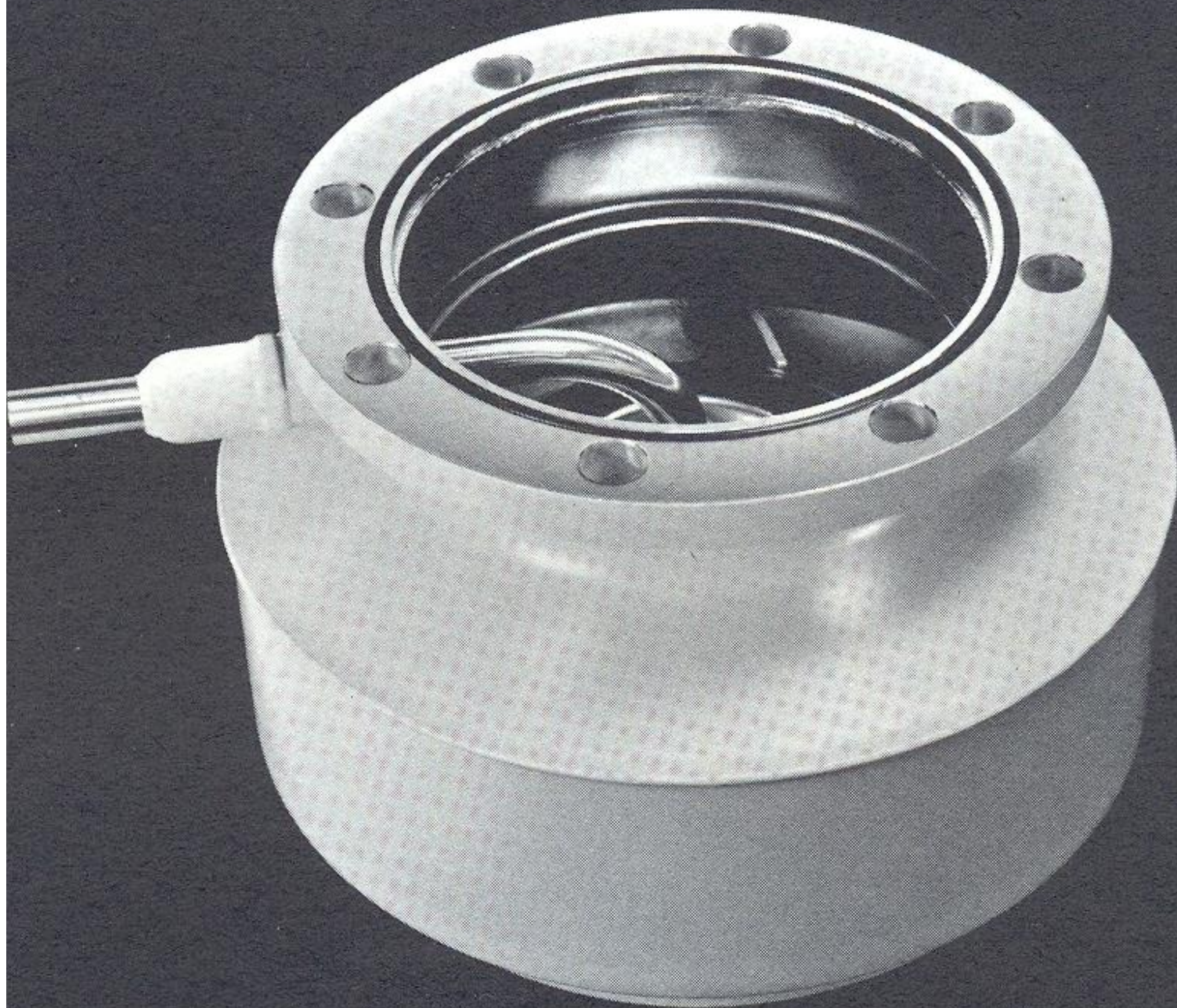




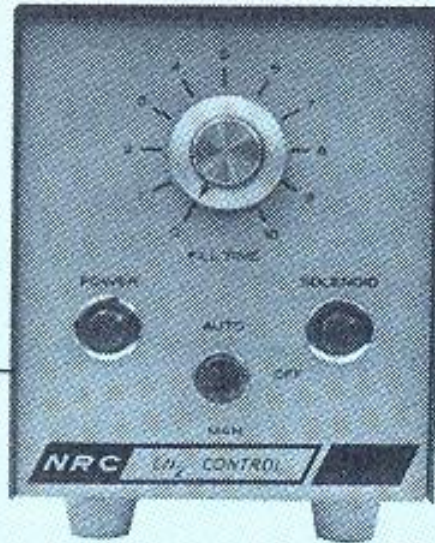
- Retrofluxo primário devido à expansão do jato
- - - - - Retrofluxo adicional devido a colisões
- · - · - Migração causada pela agitação térmica
- \* \* Colisões entre moléculas





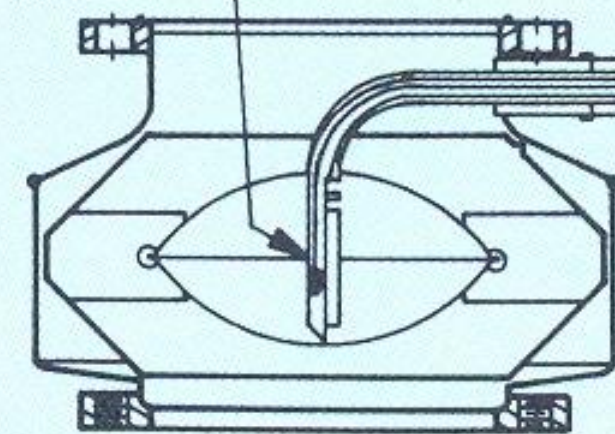


CONTROL



115 VAC

SENSOR



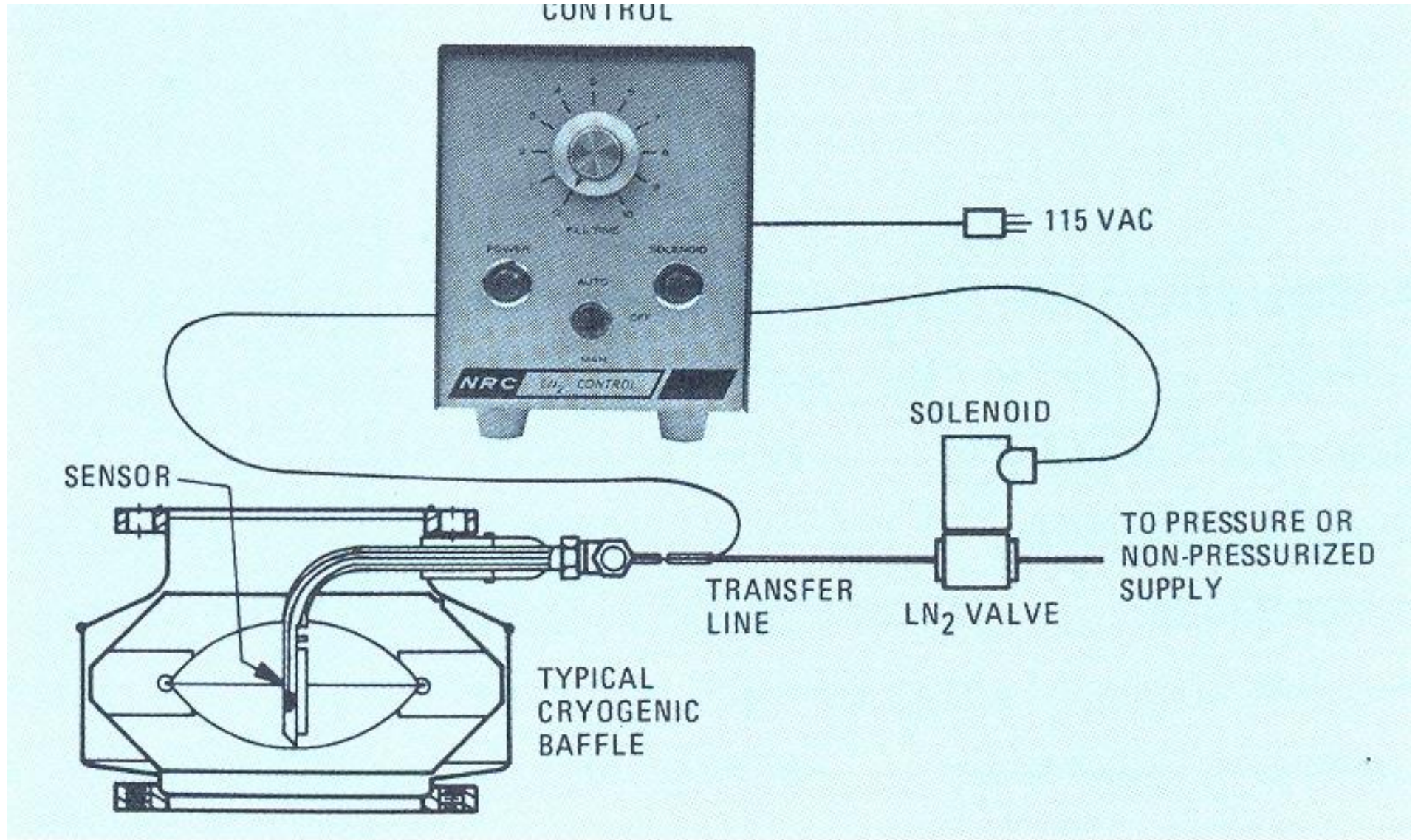
TYPICAL  
CRYOGENIC  
BAFFLE

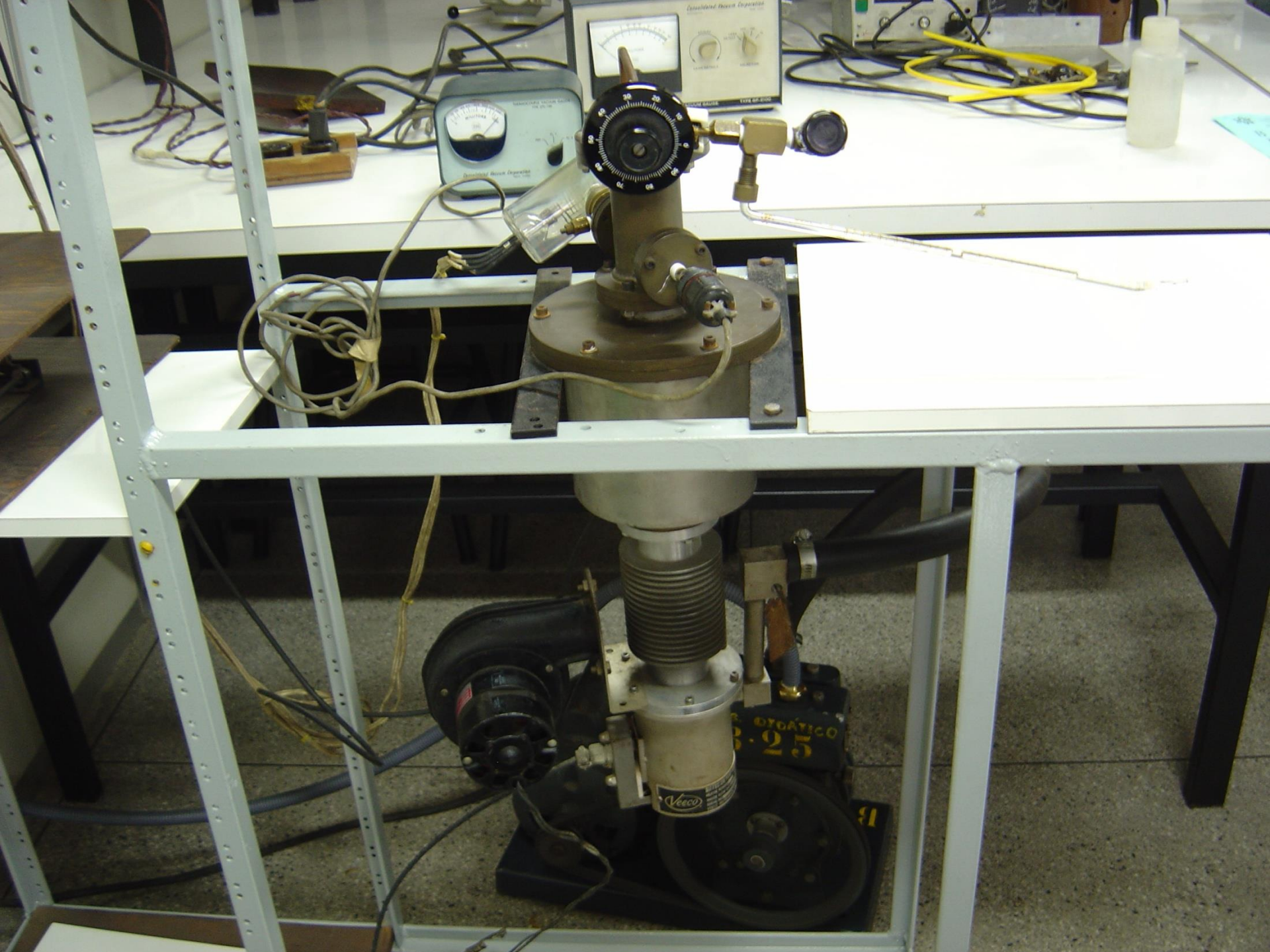
TRANSFER  
LINE

SOLENOID

LN<sub>2</sub> VALVE

TO PRESSURE OR  
NON-PRESSURIZED  
SUPPLY



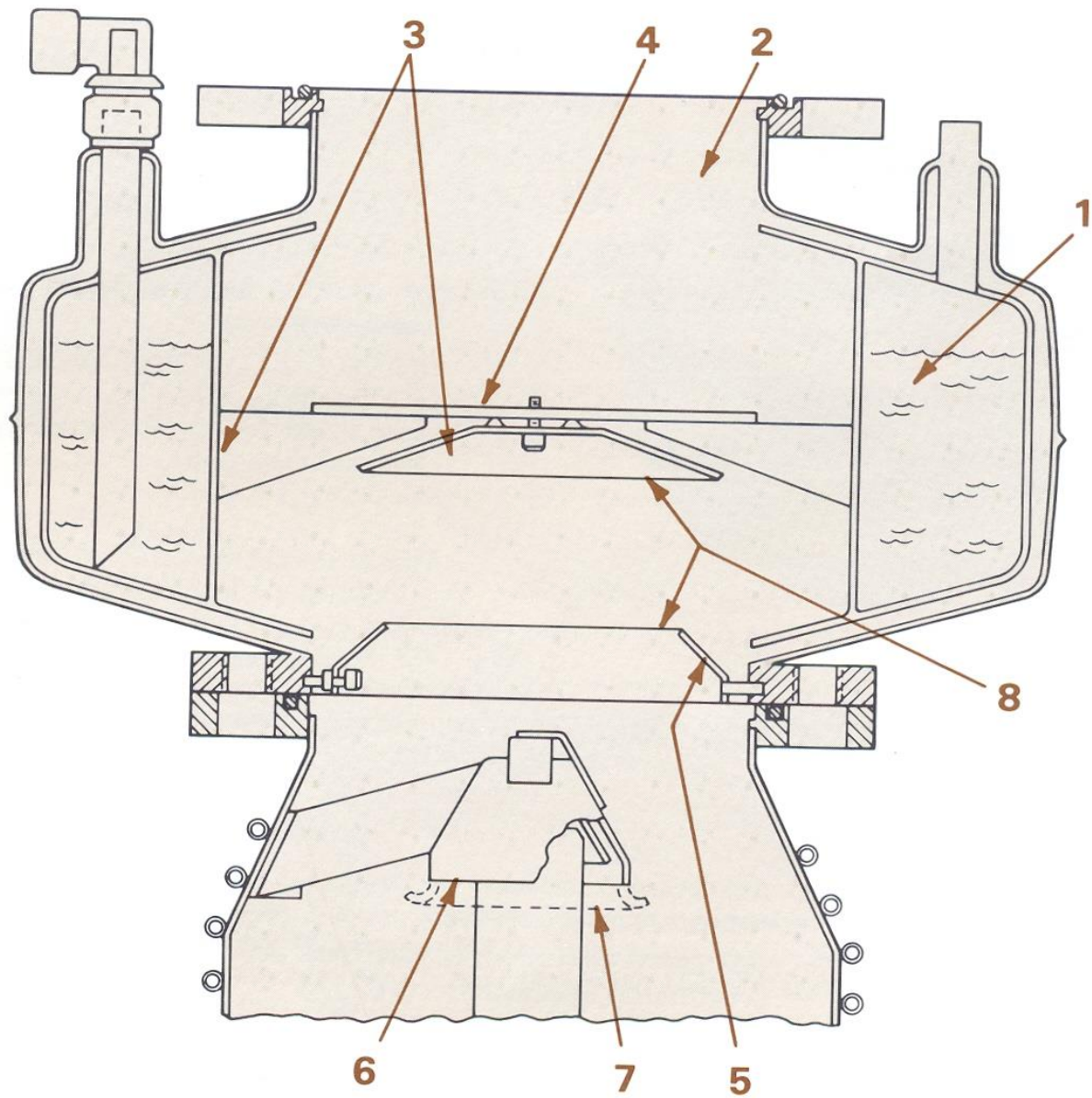


Controlled Reaction Apparatus  
PRESSURE GAUGE TYPE GP-2100

MANUFACTURED BY VEECO  
CONTROLLED REACTION APPARATUS

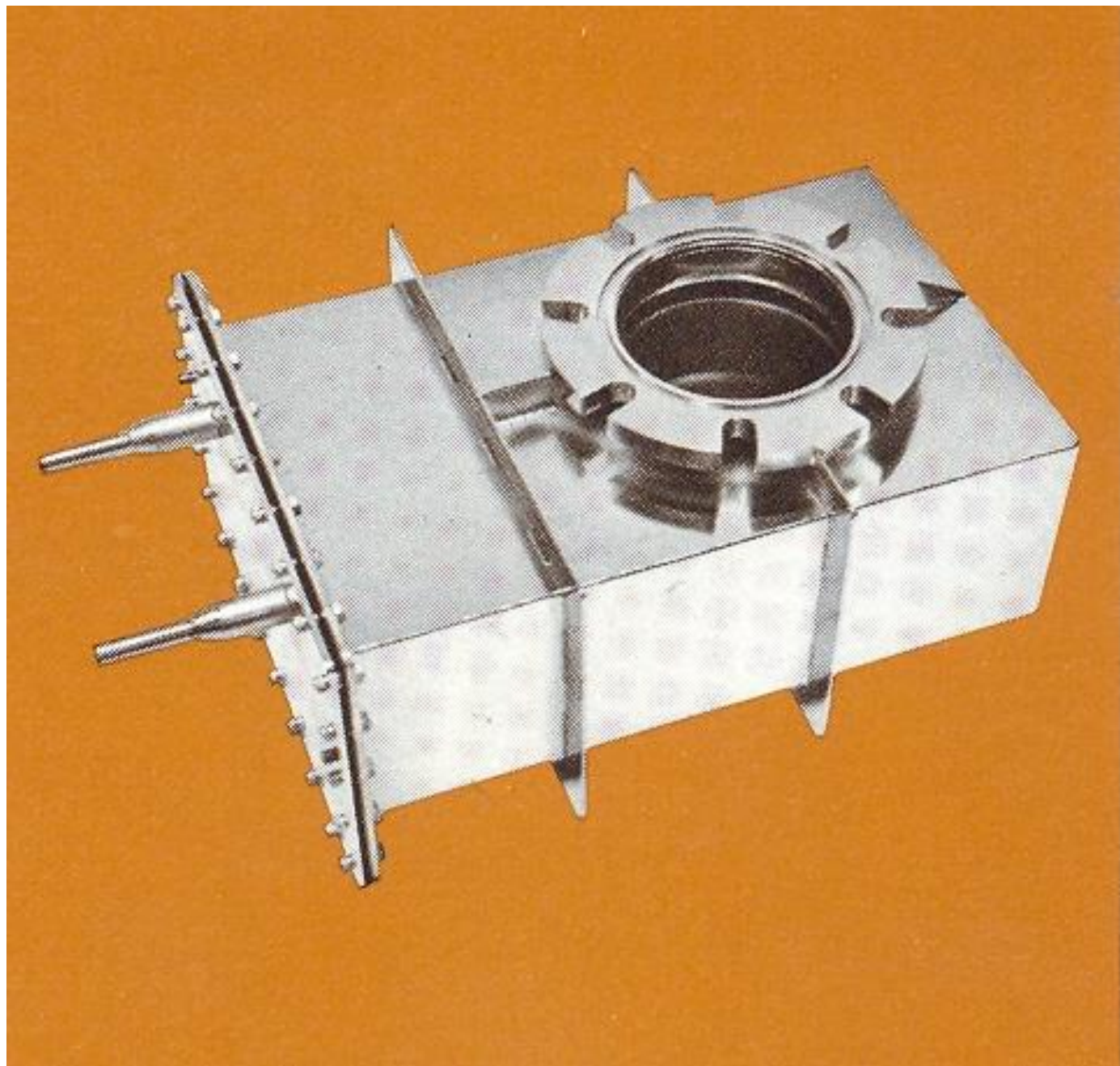
Veeco

ORGANICO  
3.25





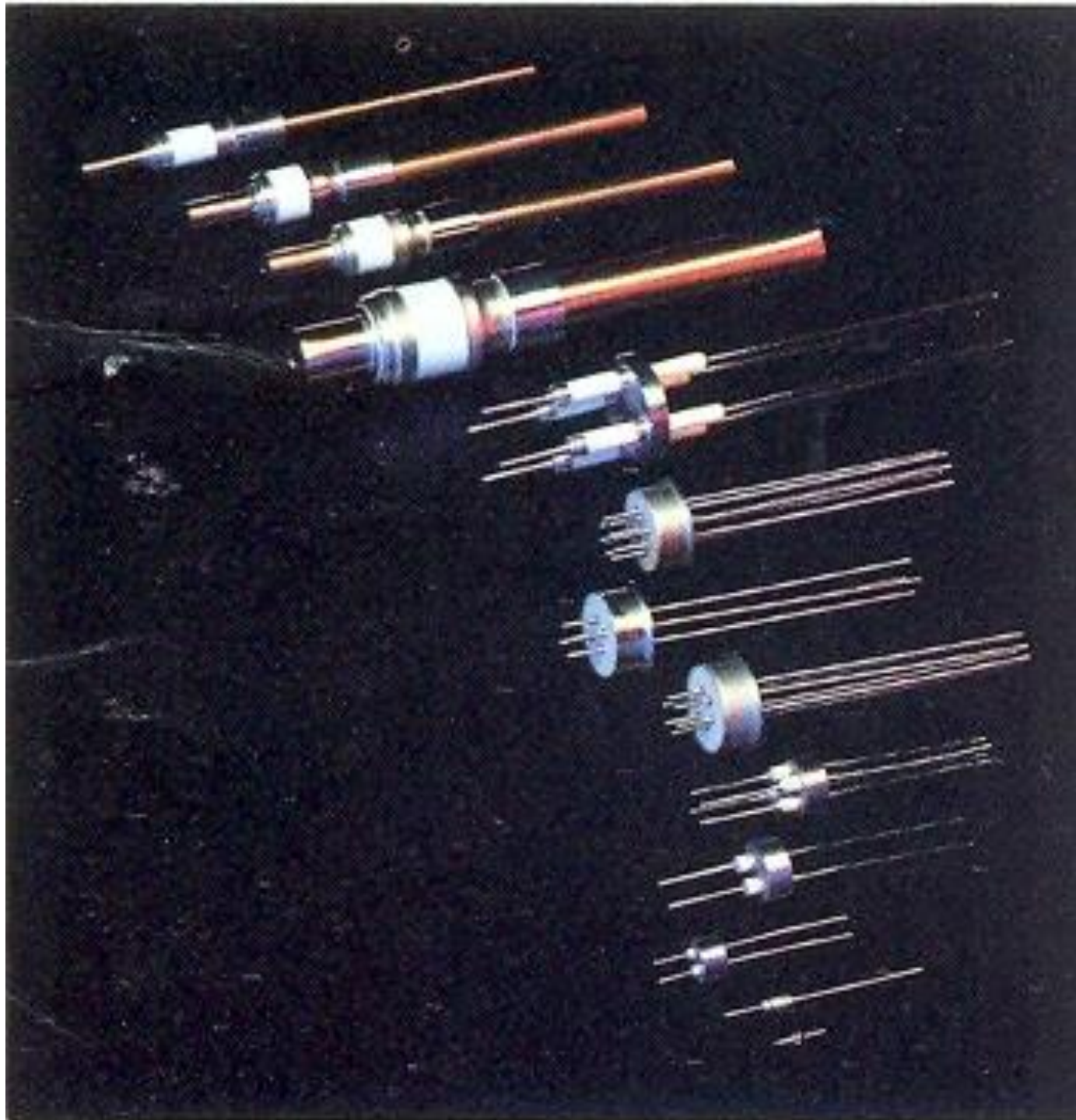


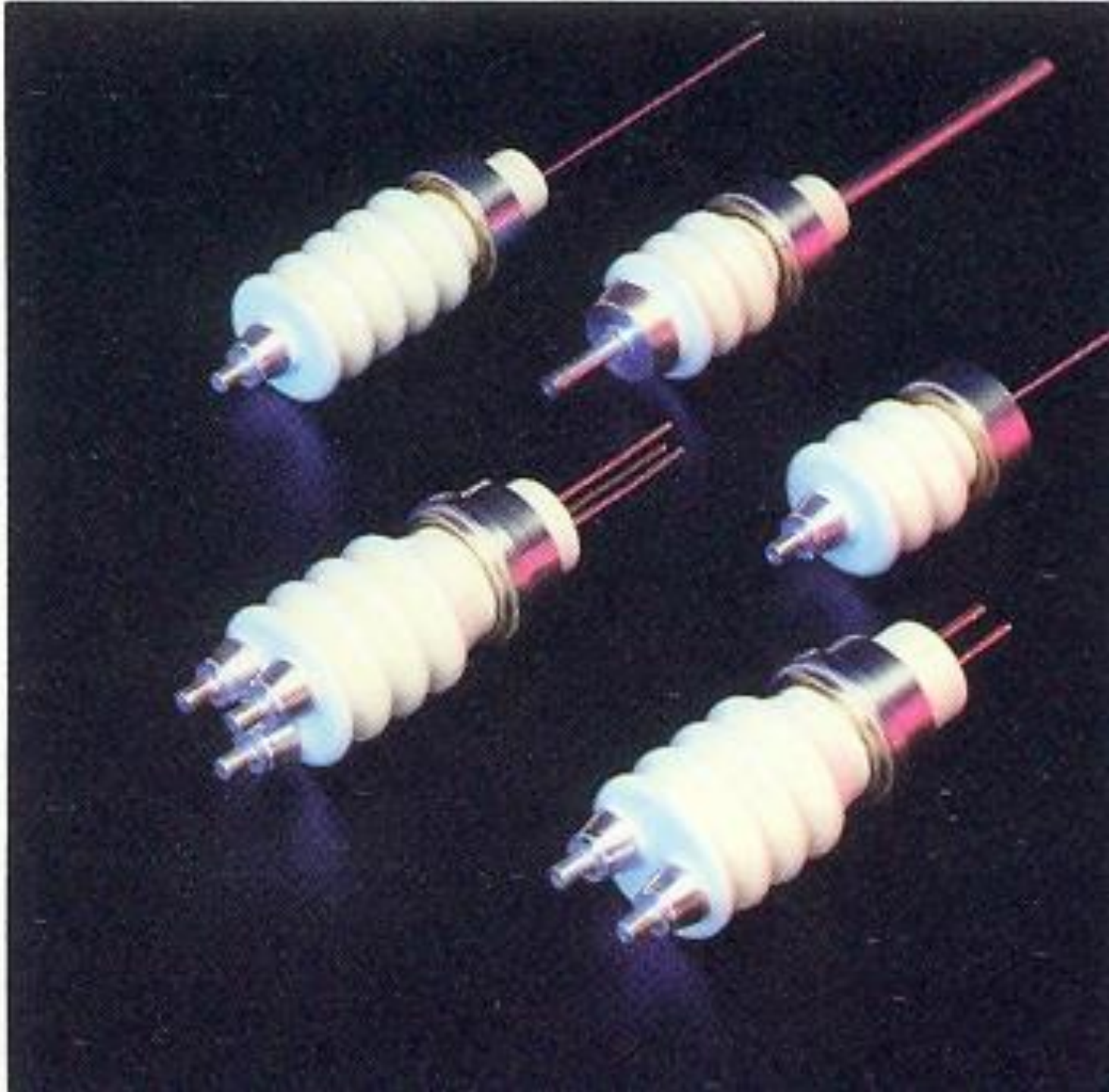




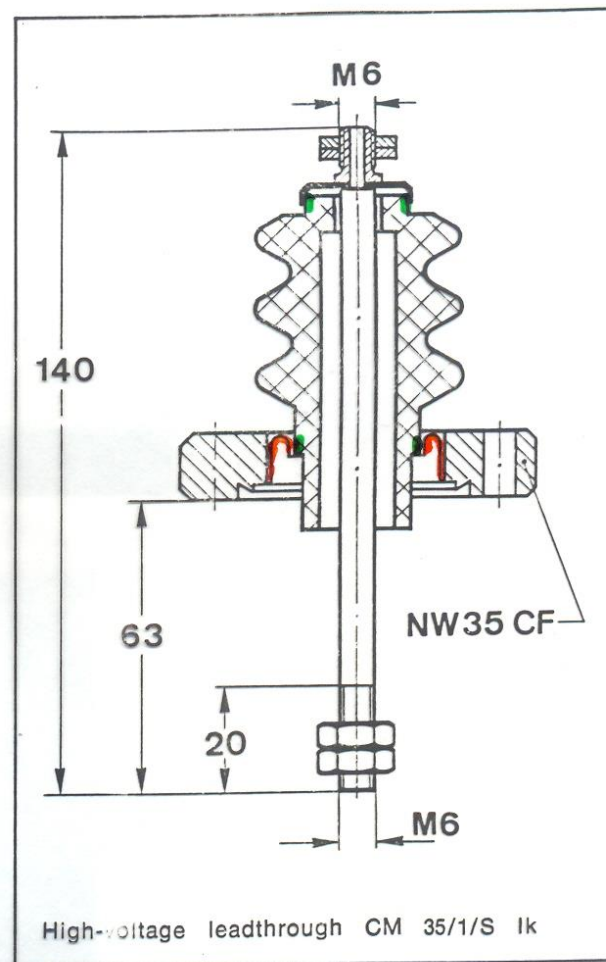
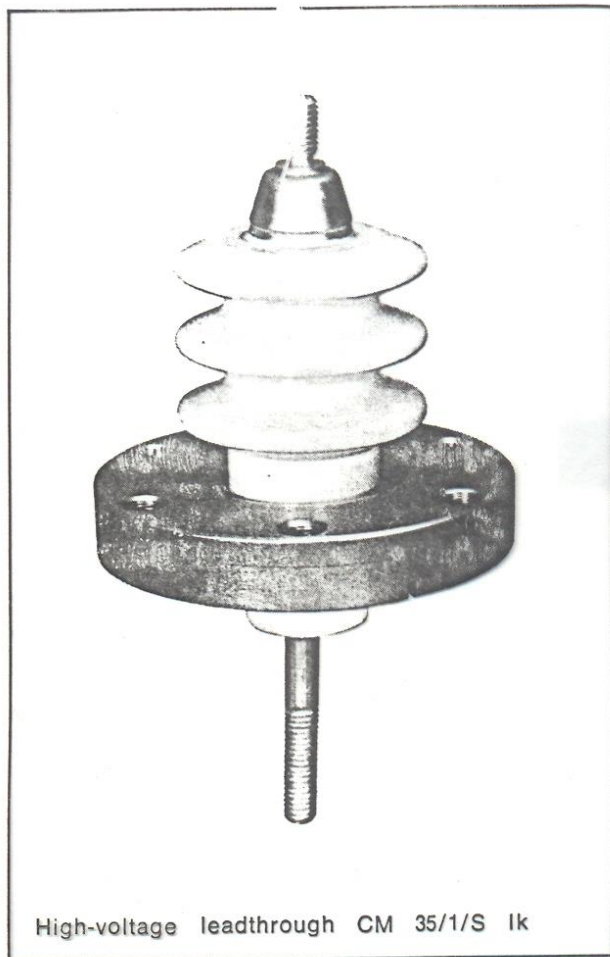


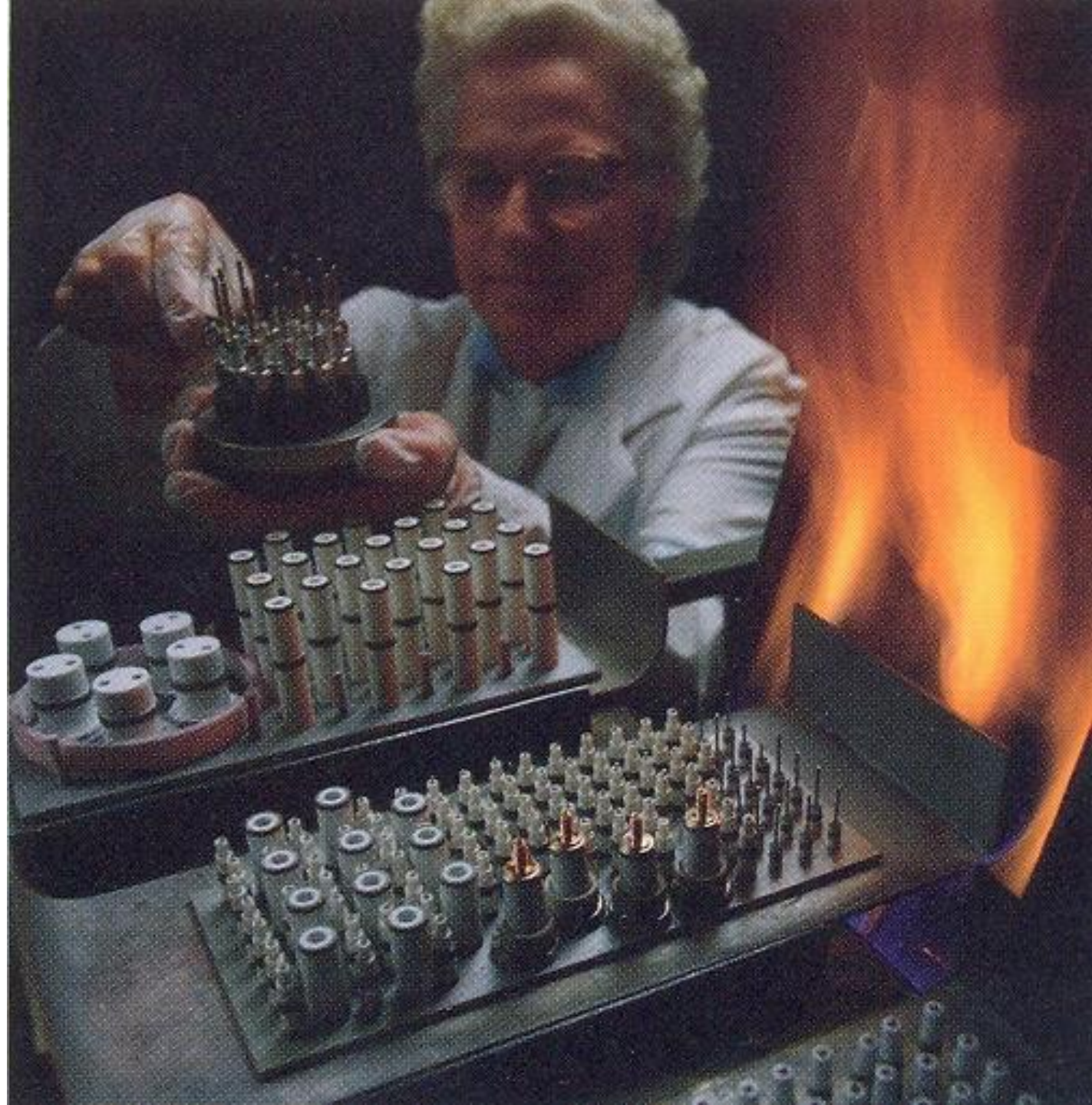




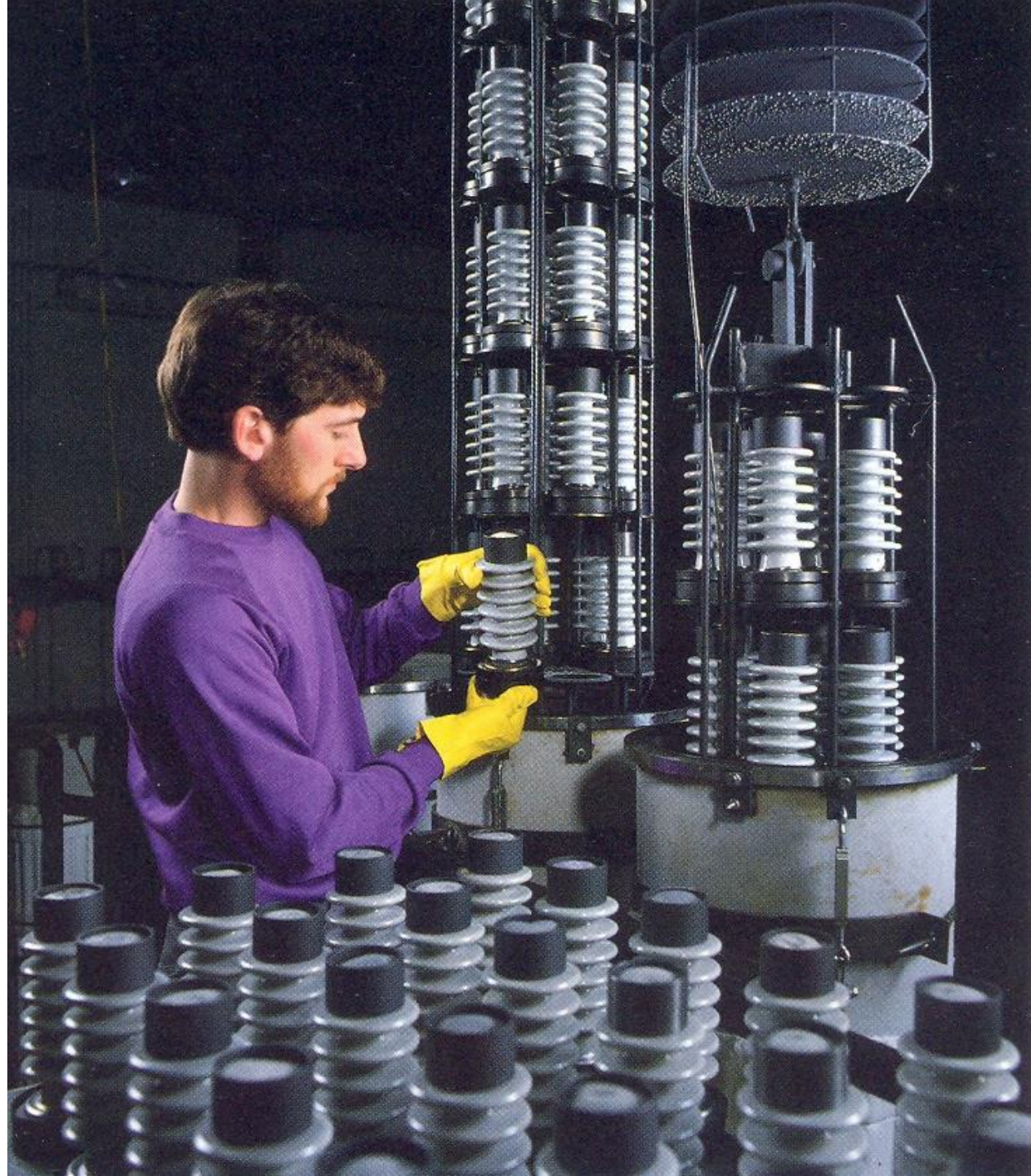


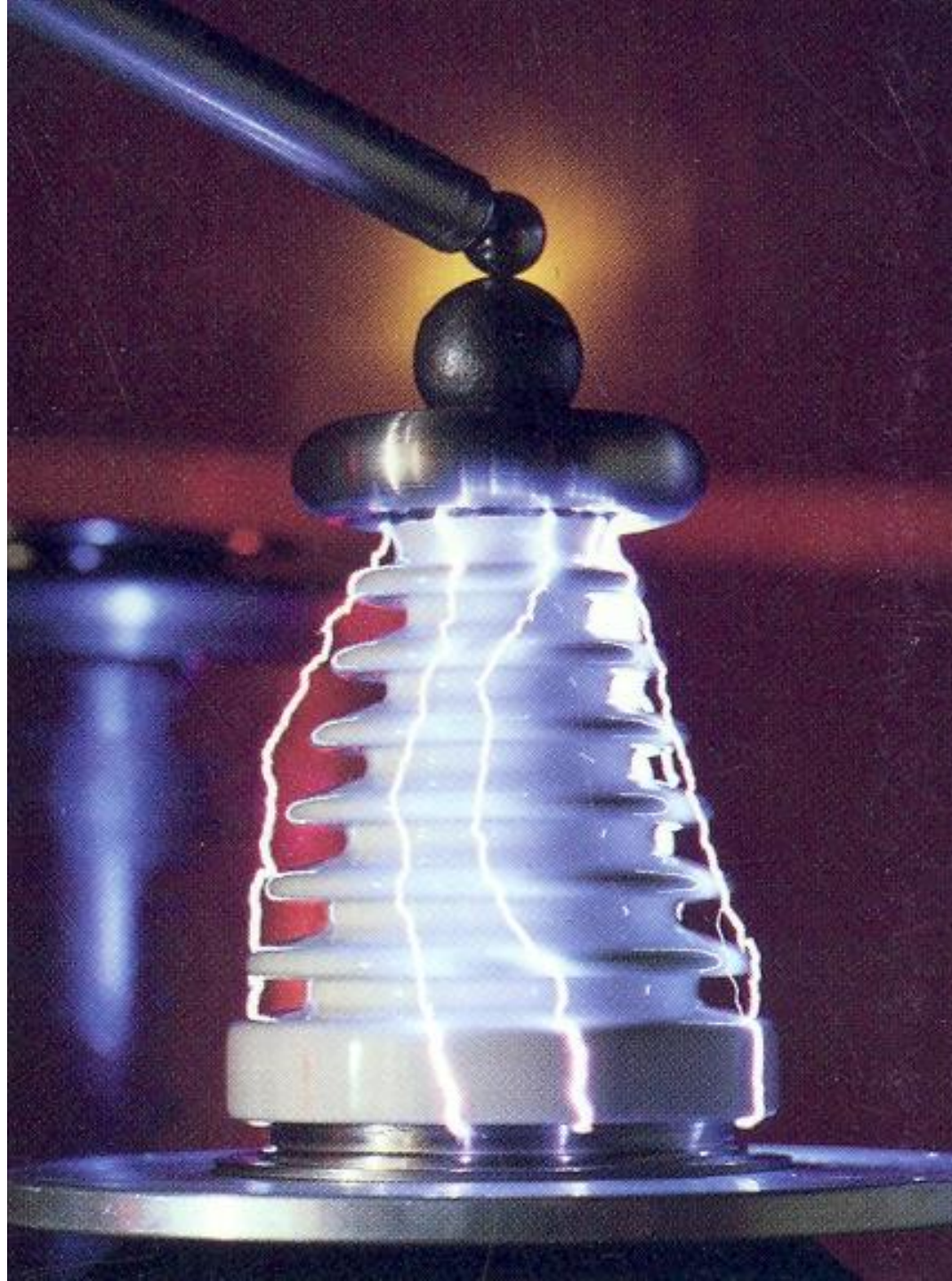
# PASSADOR DE ALTA TENSÃO











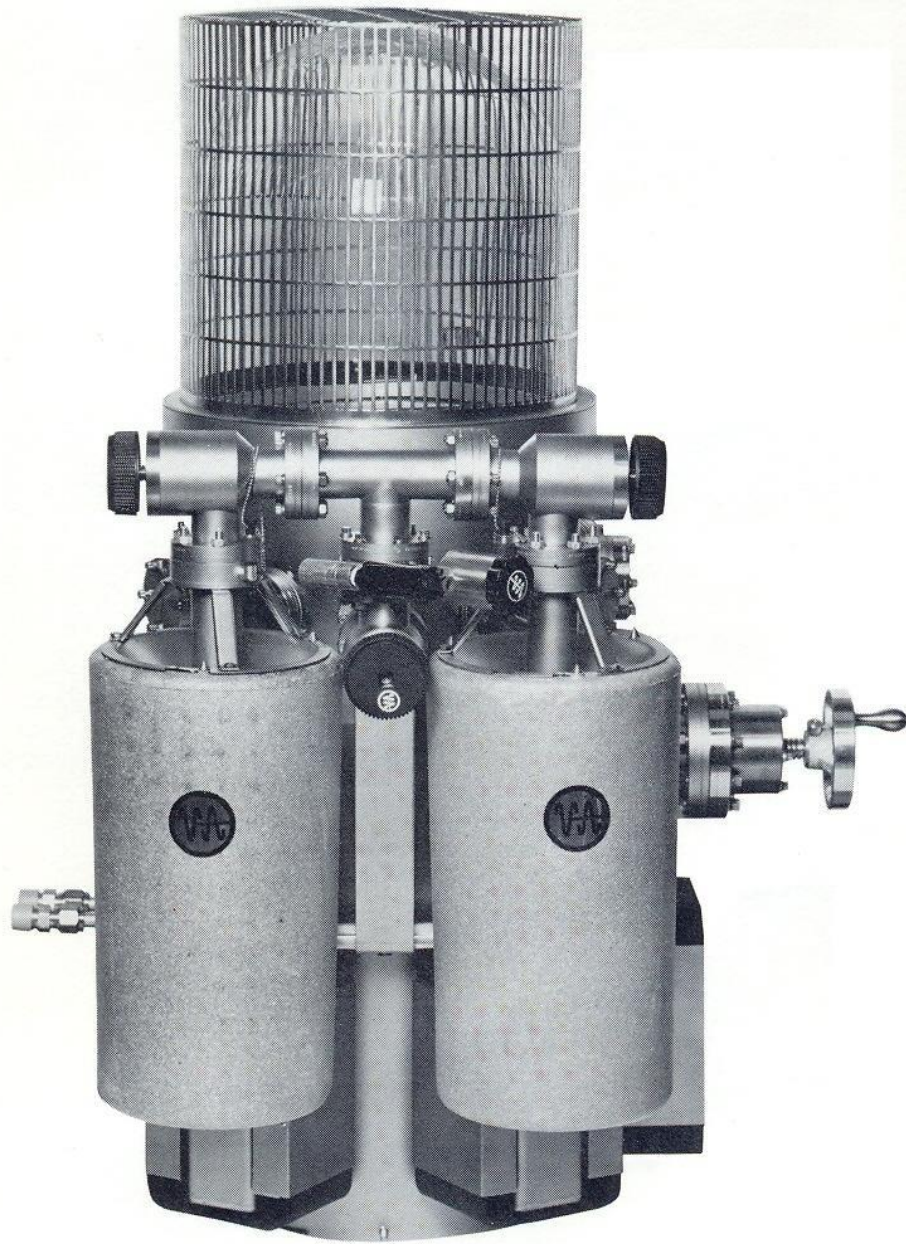


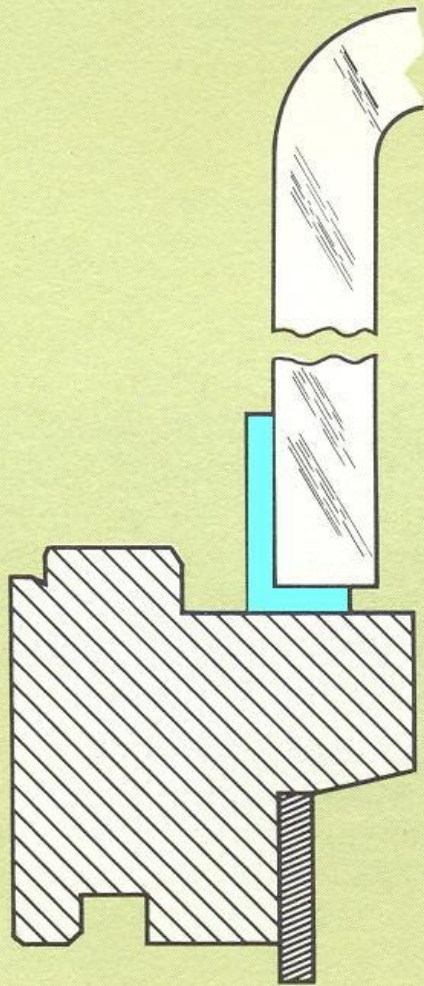
# **PASSADOR DE FLUIDO MAGNÉTICO**



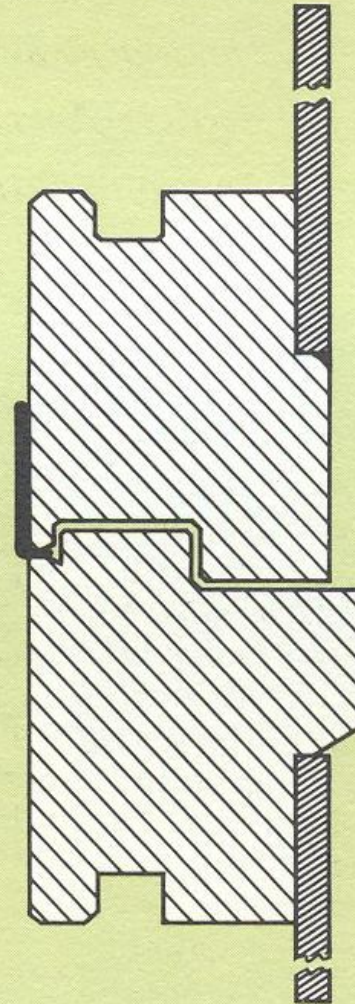
# VISORES (VIDRO RECOZIDO)







Male Flange with Glass Bell Jar



Flanges Sealed with Viton Gasket









