

**4º CURSO DE TECNOLOGIA DO VÁCUO
PARA INDÚSTRIA E LABORATÓRIOS**

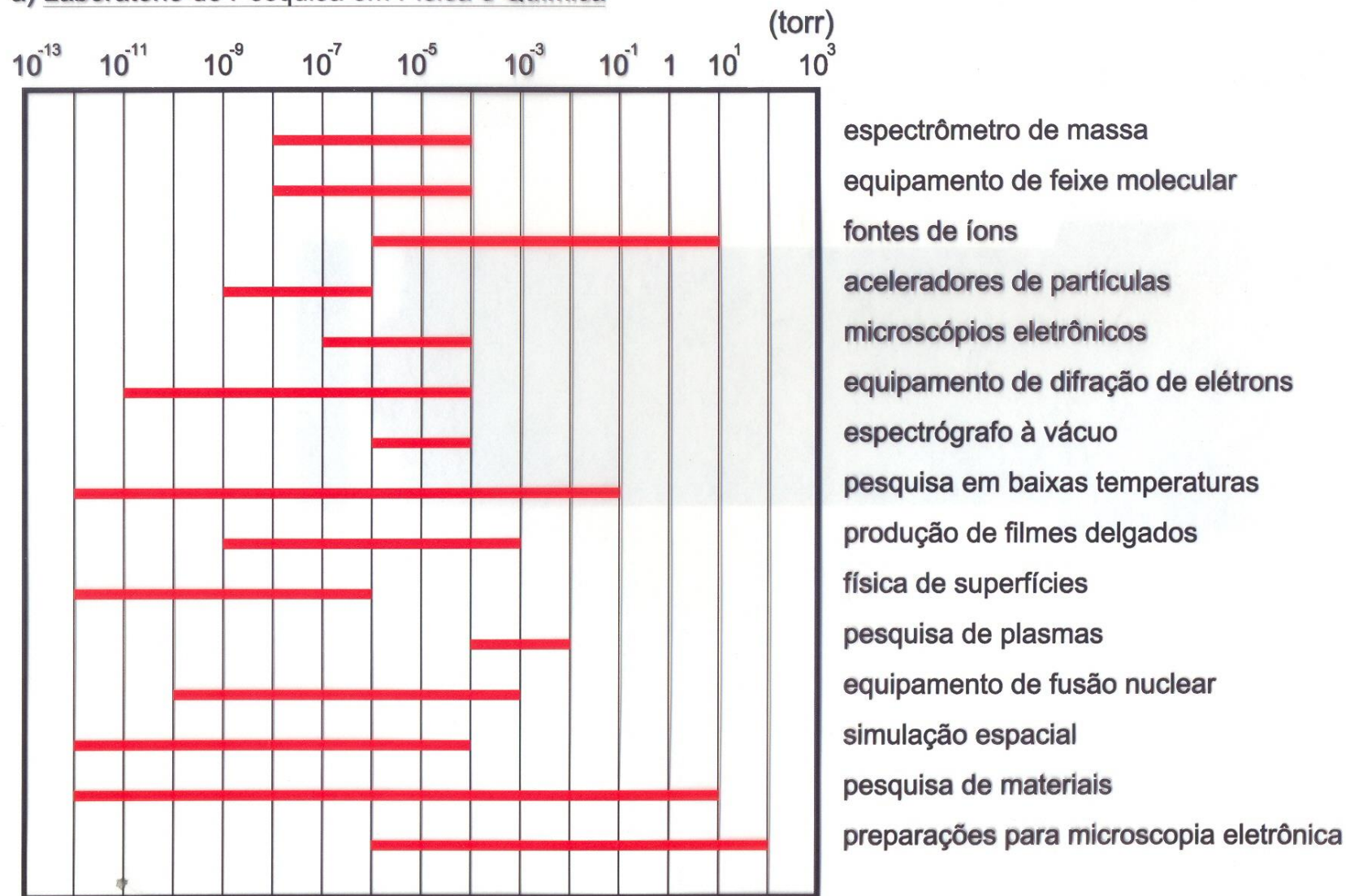
BOMBAS DE VÁCUO - 1

30 - agosto - 2016

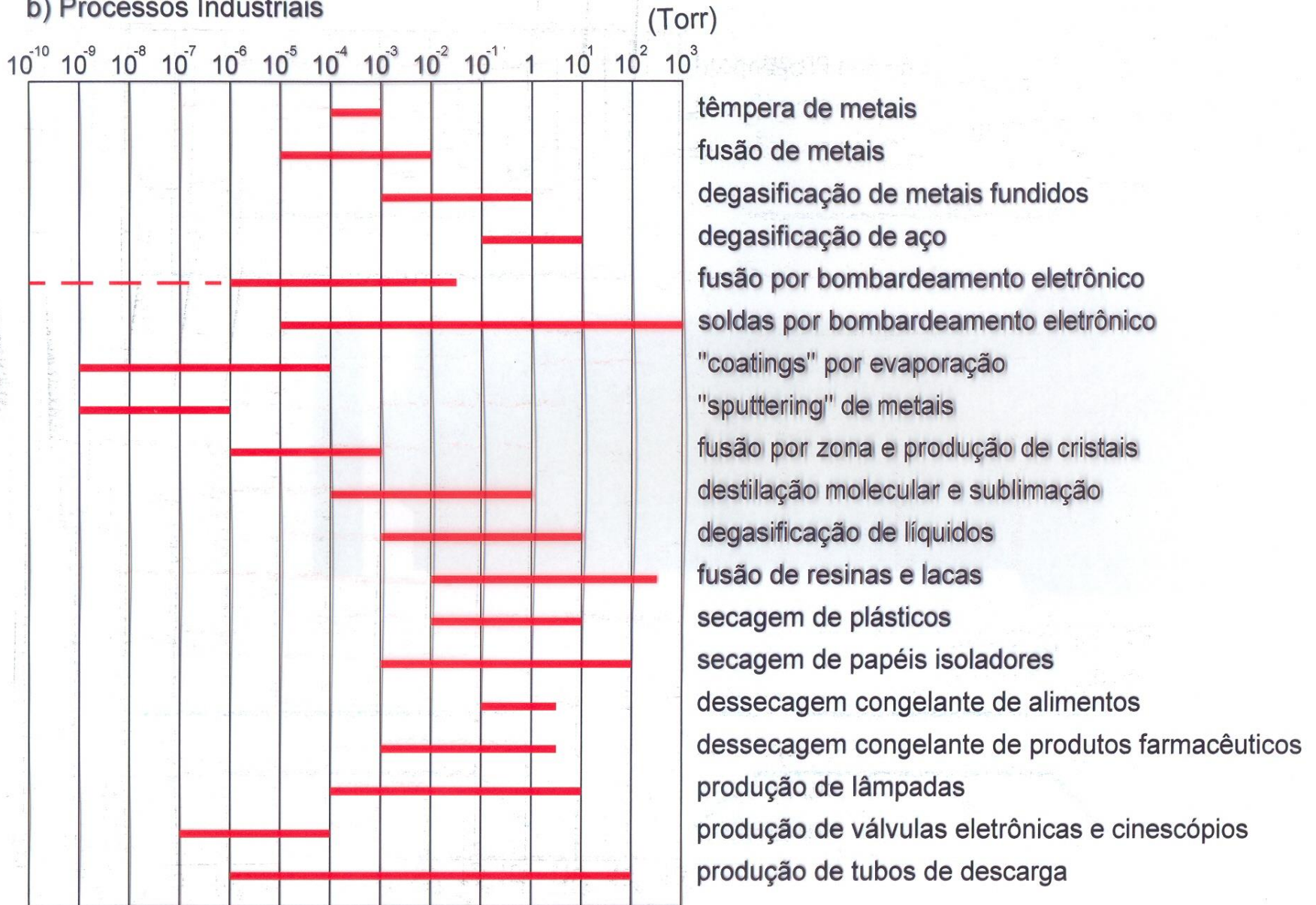
UNIVERSIDADE DE SÃO PAULO - INSTITUTO DE FÍSICA

ALGUMAS APLICAÇÕES DO VÁCUO E SUAS FAIXAS DE PRESSÃO

a) Laboratório de Pesquisa em Física e Química



b) Processos Industriais



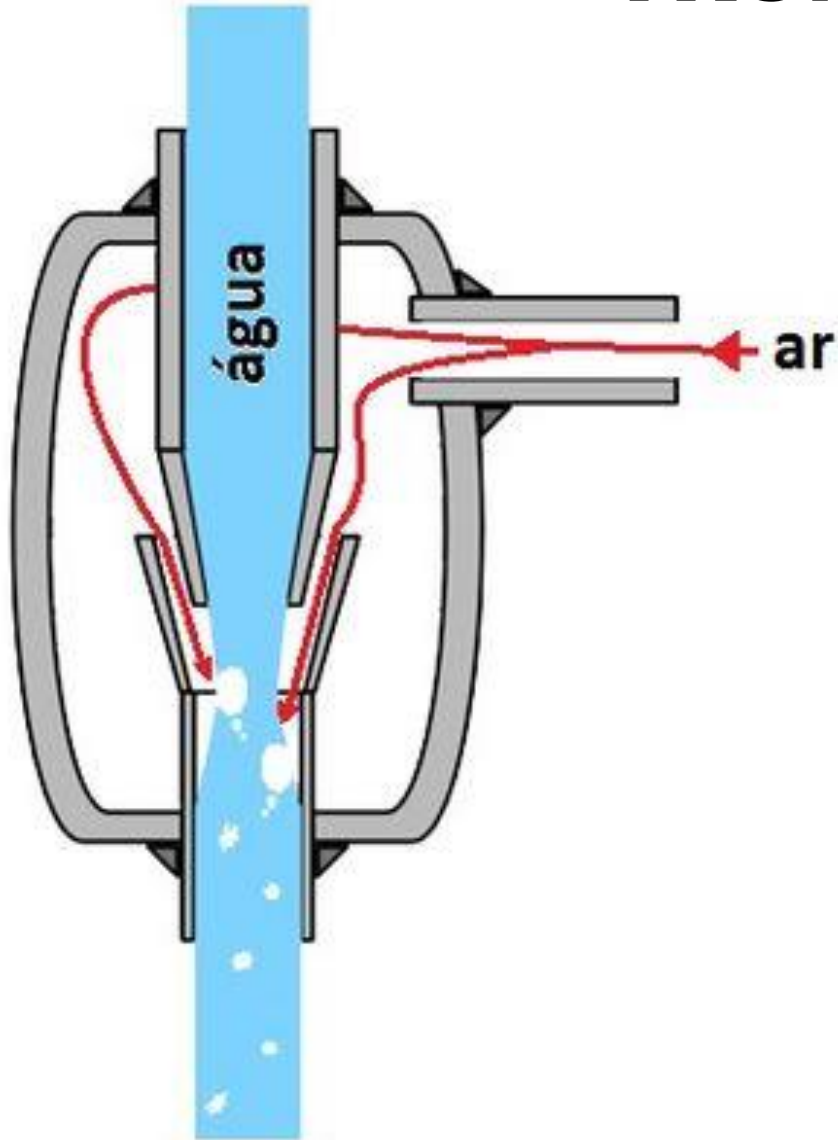




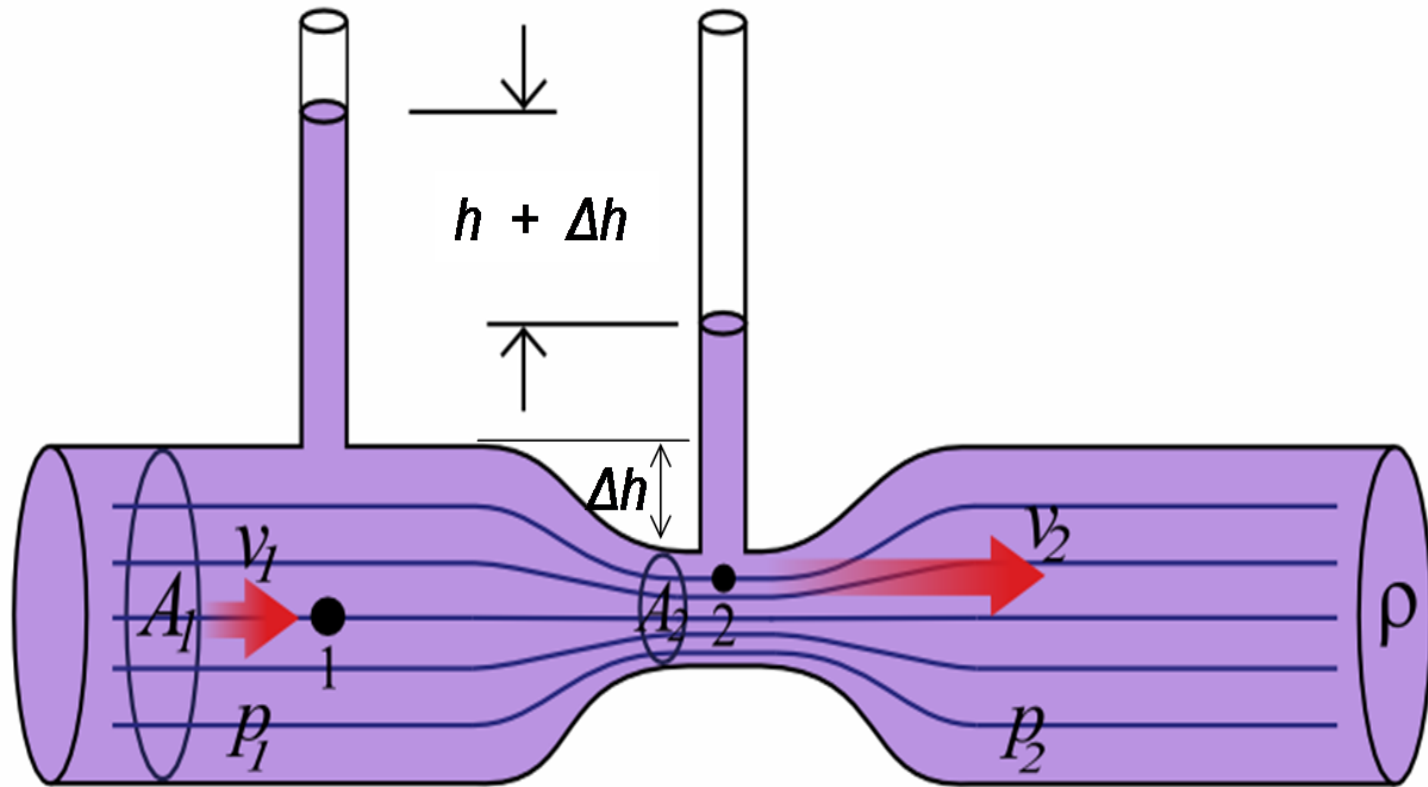
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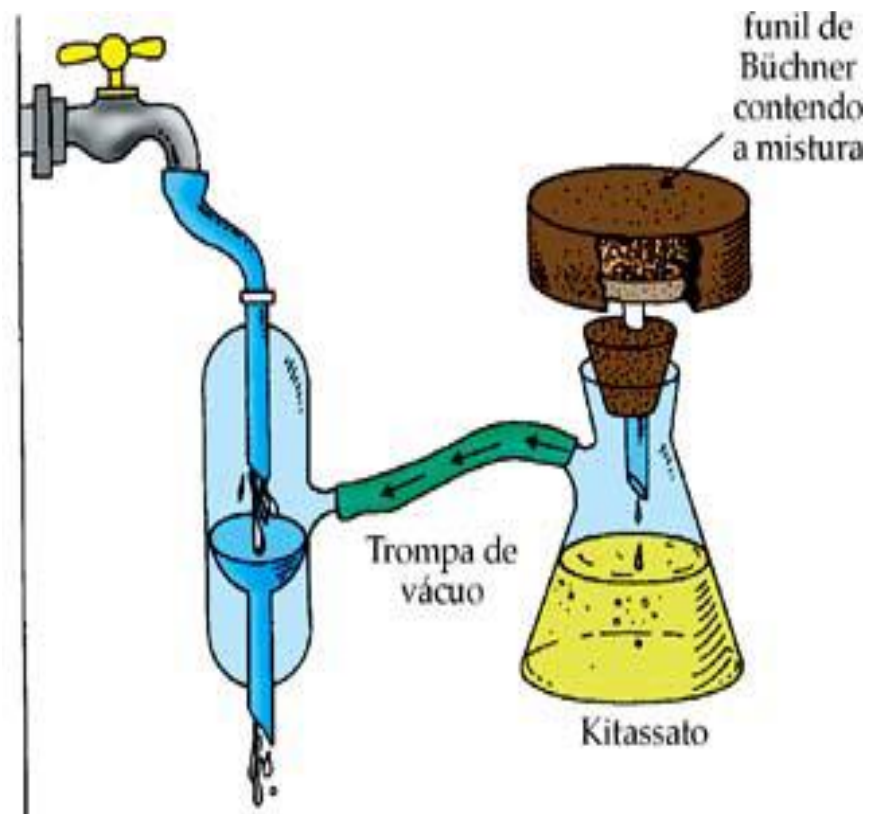
TROMPA DE VÁCUO



TUBO DE VENTURI



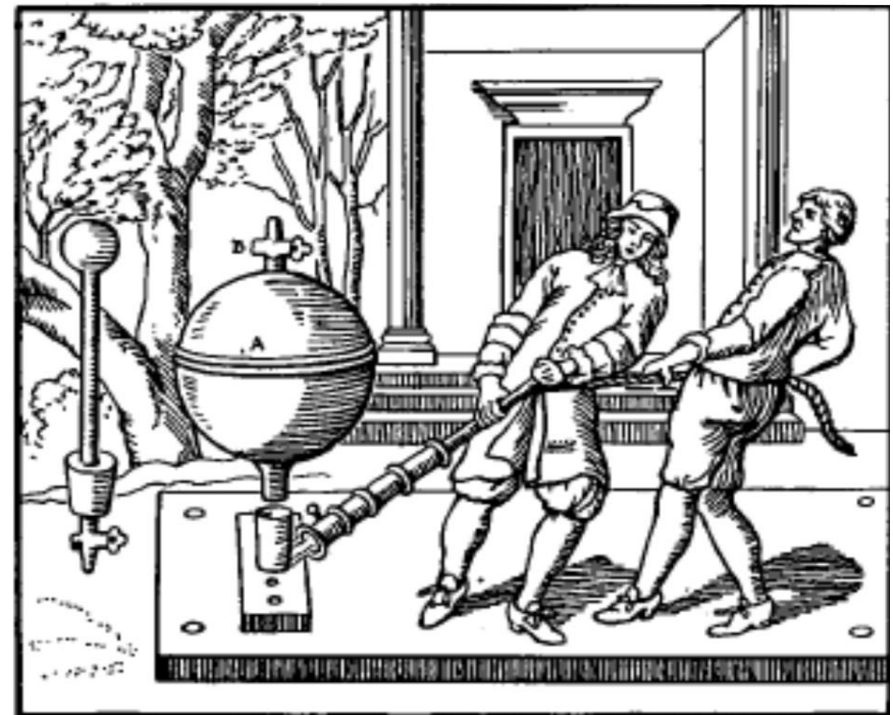
FILTRAÇÃO A VÁCUO



BOMBAS A PISTÃO

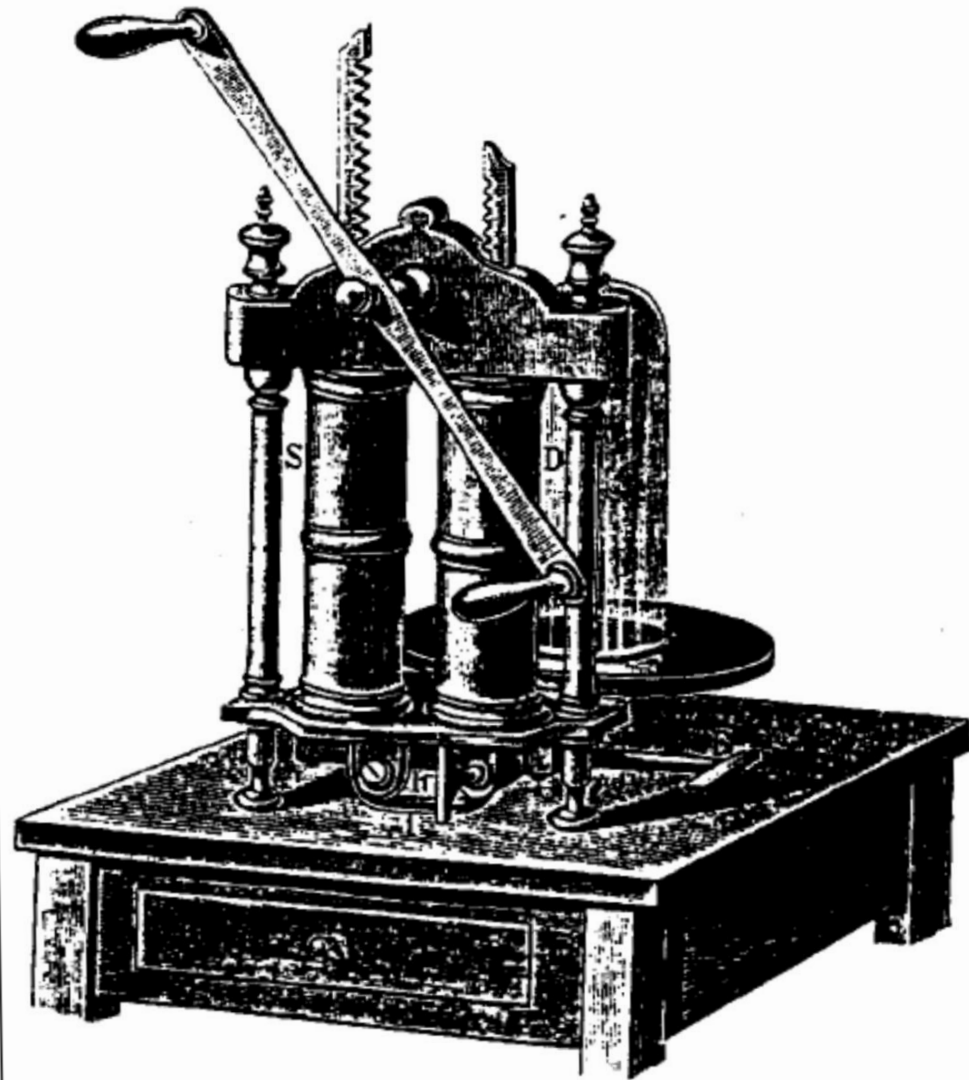
Primeiros modelos de
Otto von Guericke

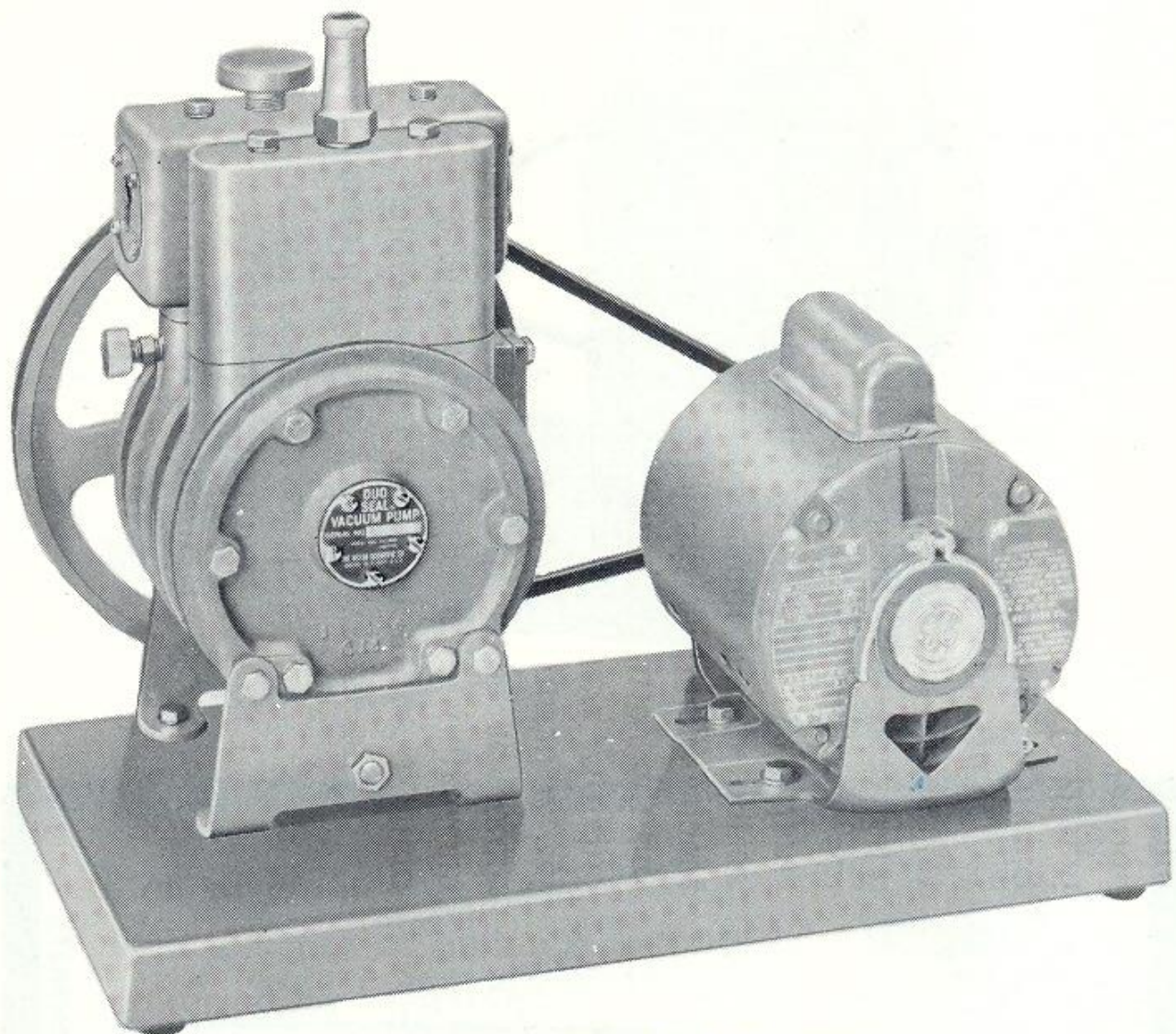
1640



BOMBA DE 2 PISTÕES

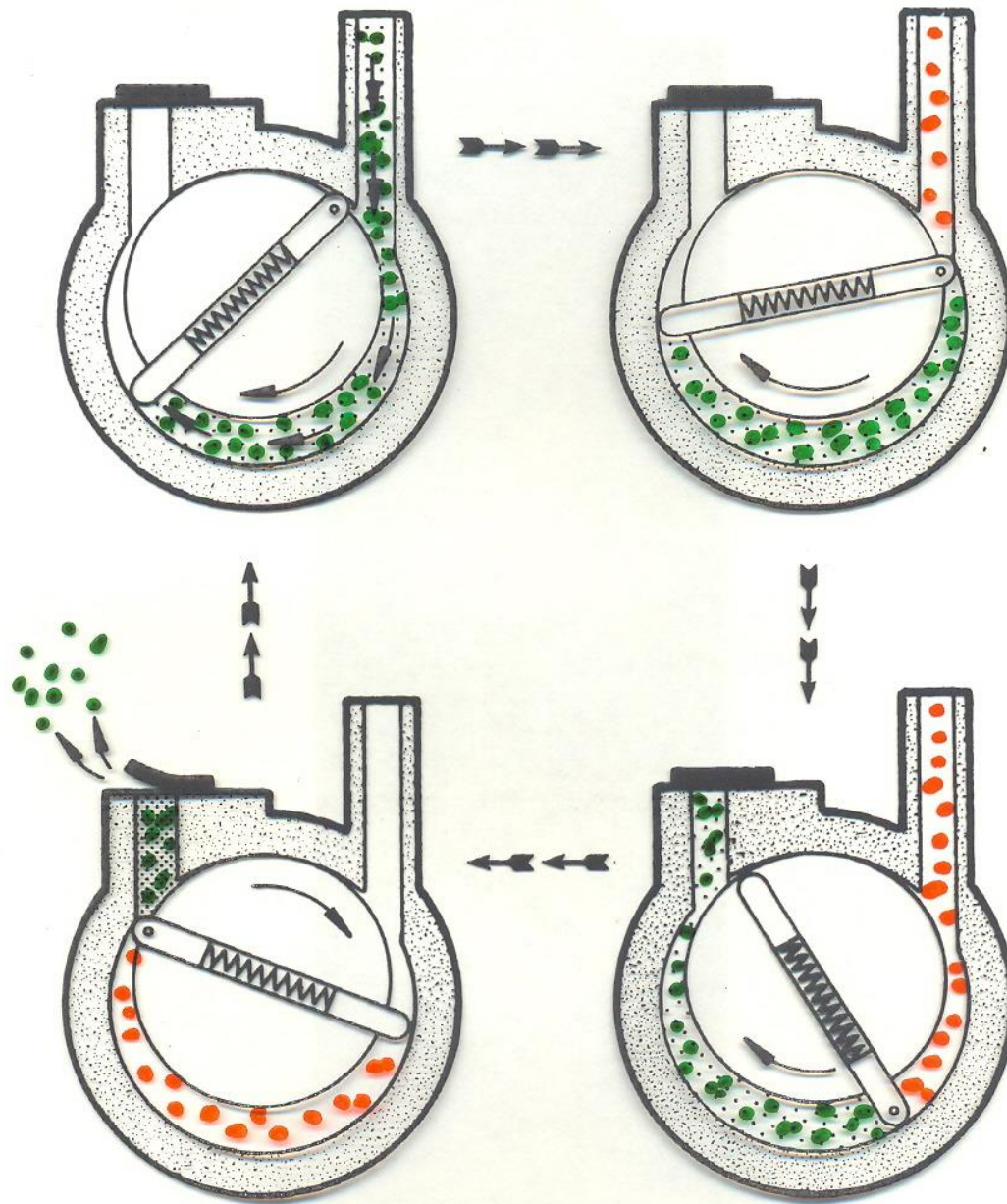
Modelo comercial
1850





TWO-STAGE

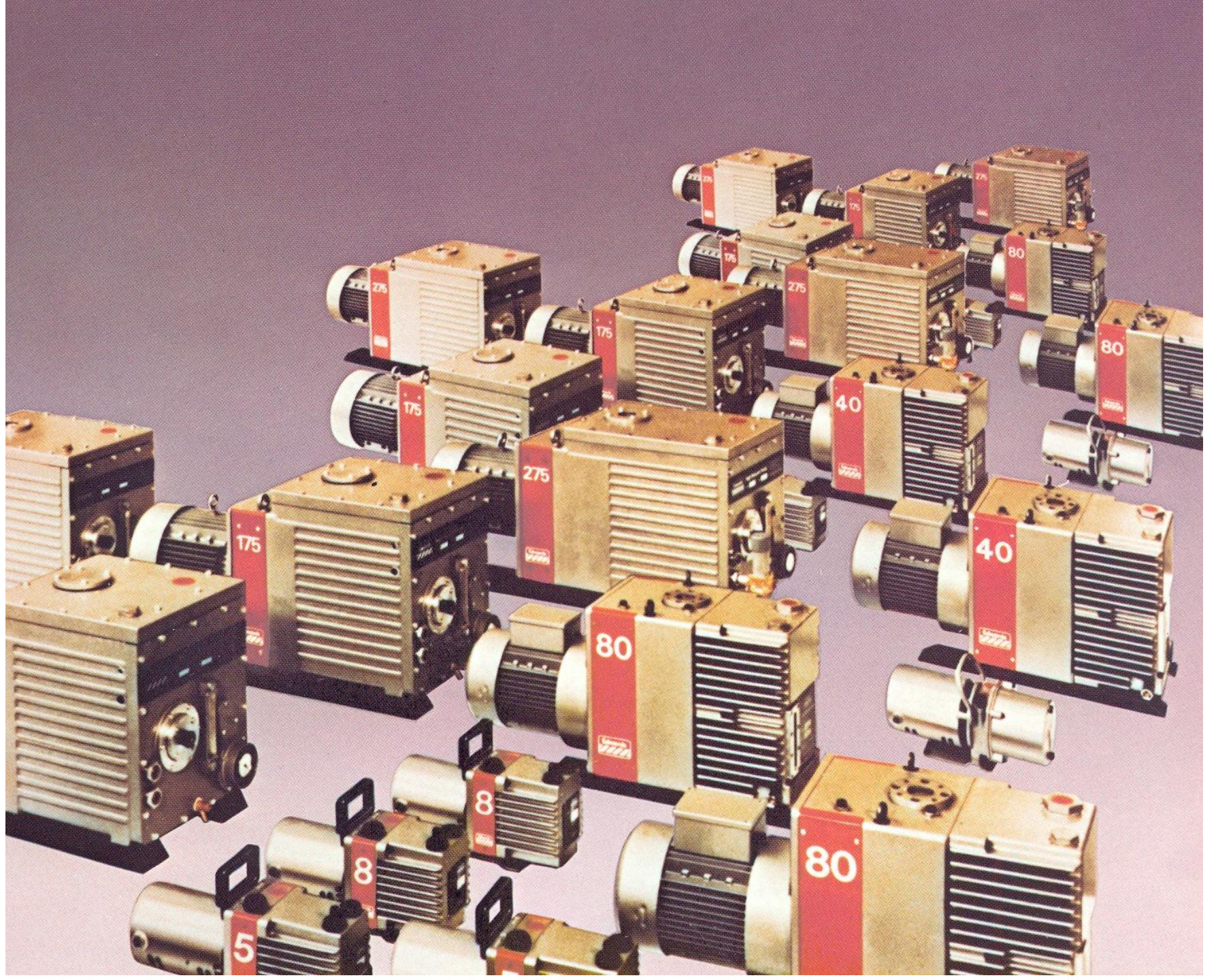
PATENTED

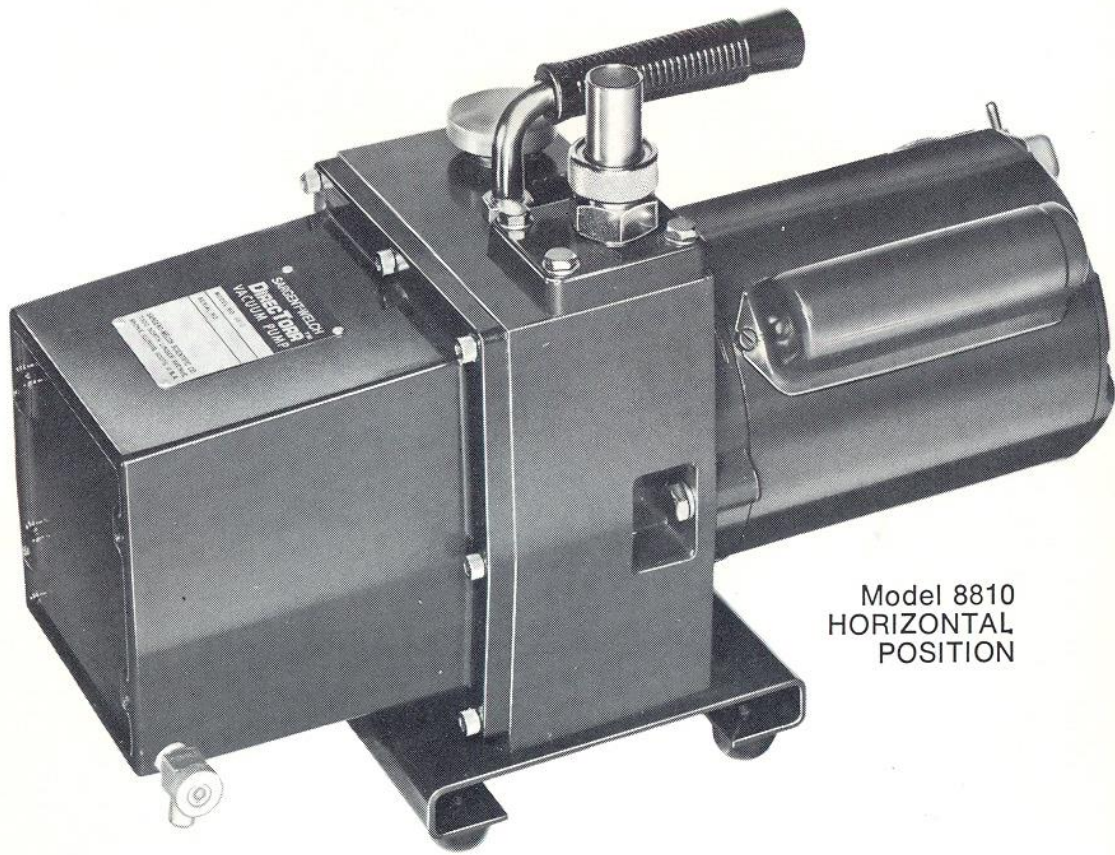




PRECISION
VACUUM PUMP
90 μ m 3.2CFM Oilless
MODEL 0090

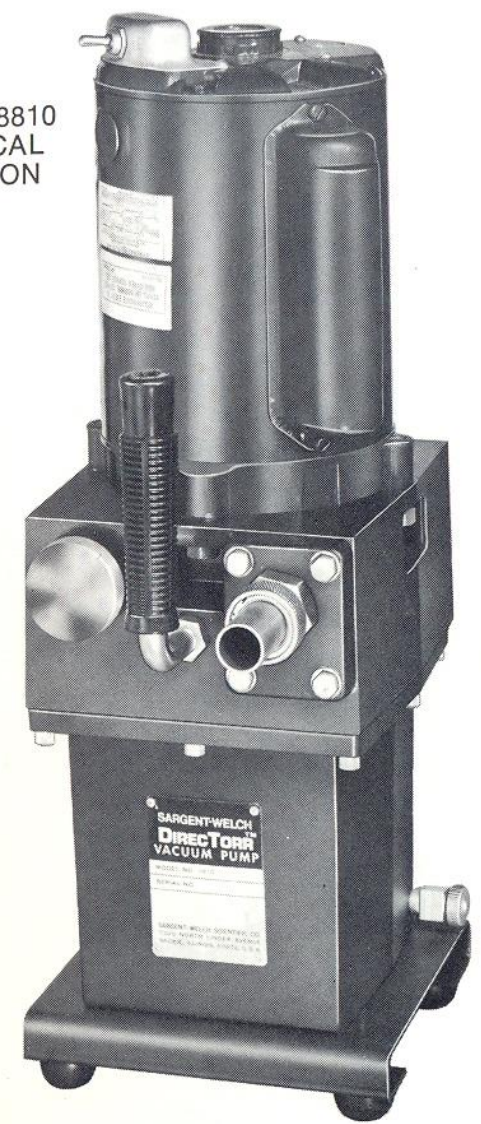


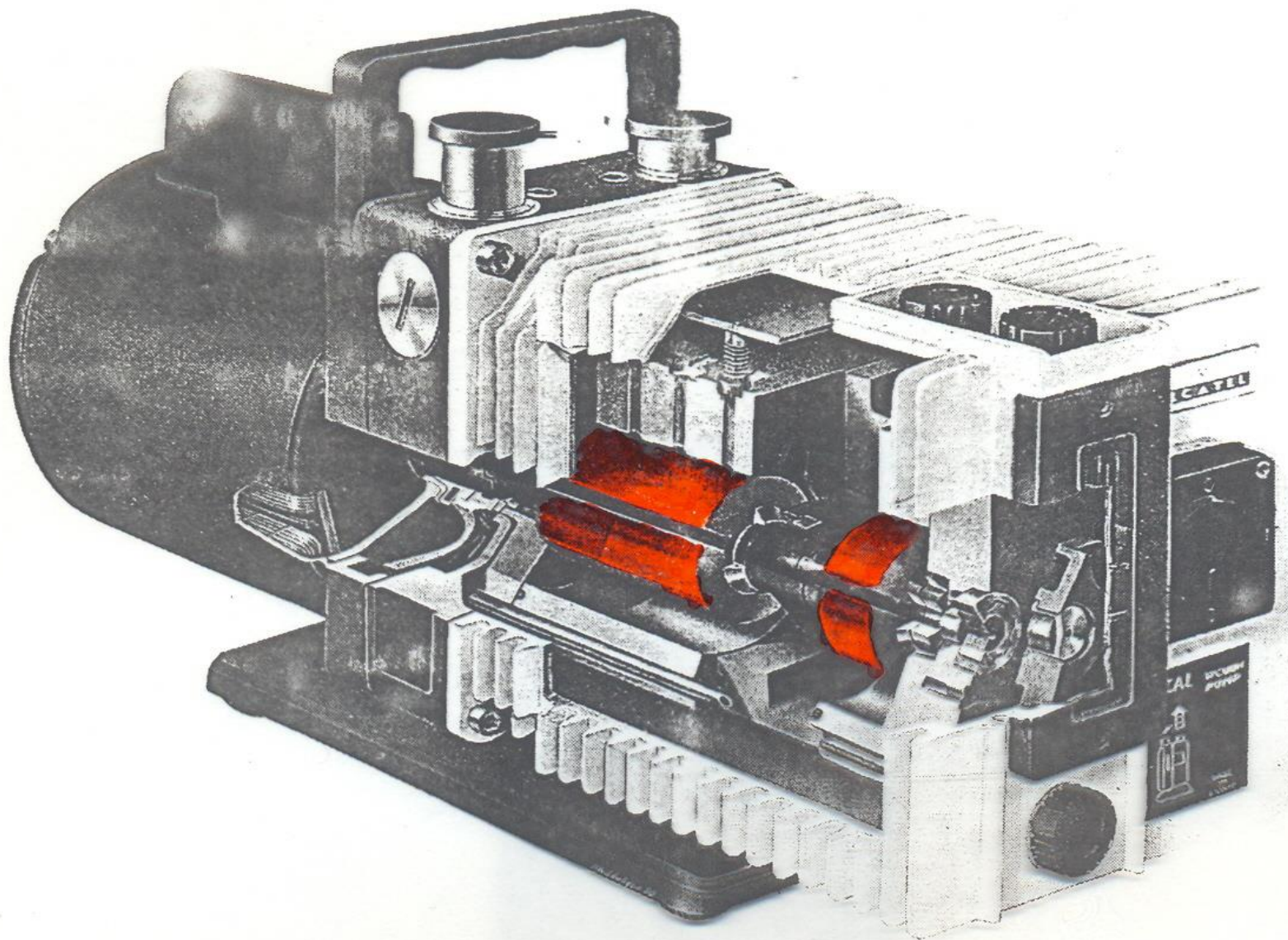




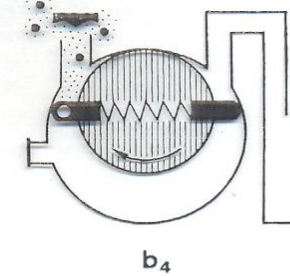
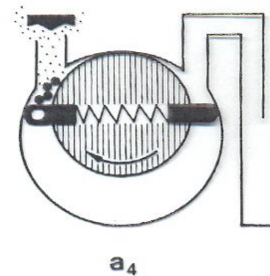
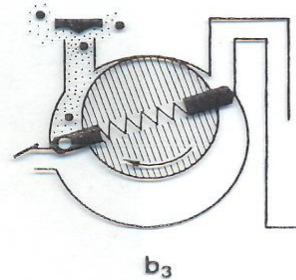
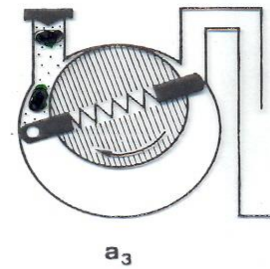
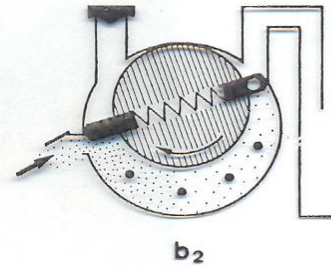
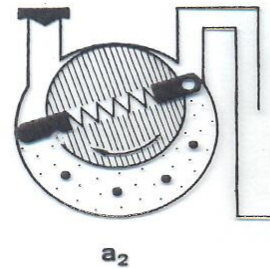
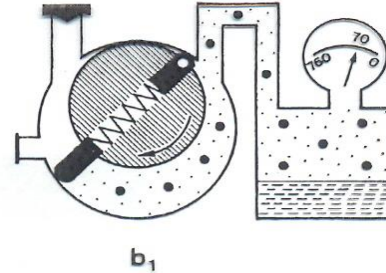
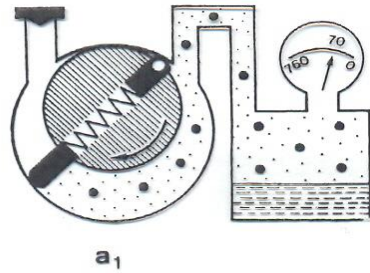
Model 8810
HORIZONTAL
POSITION

Model 8810
VERTICAL
POSITION

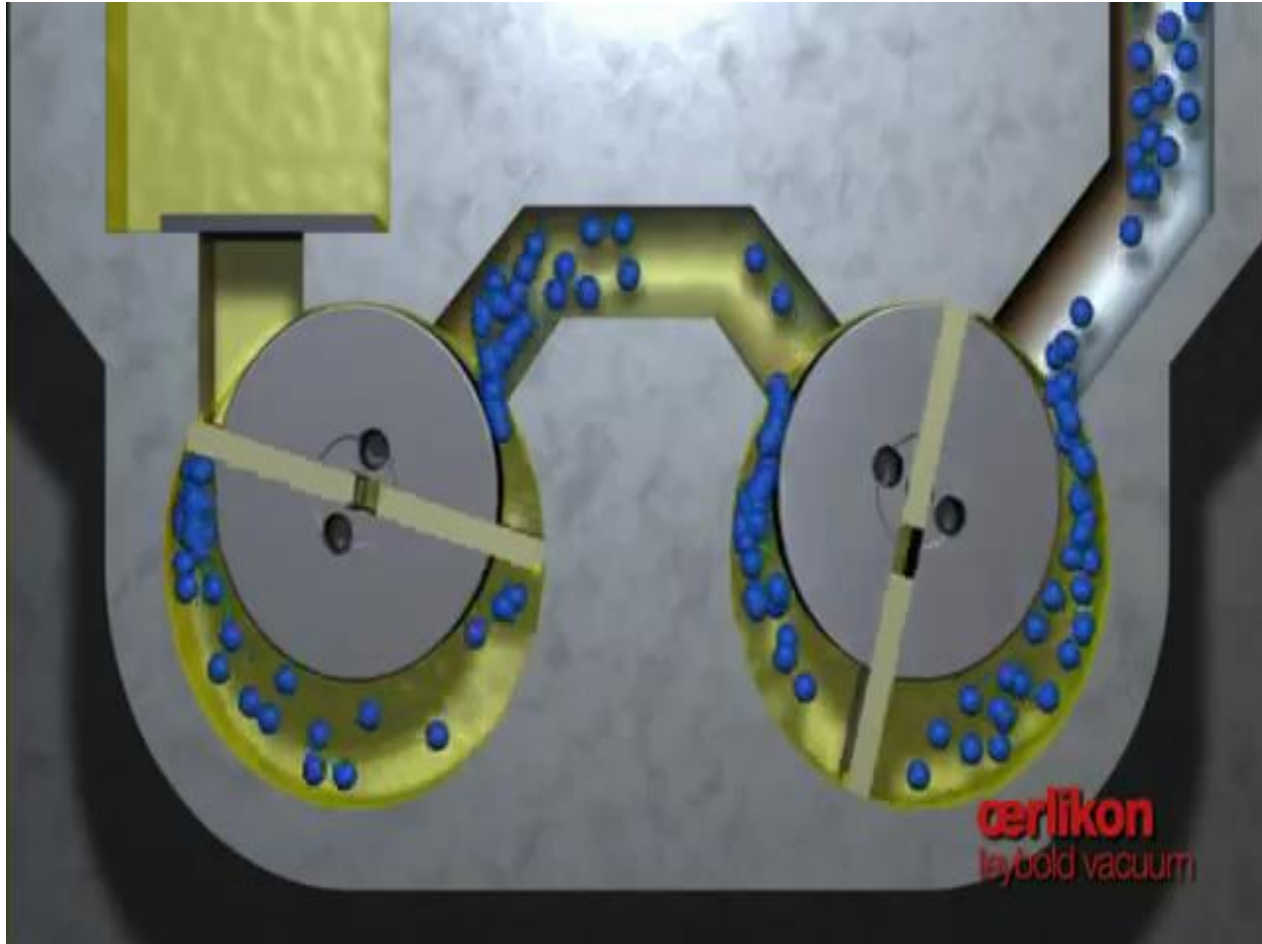


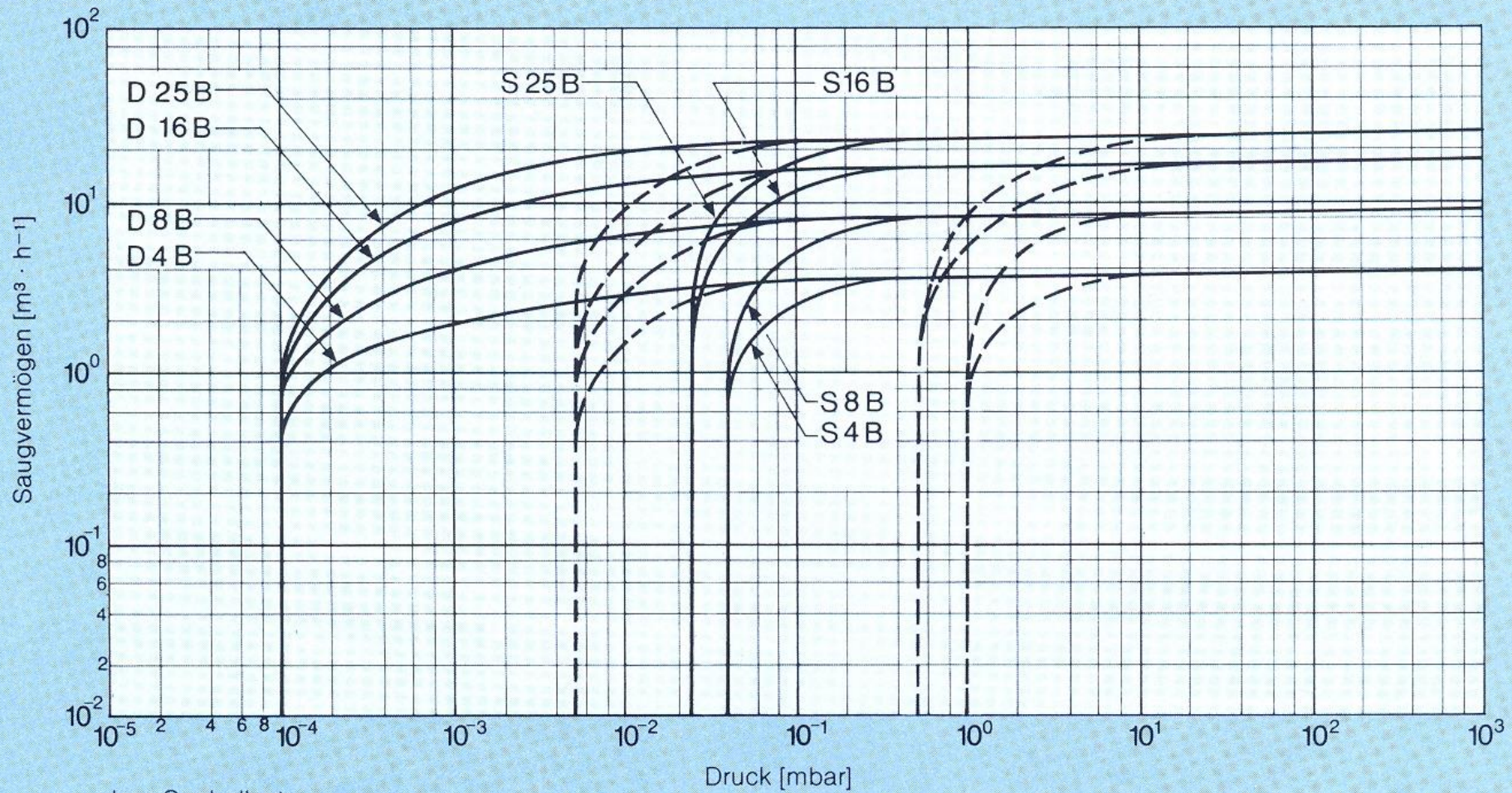


SEM GAS BALLAST



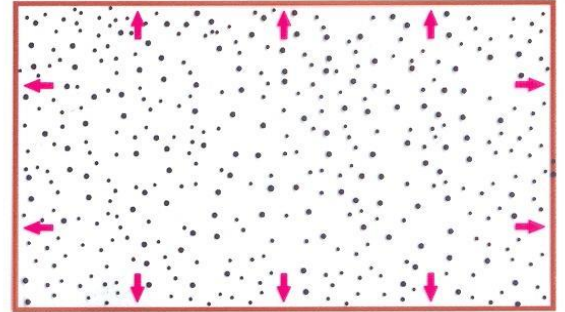
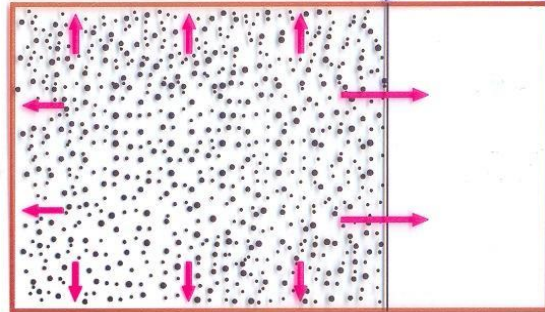
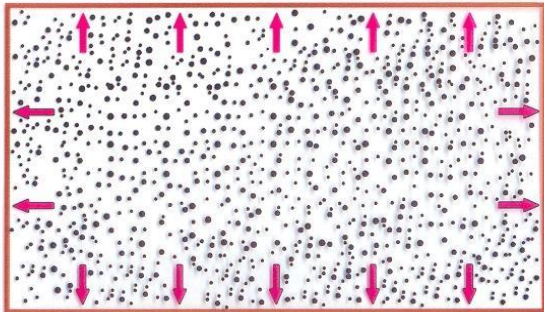
COM GAS BALLAST



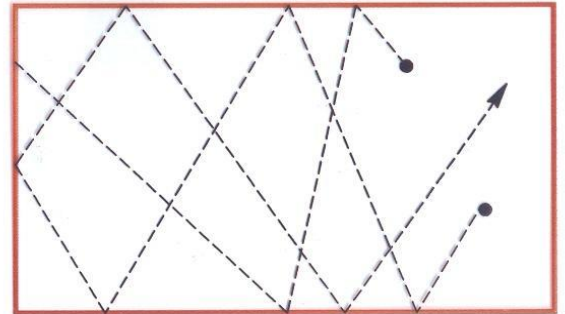
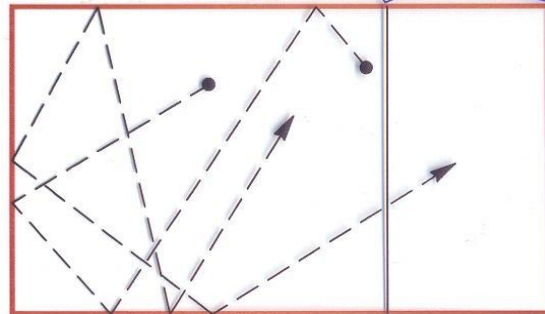
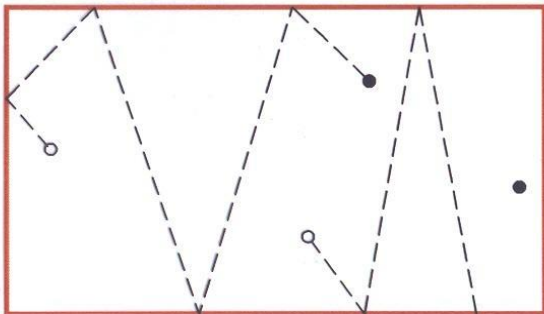


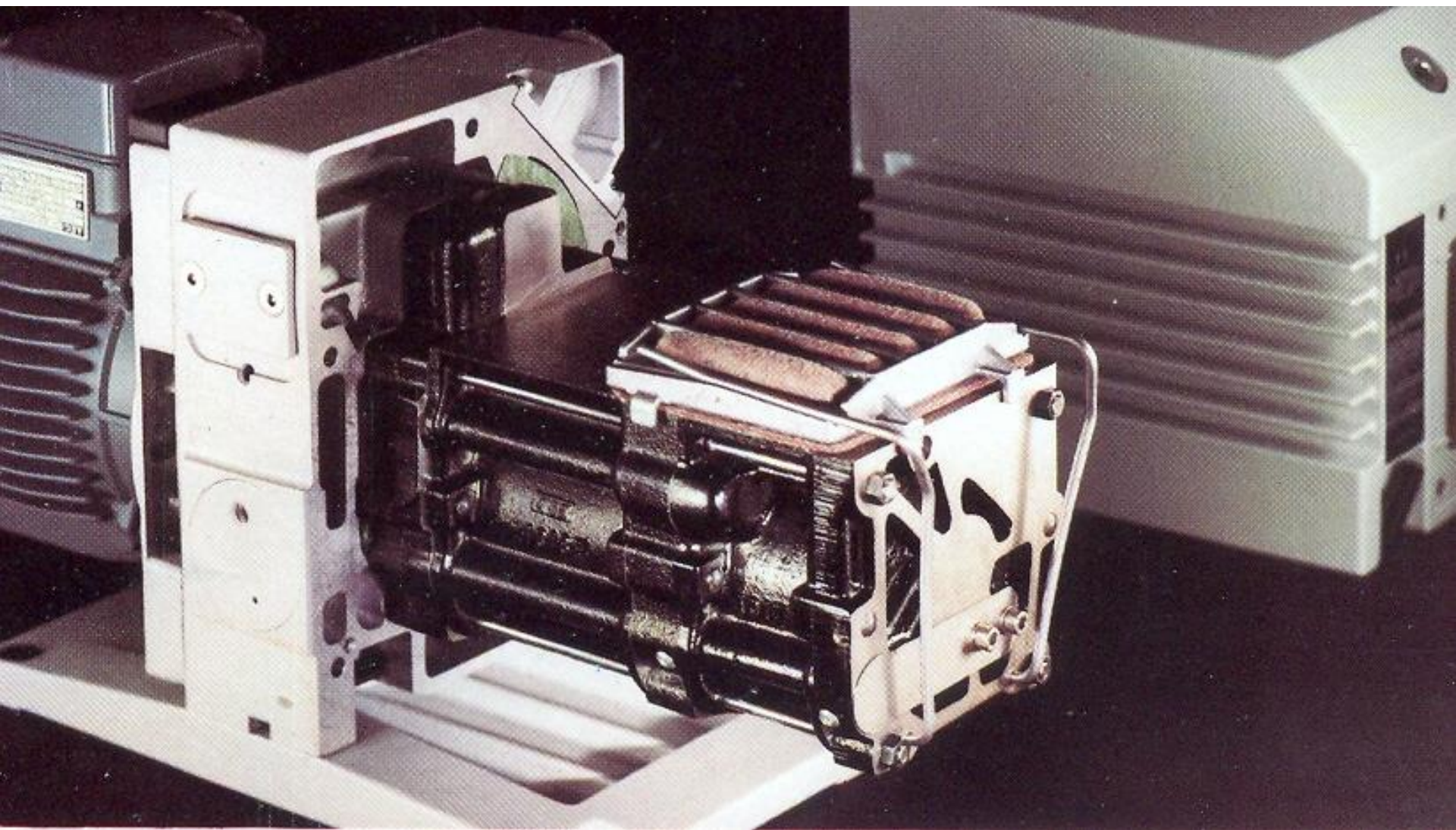
— ohne Gasballast
 - - - mit Gasballast

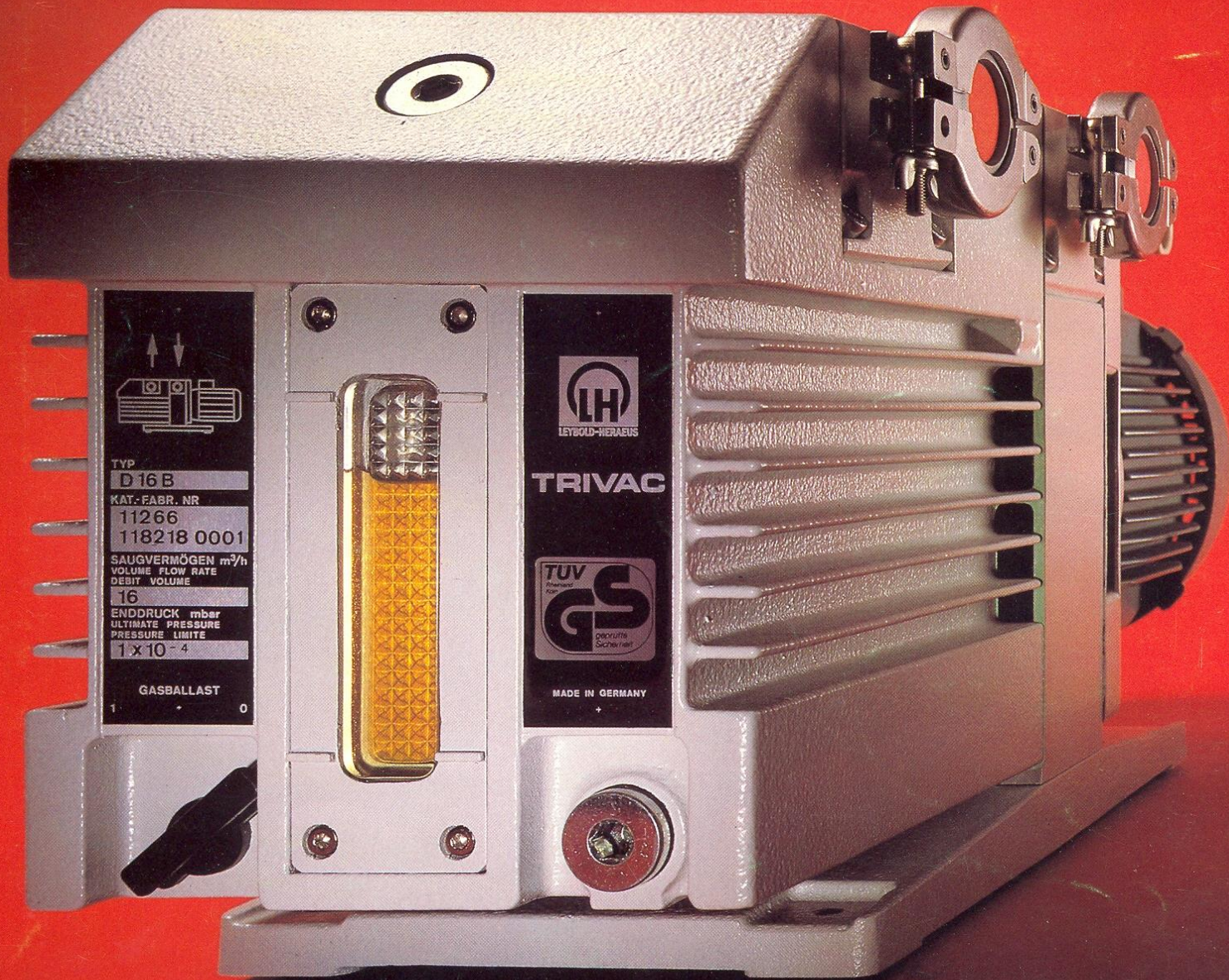
Regime Viscoso






Regime Molecular

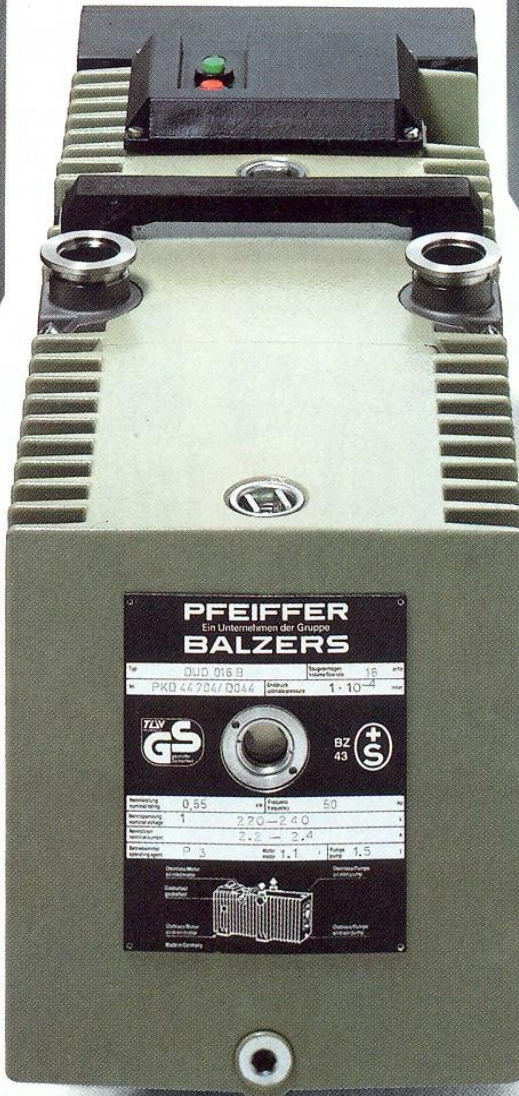


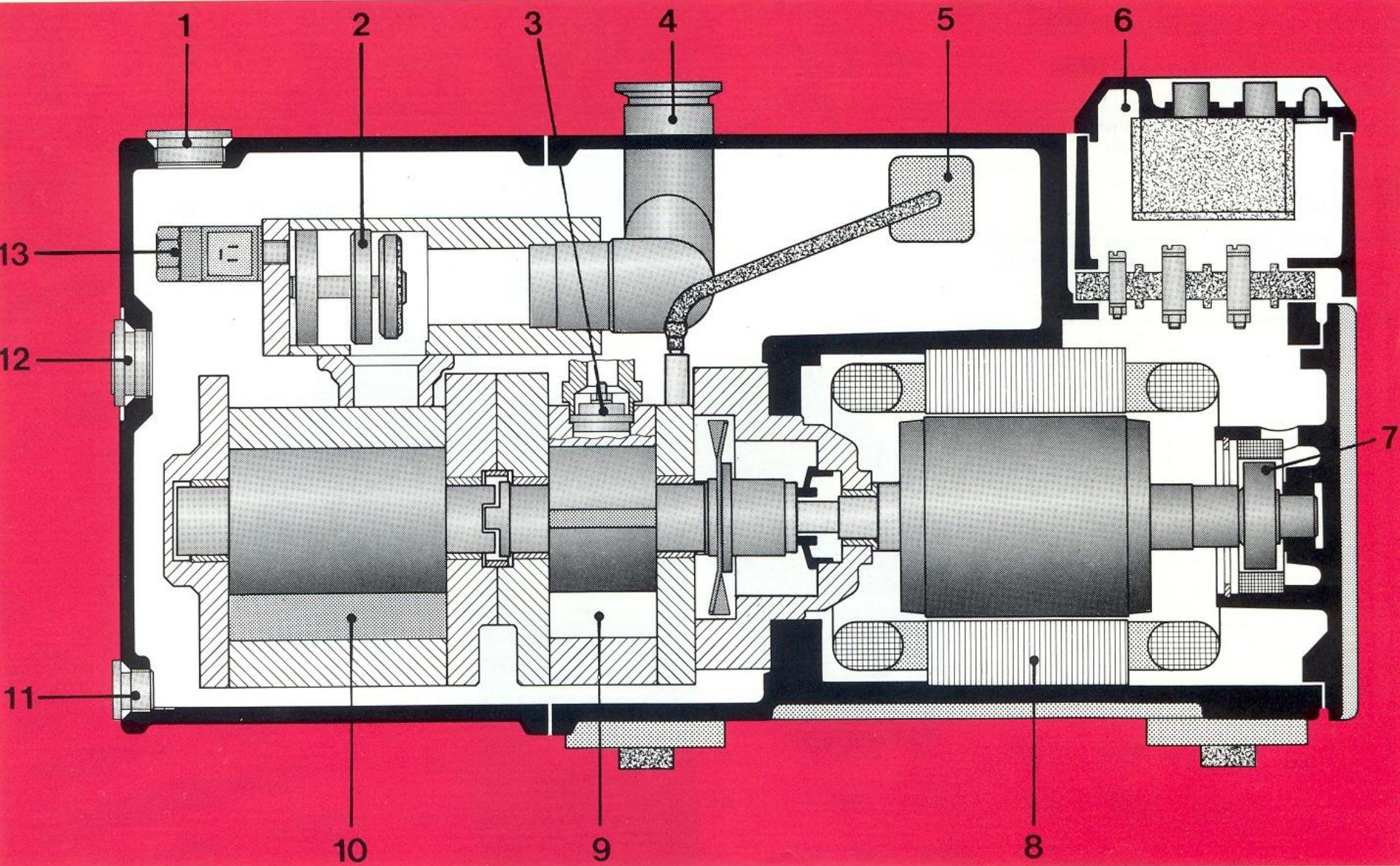


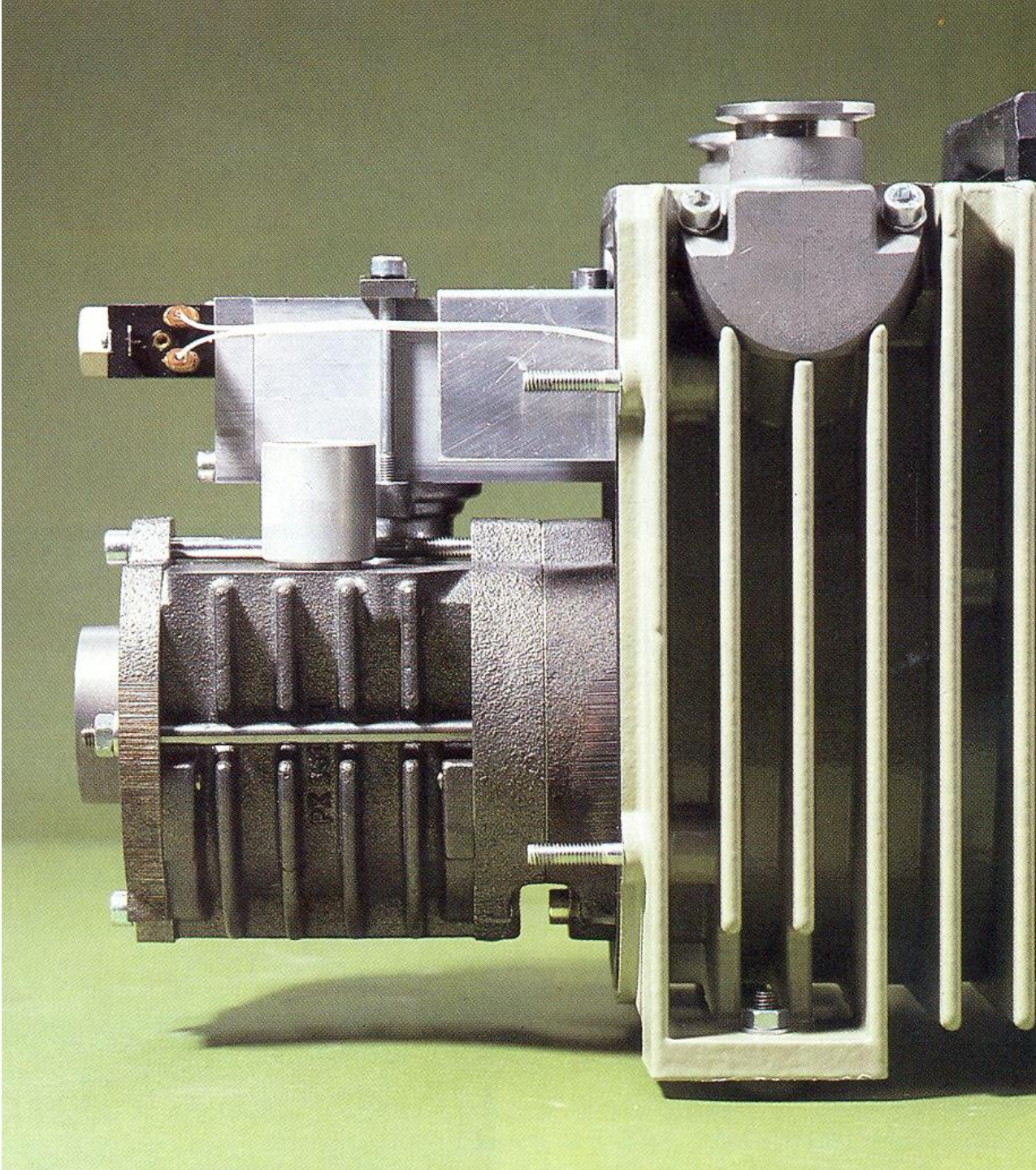


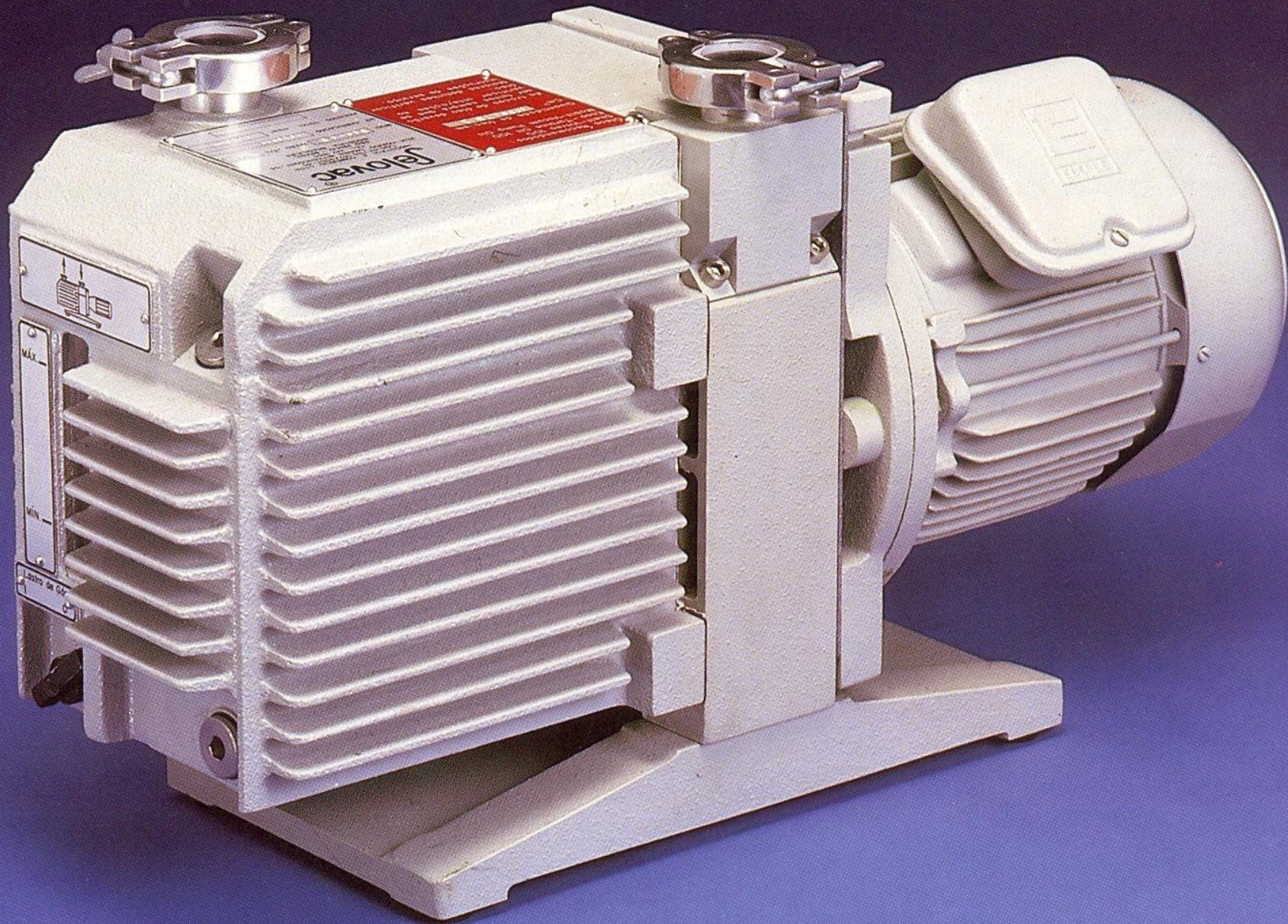
↑ ↓

TYP
D 16 B
KAT.-FABR. NR
11266
118218 0001
SAUGVERMÖGEN m³/h
VOLUME FLOW RATE
DEBIT VOLUME
16
ENDDRUCK mbar
ULTIMATE PRESSURE
PRESSURE LIMITE
1 x 10⁻⁴
GASBALLAST
1 0


LEYBOLD-HERAEUS
TRIVAC

MADE IN GERMANY
+

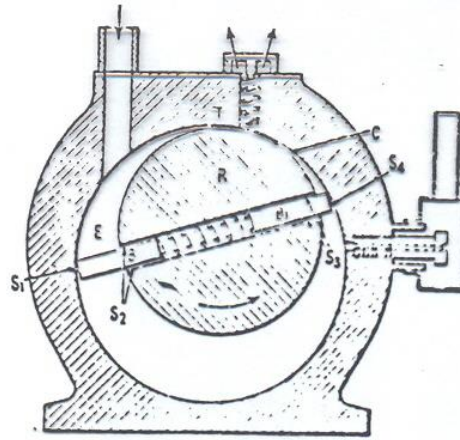




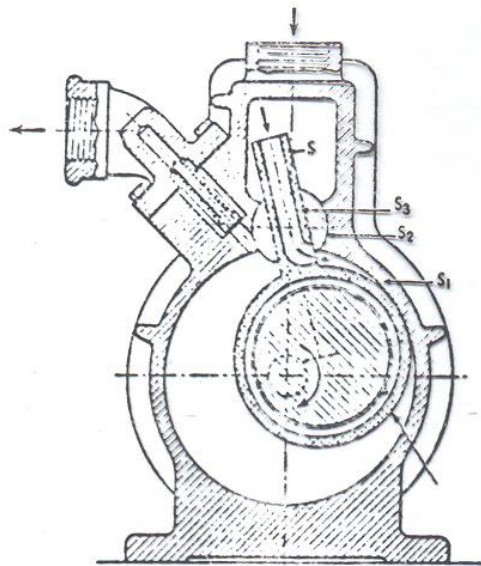




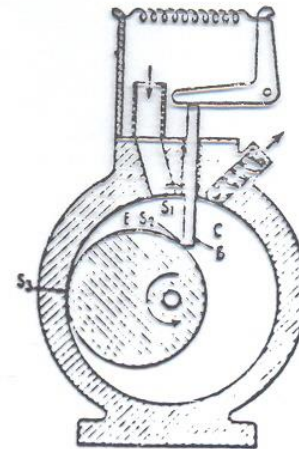




Bomba de palhetas desenvolvida por Gaede

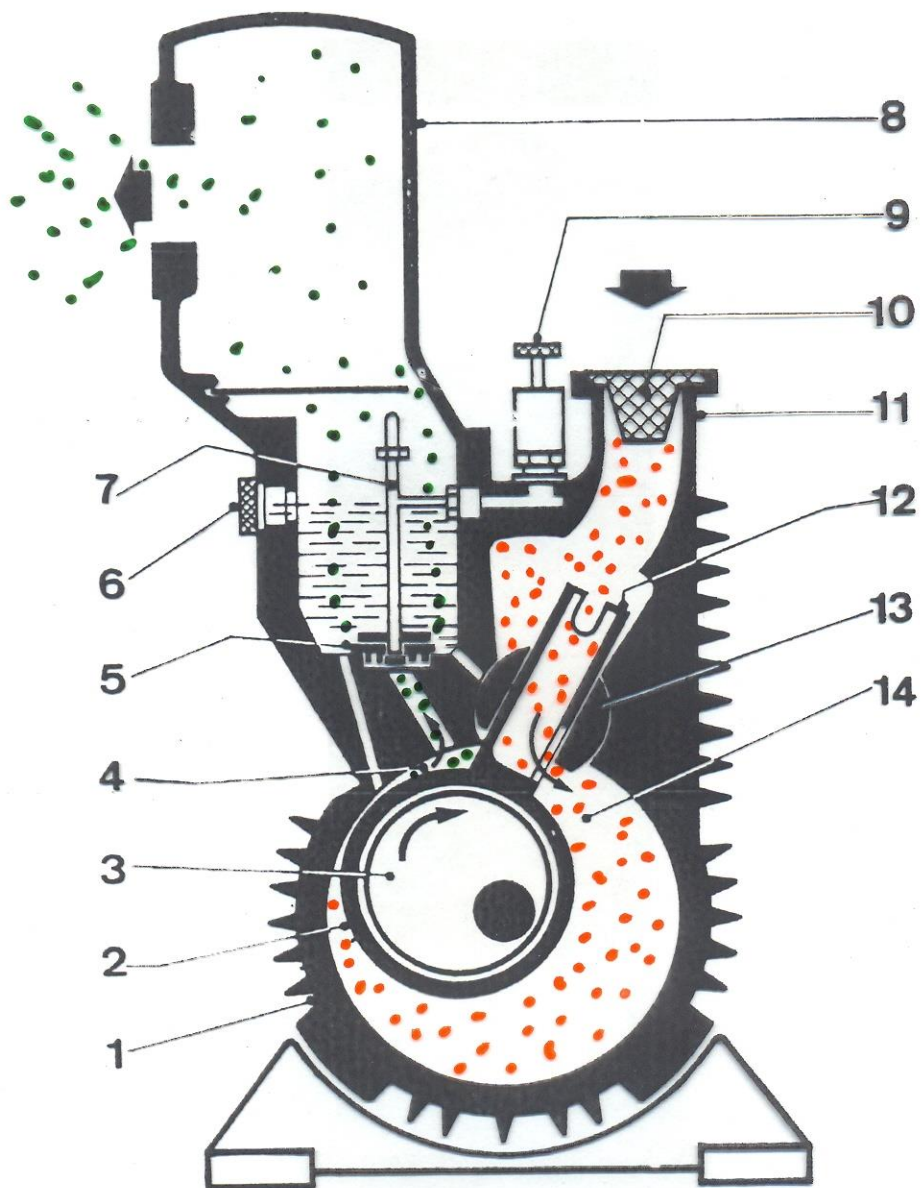


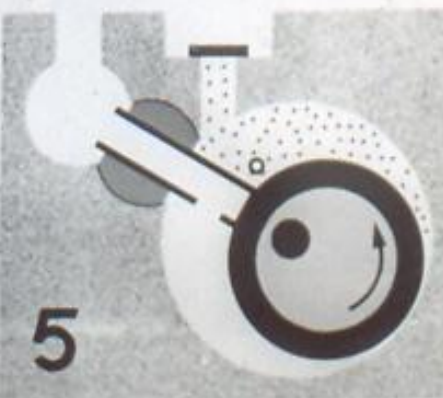
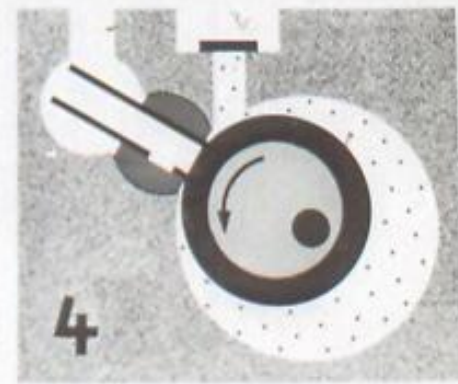
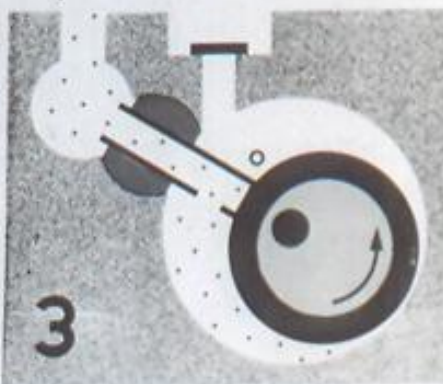
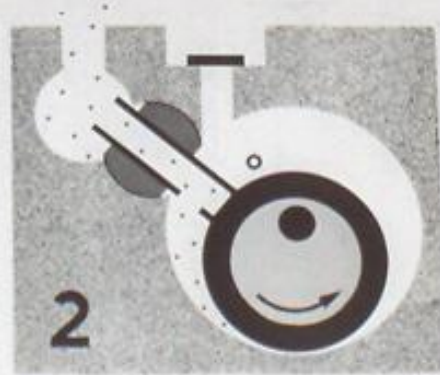
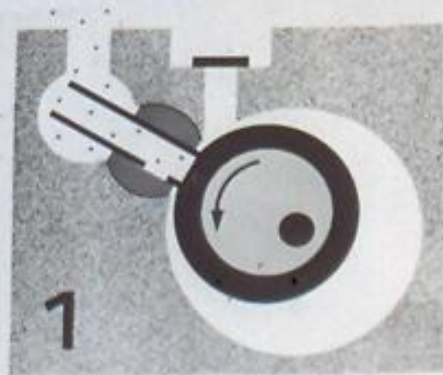
Modelo de pistão oscilante de Kinney

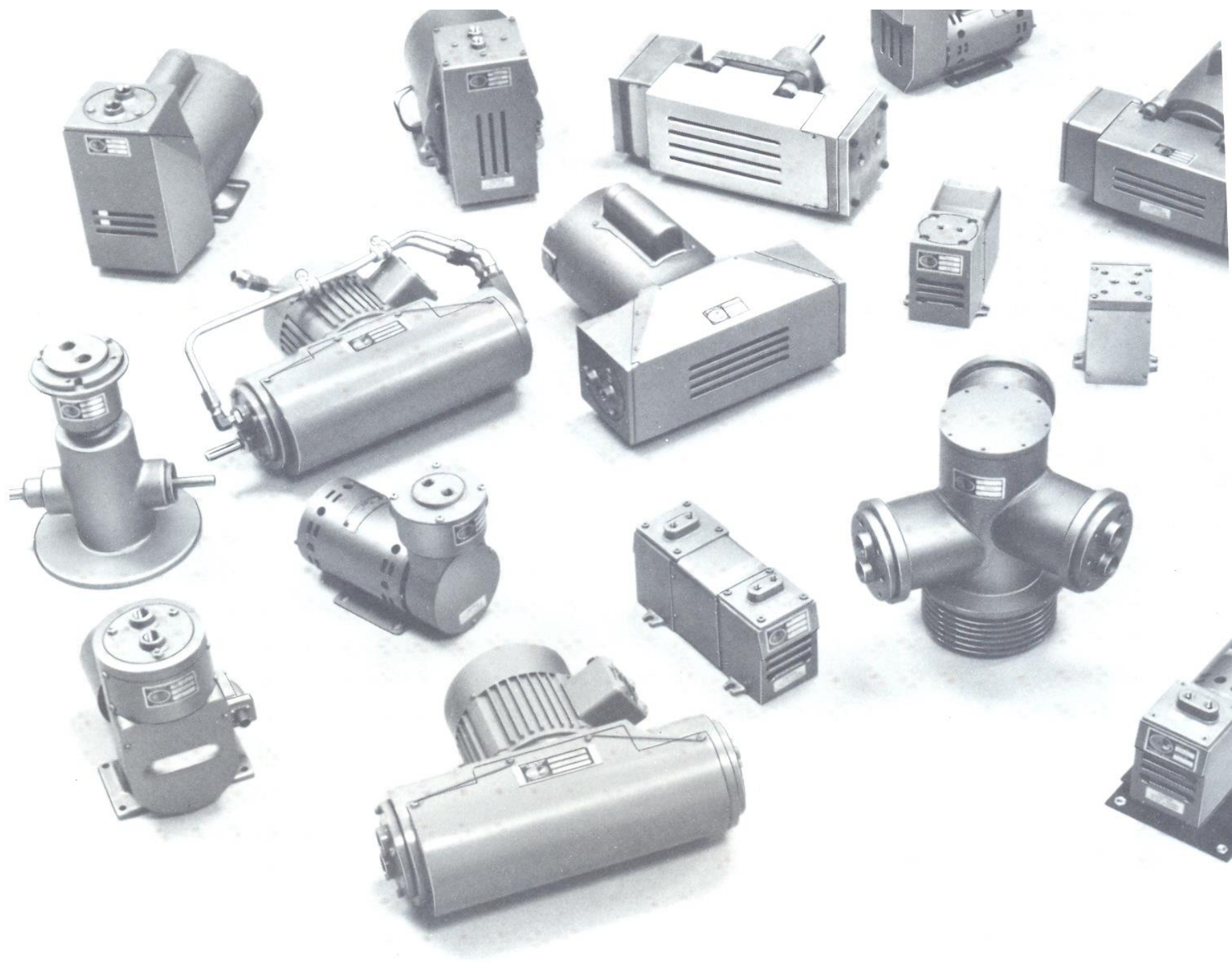


Bomba de uma só palheta da Cenco

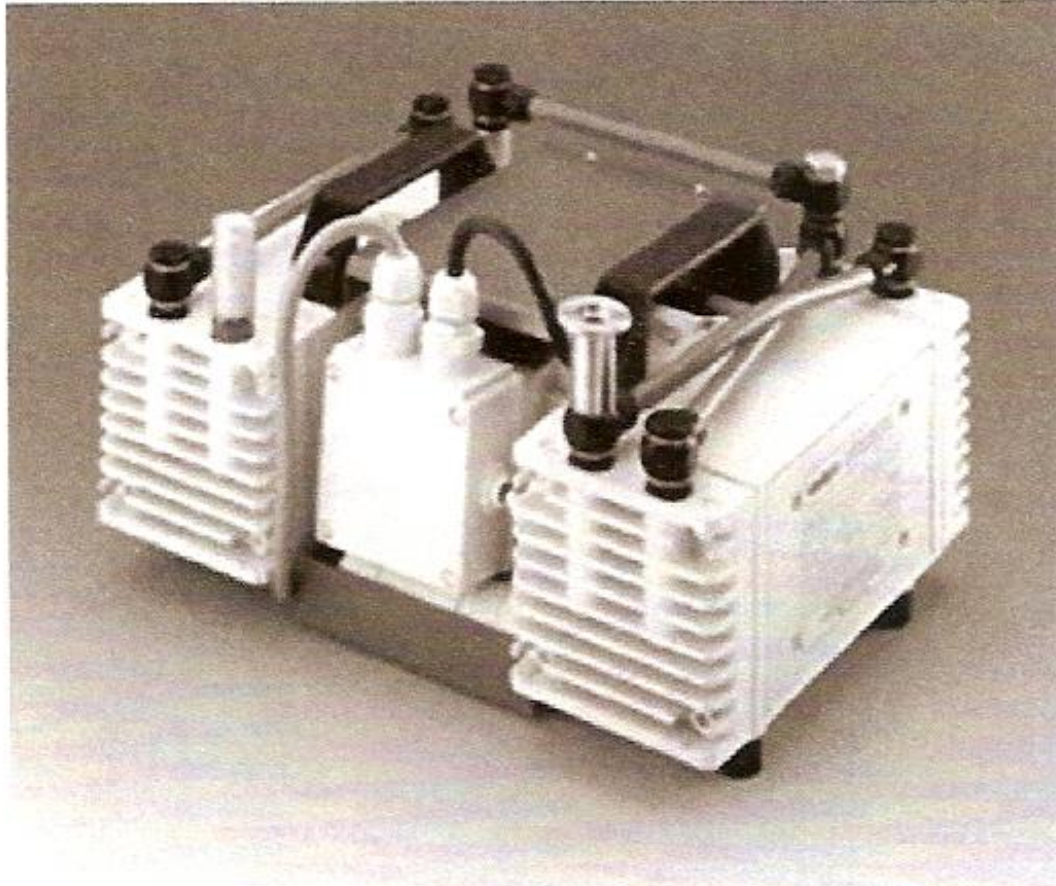
BOMBA DE PISTÃO OSCILANTE (KINNEY)







BOMBA DE DIAFRAGMA

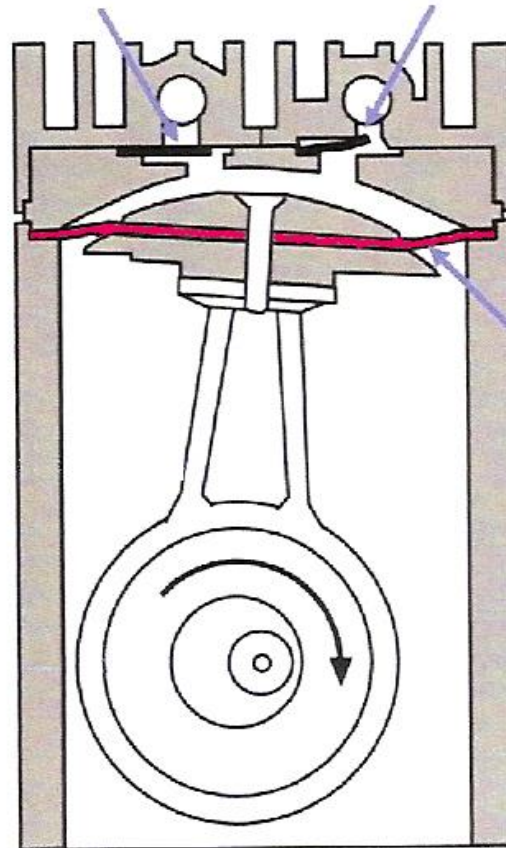


Agilent Technologies

BOMBA DE DIAFRAGMA

VÁLVULA DE
ENTRADA

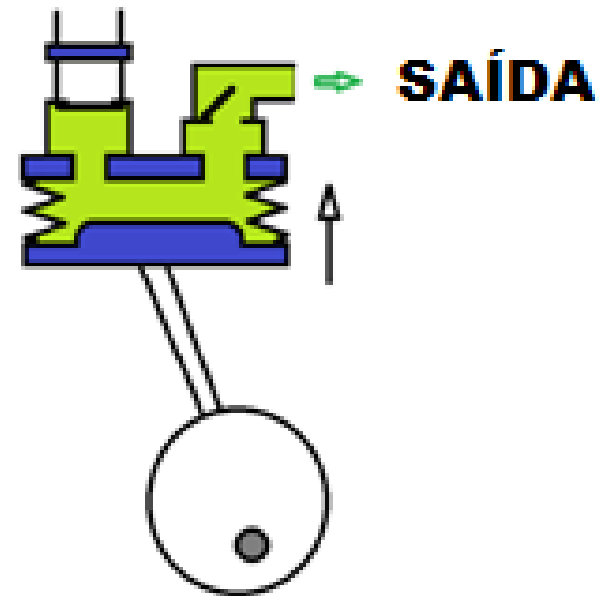
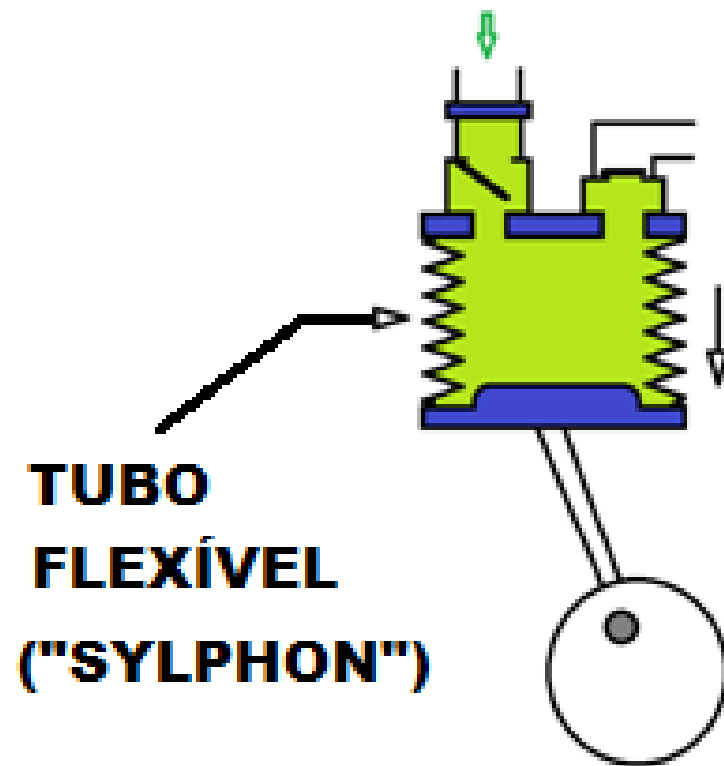
VÁLVULA DE
SAÍDA

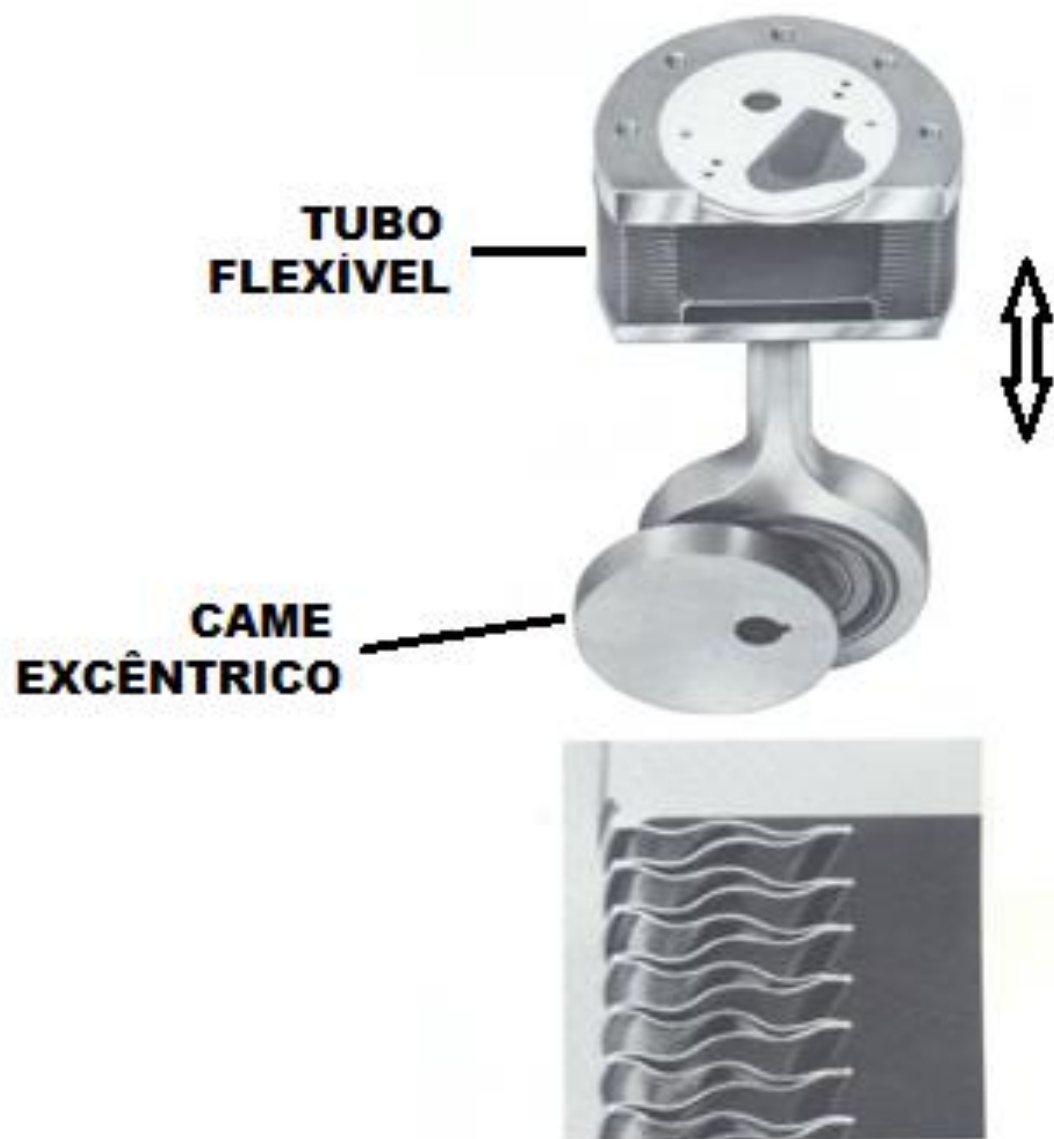


DIAFRAGMA

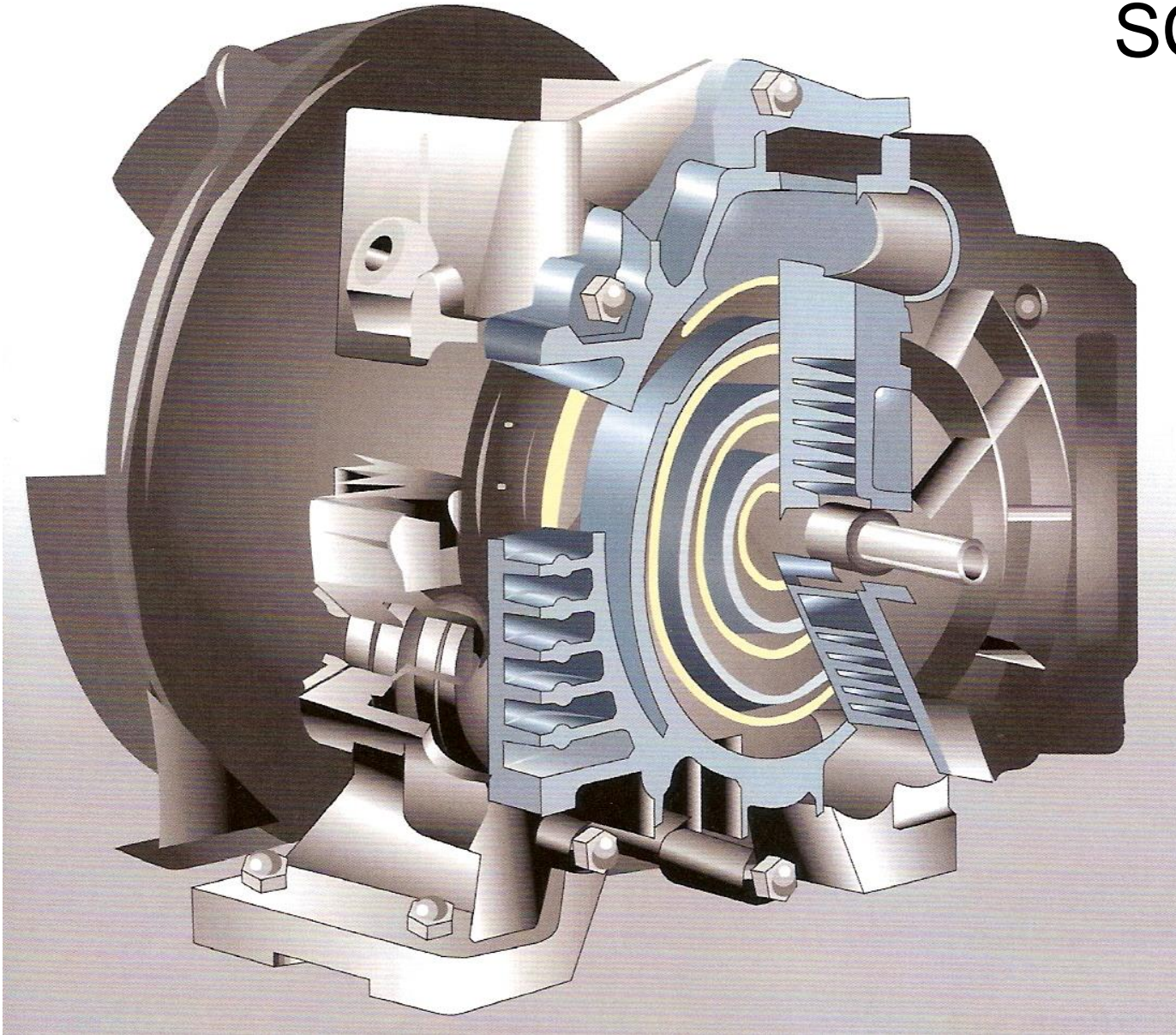
BOMBA MECÂNICA SECA ("DRY PUMP")

ENTRADA

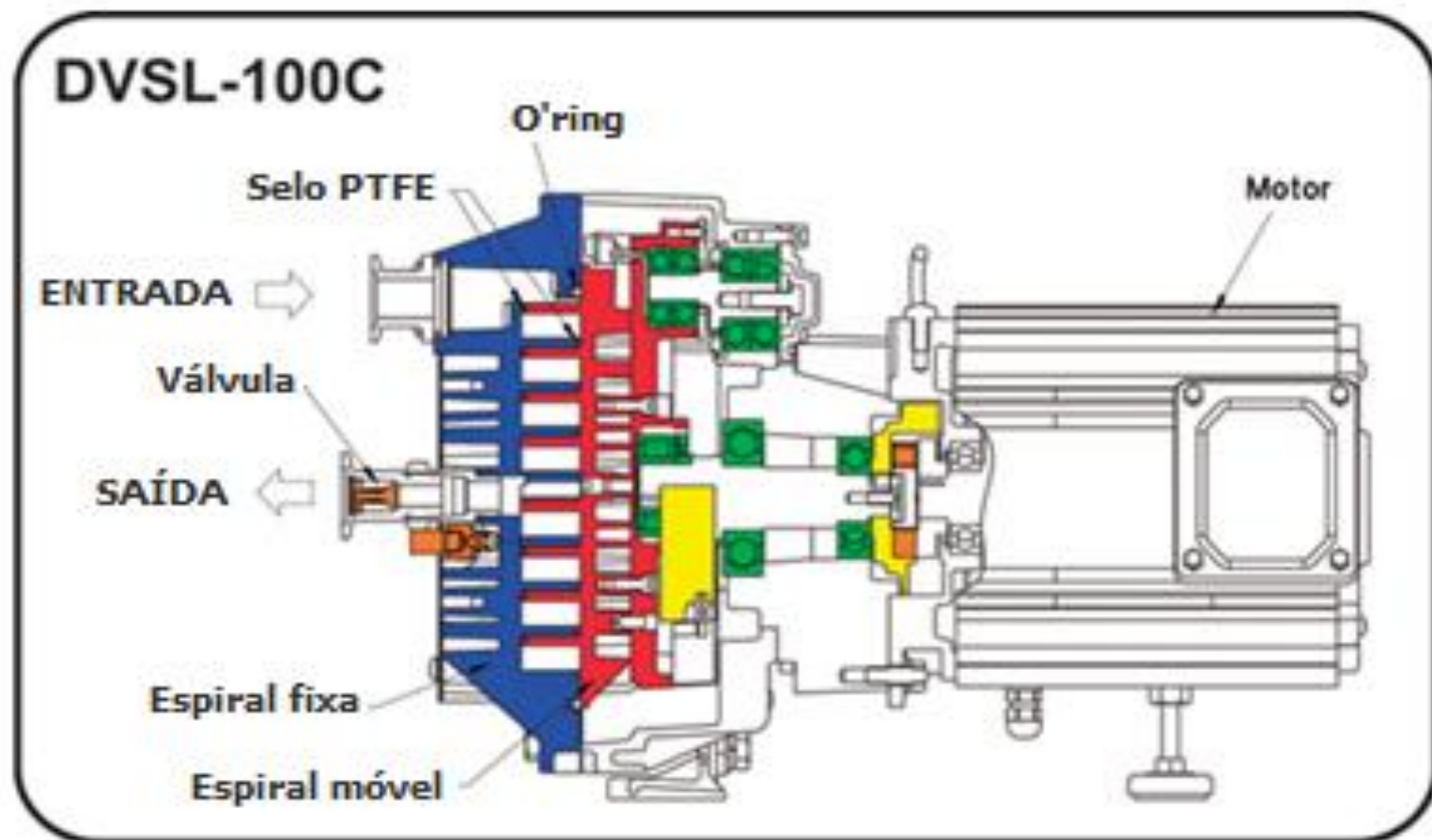


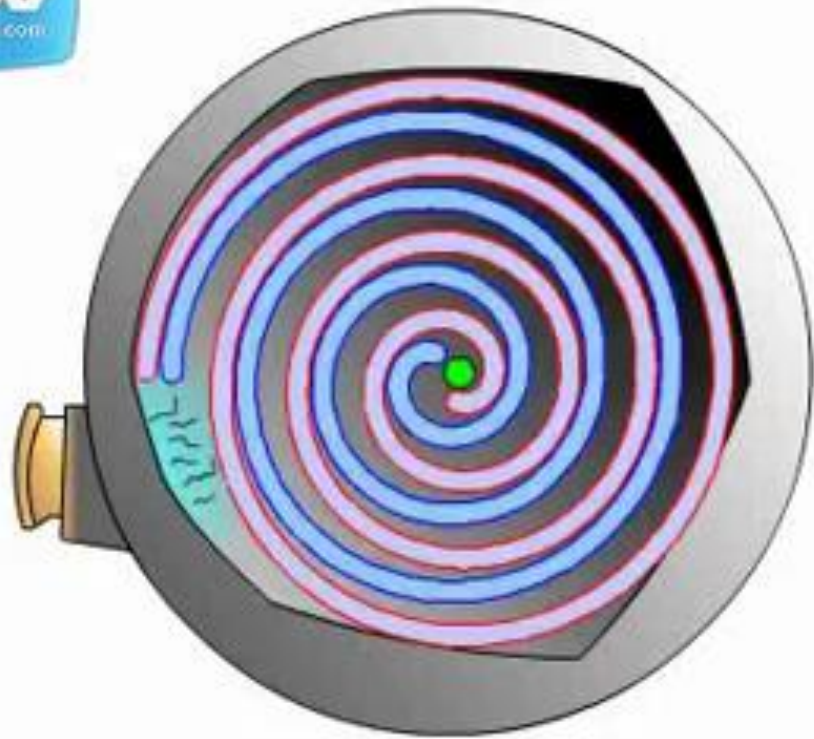


BOMBA SCROLL

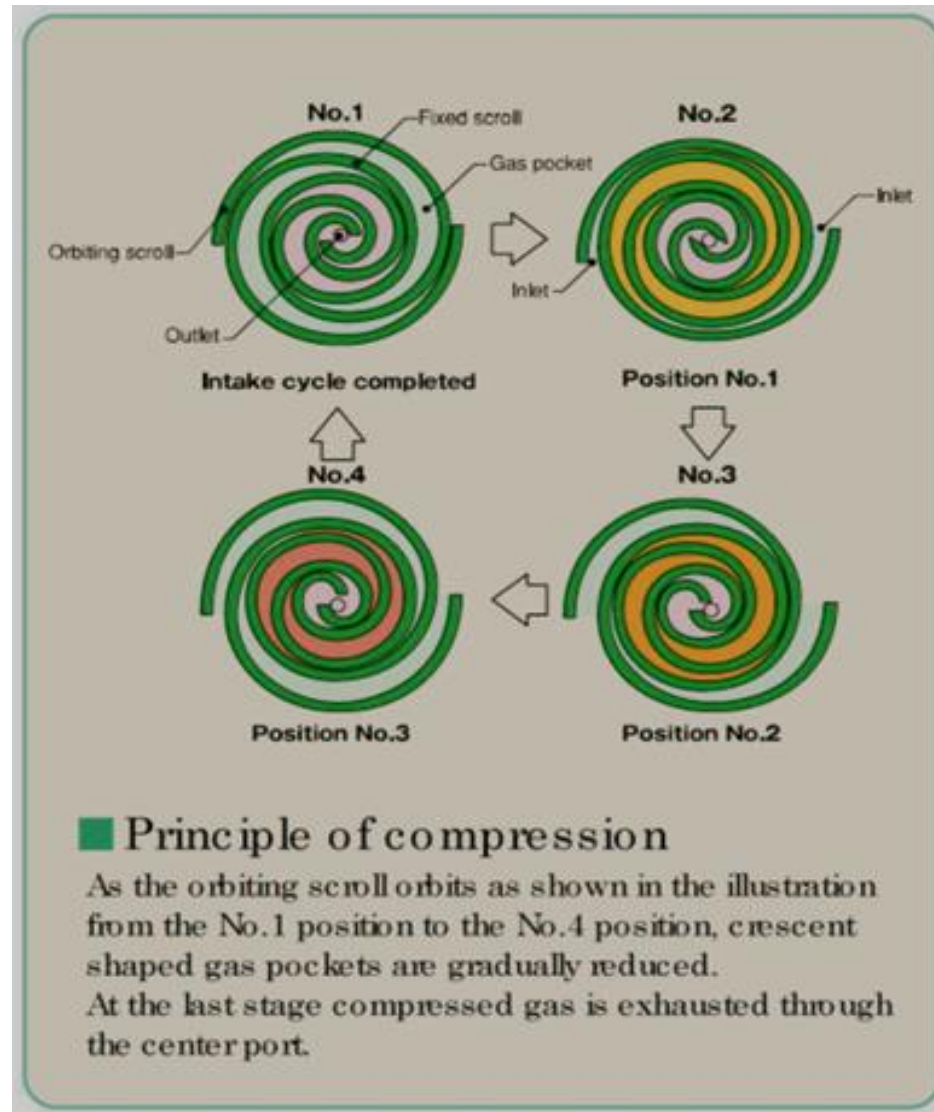


BOMBA DO TIPO ESPIRAL (“SCROLL”)

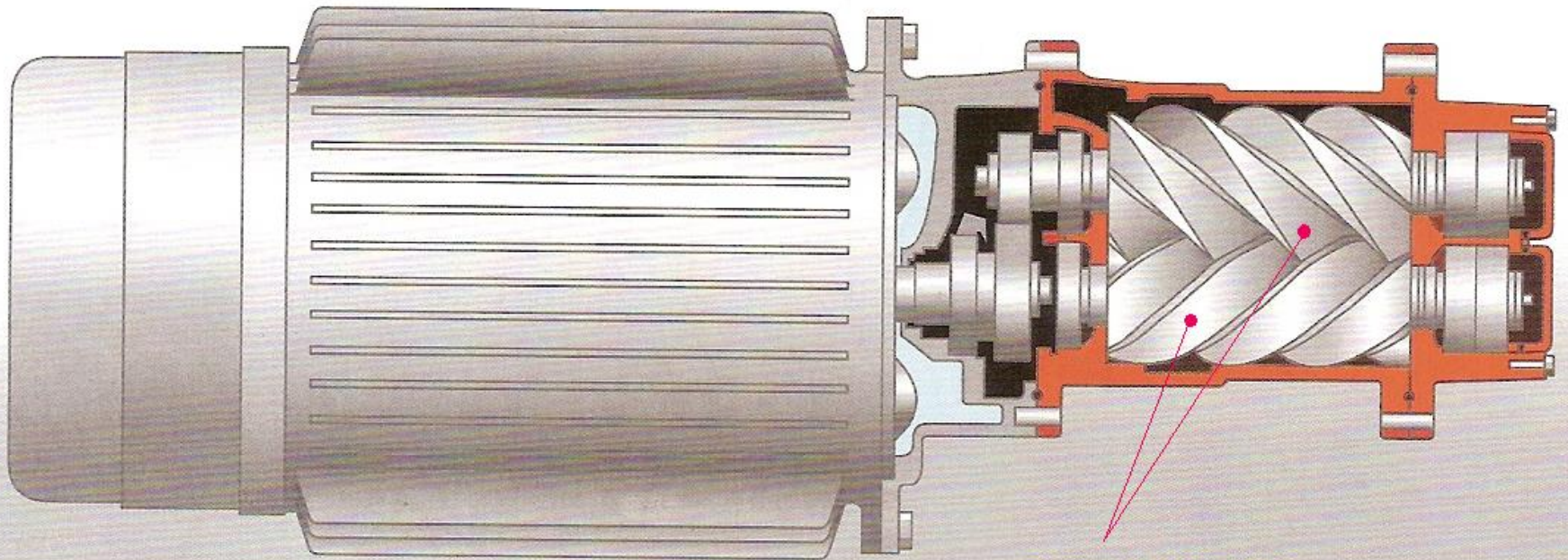




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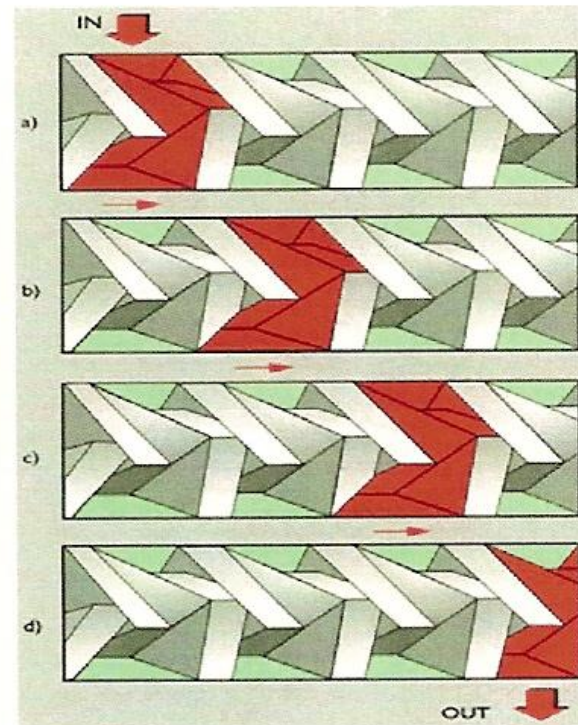
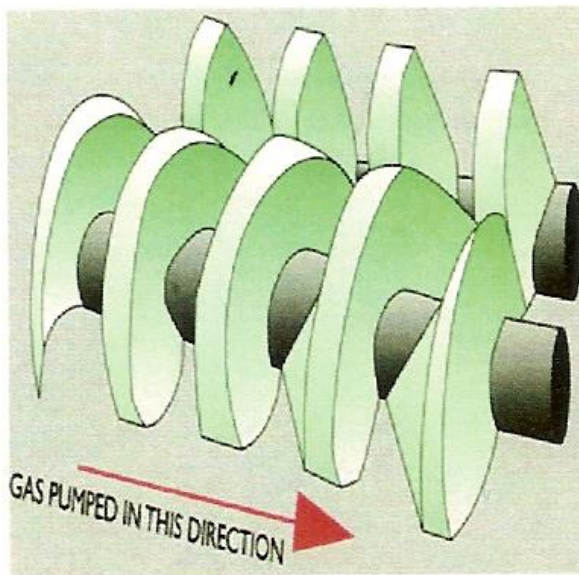


BOMBA DE PARAFUSOS



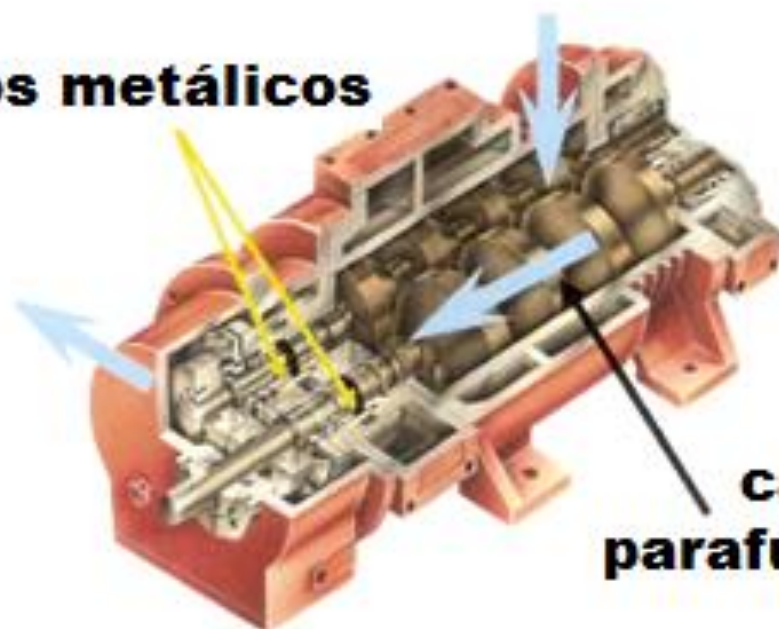
**PARAFUSOS
(SEM CONTATO)**

BOMBA AUTOLUBRIFICADA - TIPO DE PARAFUSOS



BOMBA AUTOLUBRIFICADA - TIPO DE PARAFUSOS

selos metálicos

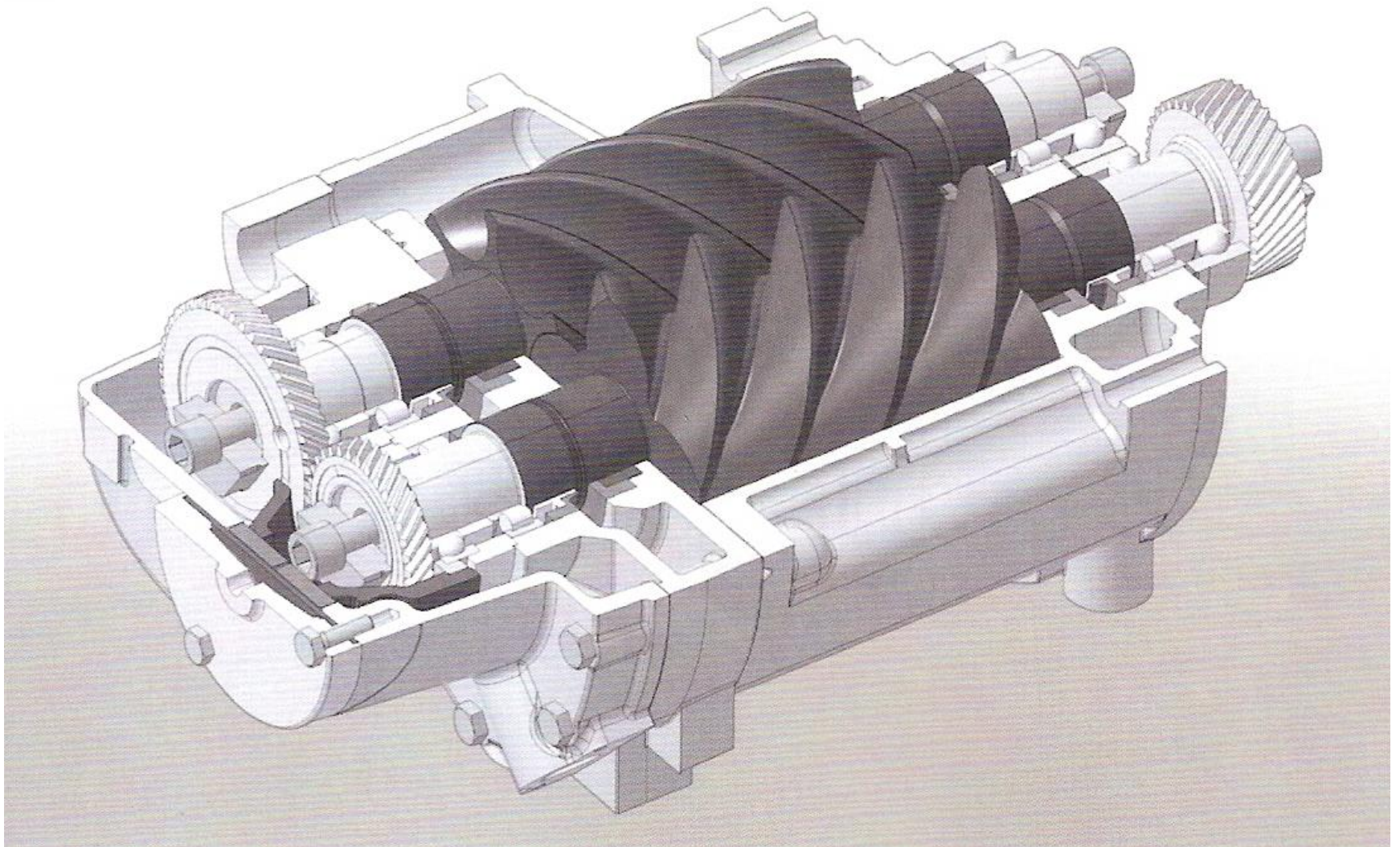


**câmara seca
parafusos sem contato**

Pressão final: 5×10^{-2} Torr

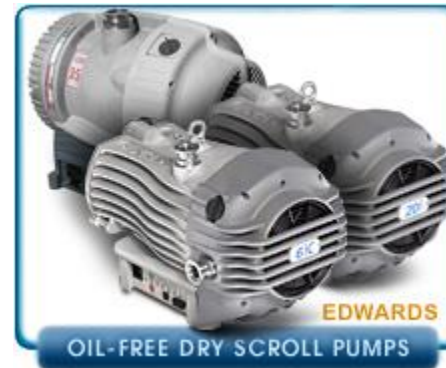
Velocidade: 90 a 460 cfm

BOMBA DE PARAFUSOS

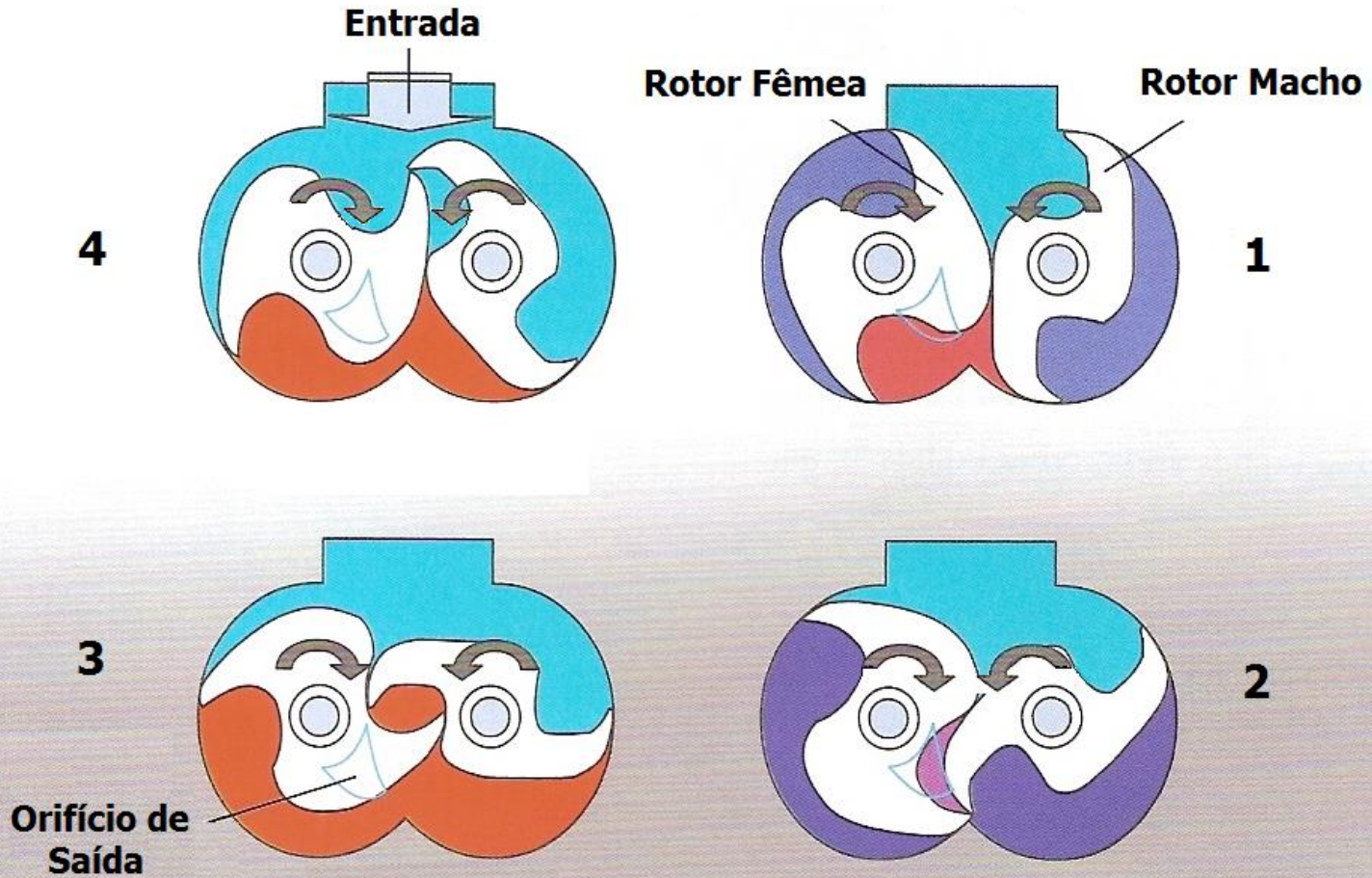


BOMBAS AUTOLUBRIFICADAS (“DRY”)

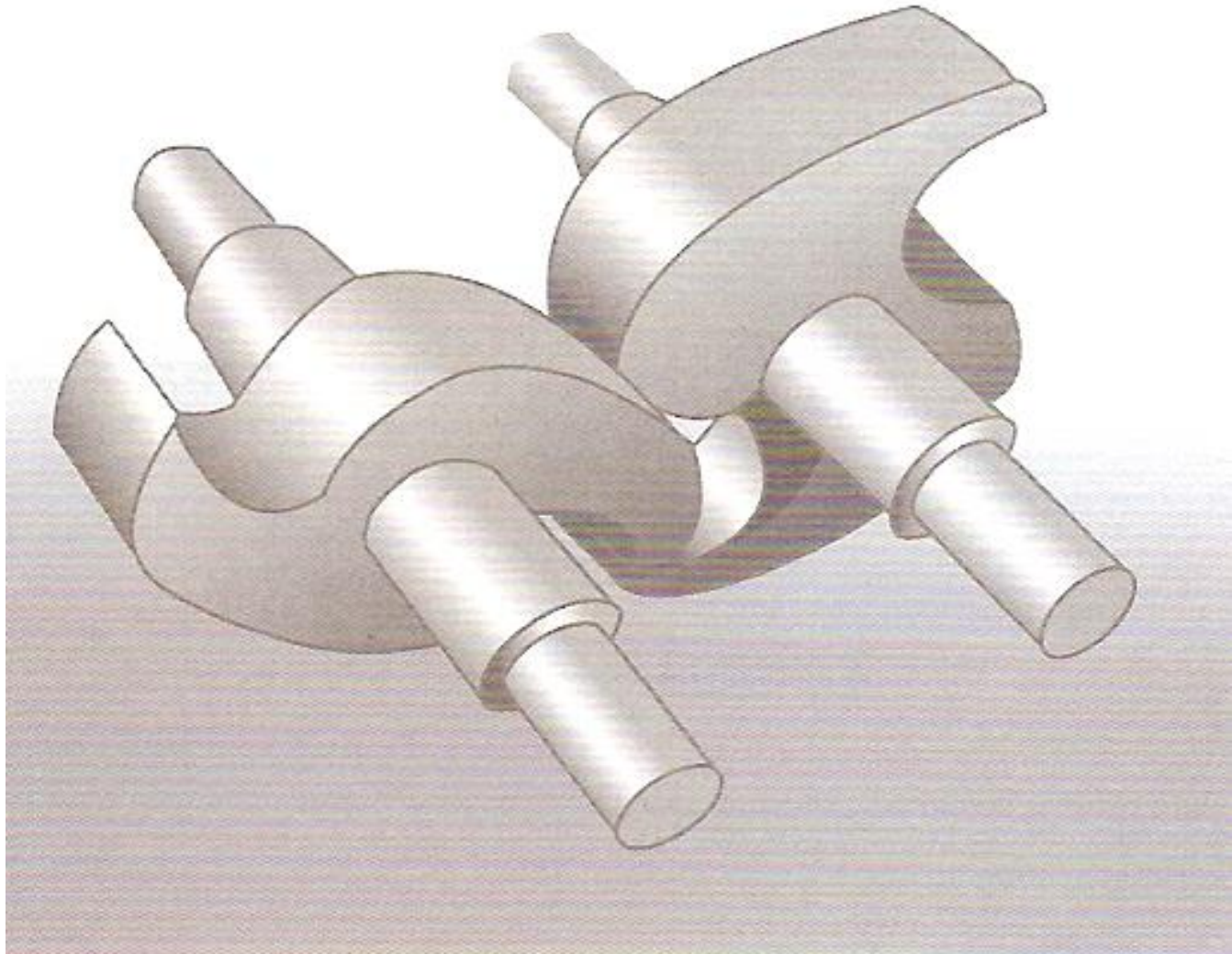
TIPO ESPIRAL (“SCROLL”)



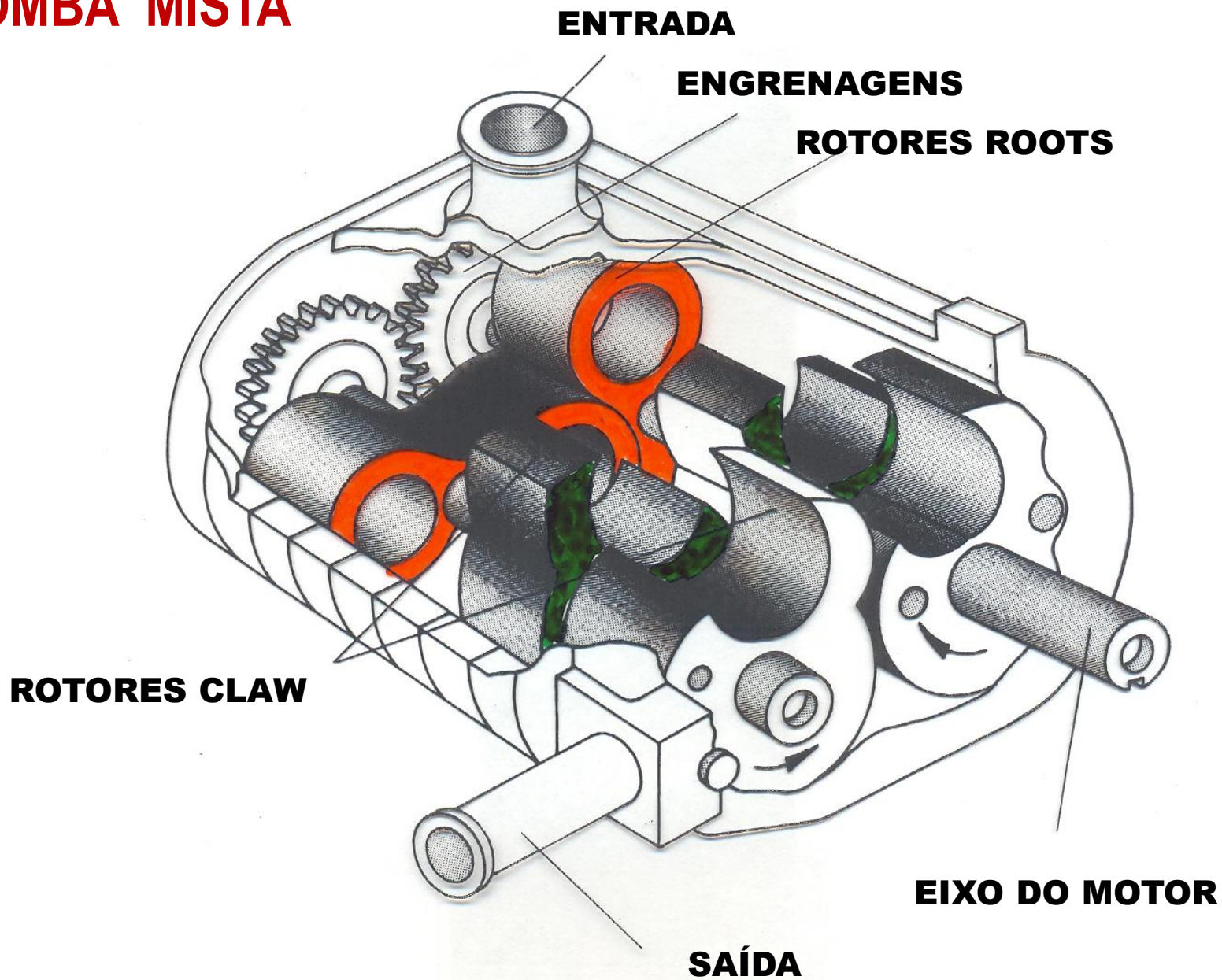
ROTORES “CLAW”



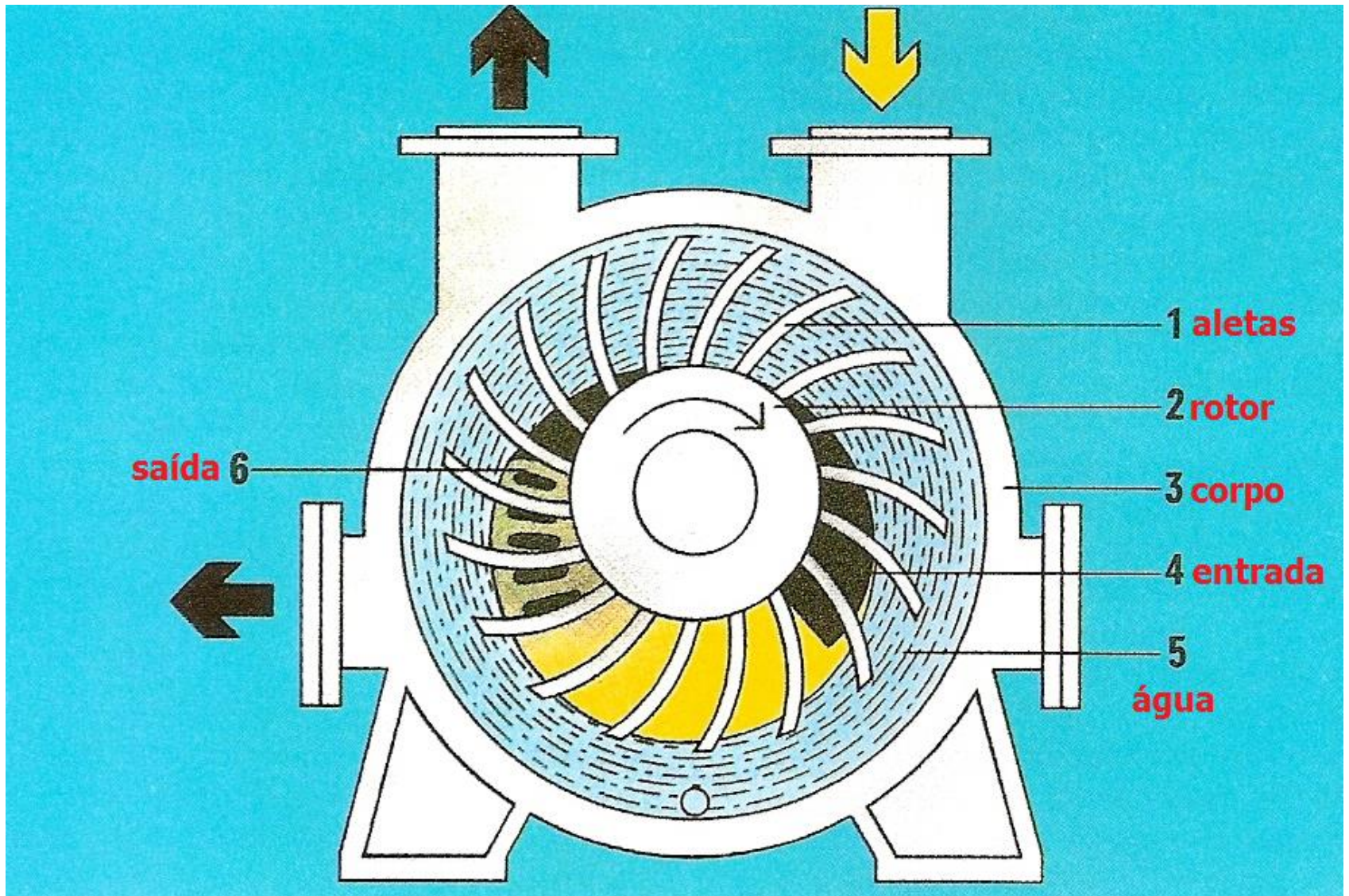
ROTORES “CLAW”



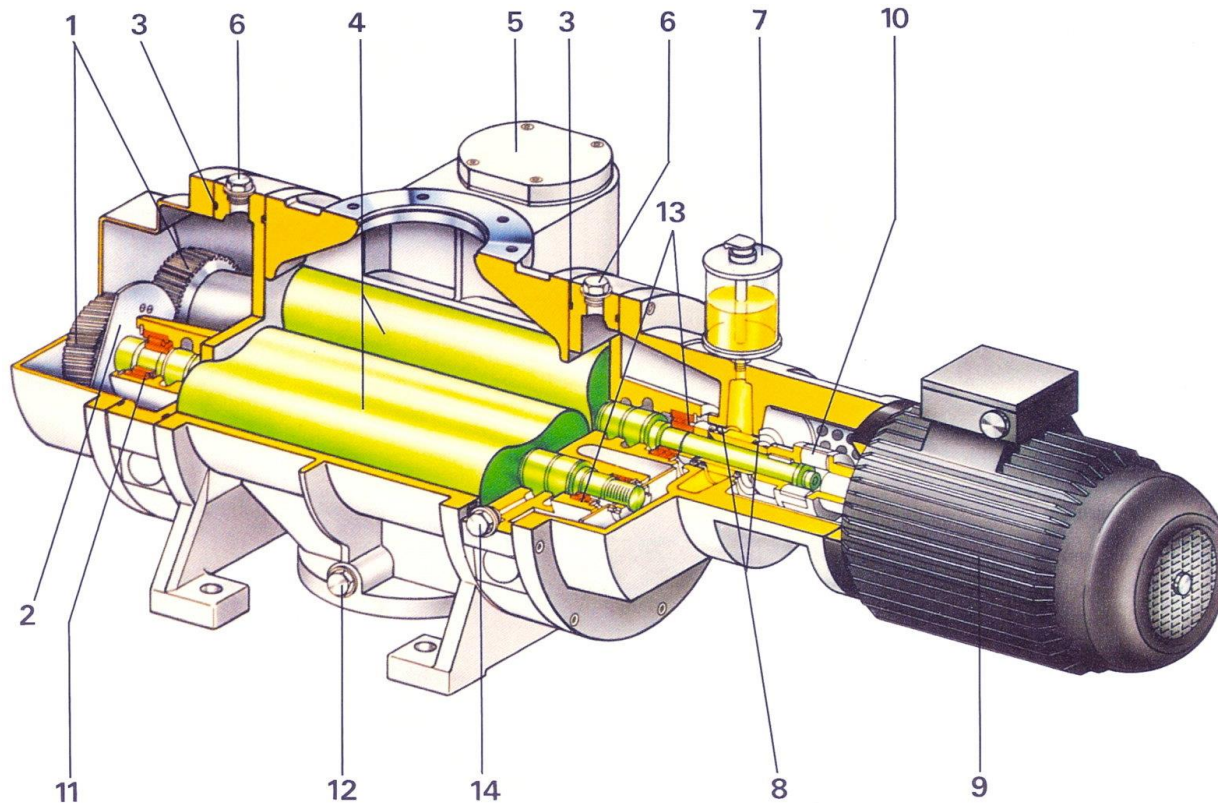
BOMBA MISTA



BOMBA DE ANEL LÍQUIDO

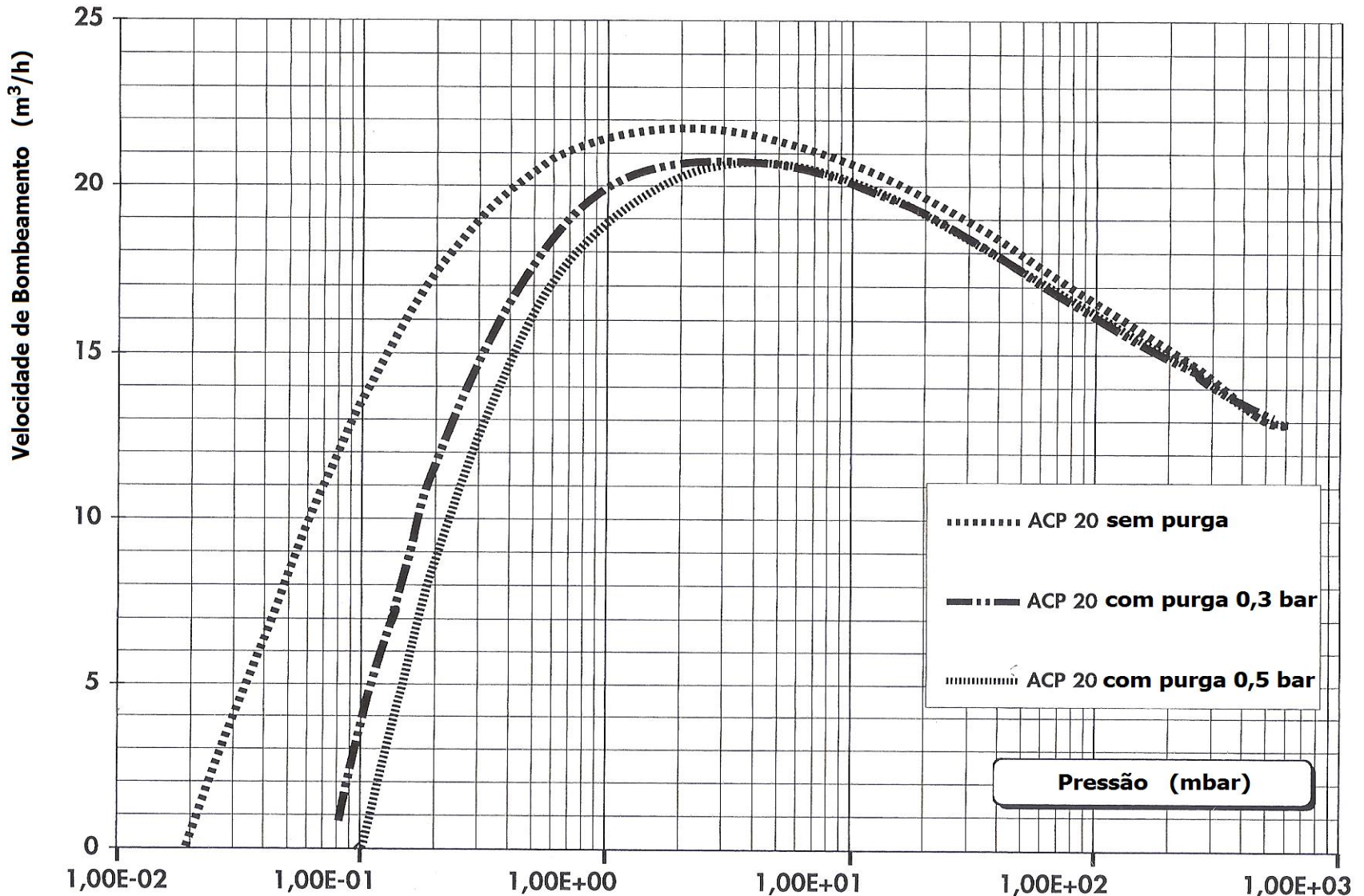


BOMBA ROOTS - CORTE



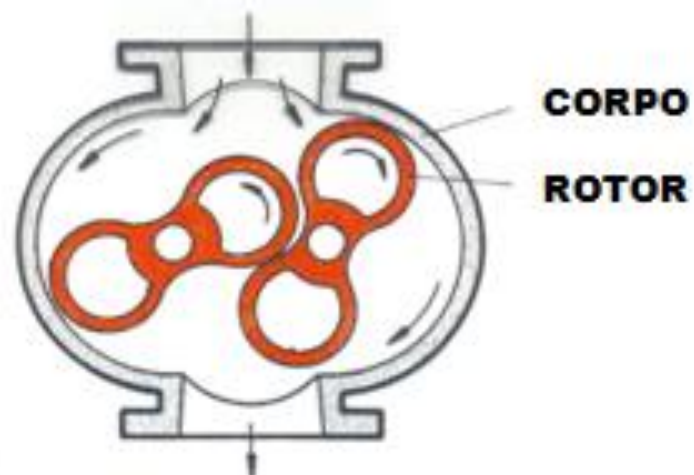
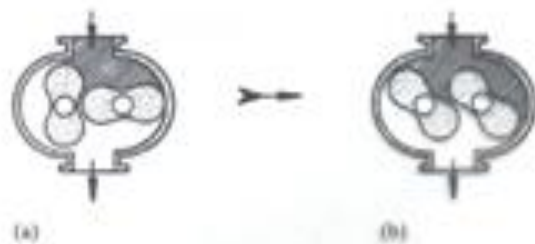
- 1 Engrenagens
- 2 Disco de óleo
- 3 O'ring
- 4 Rotores
- 5 Válvula de escape
- 6 Conexão de vácuo
- 7 Óleo
- 8 Gaxetas do eixo
- 9 Motor
- 10 Acoplamento
- 11 Rolamento
- 12 Medidor
- 13 Rolamentos
- 14 Conexão de gás

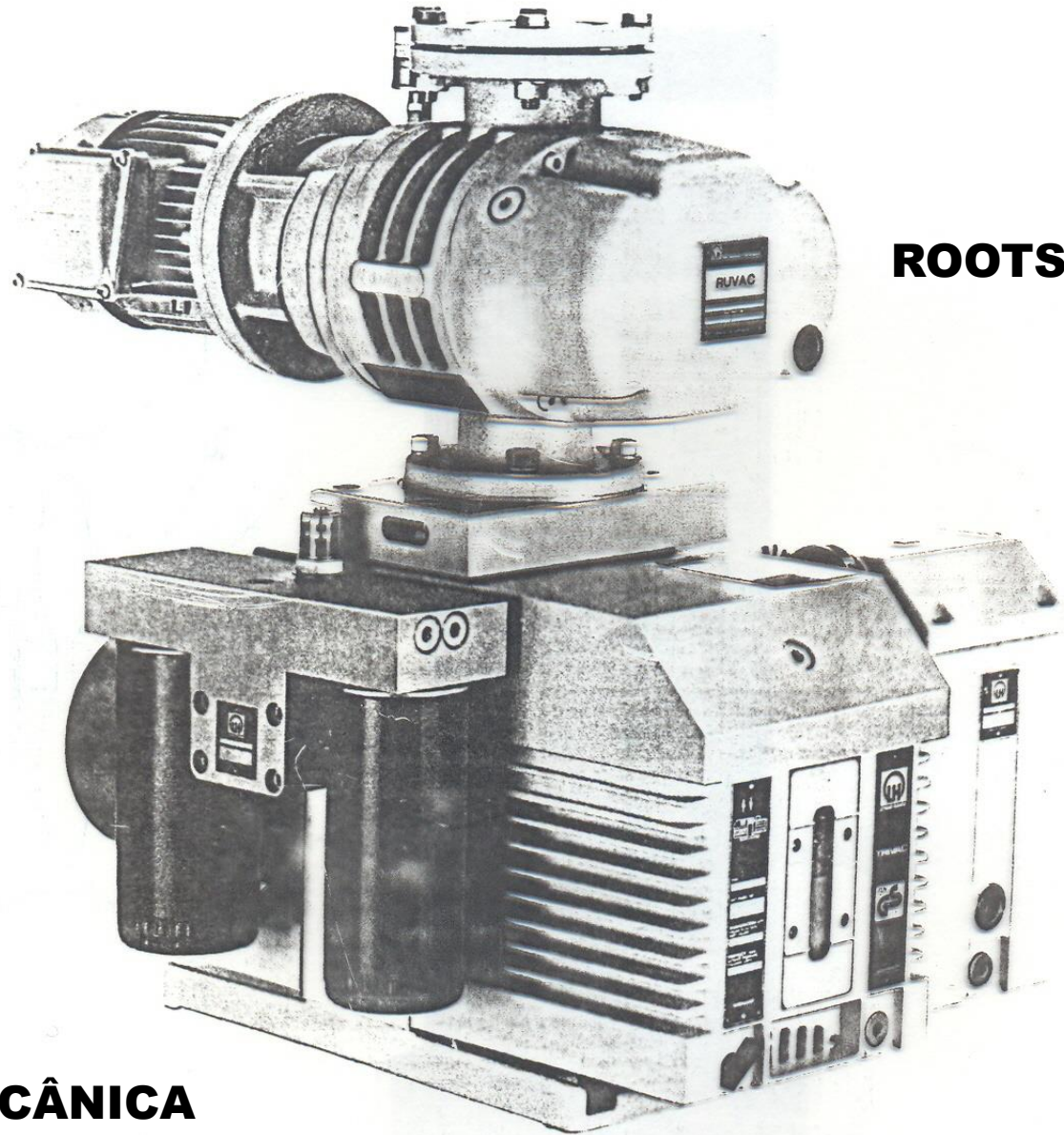
BOMBAS SECAS – CURVAS DE VELOCIDADE



BOMBA ROOTS

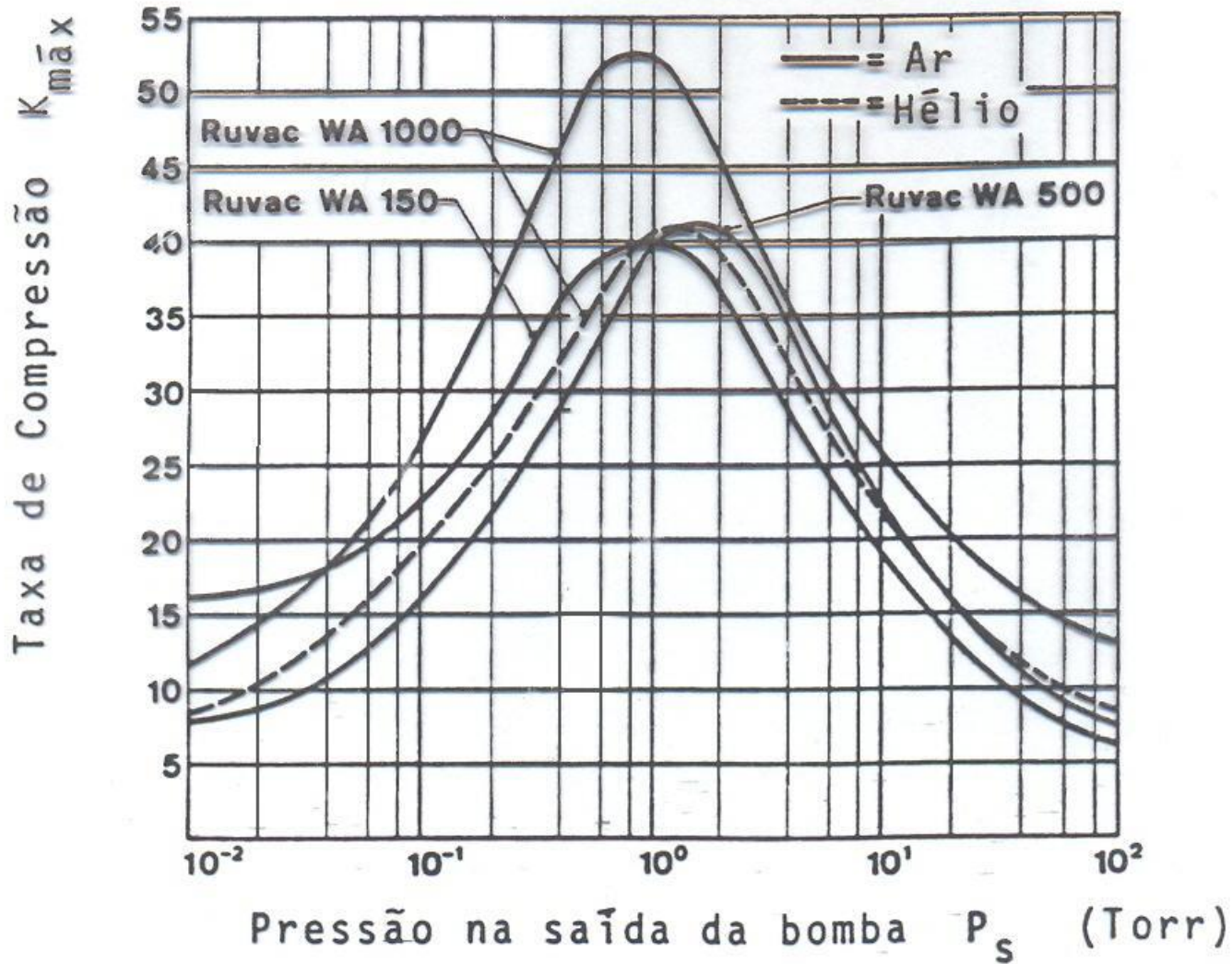
(SEM CONTATO
MECÂNICO)





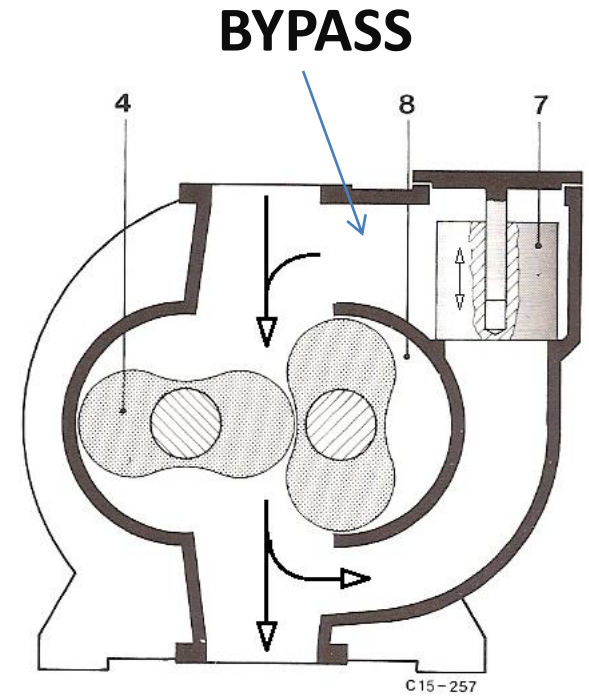
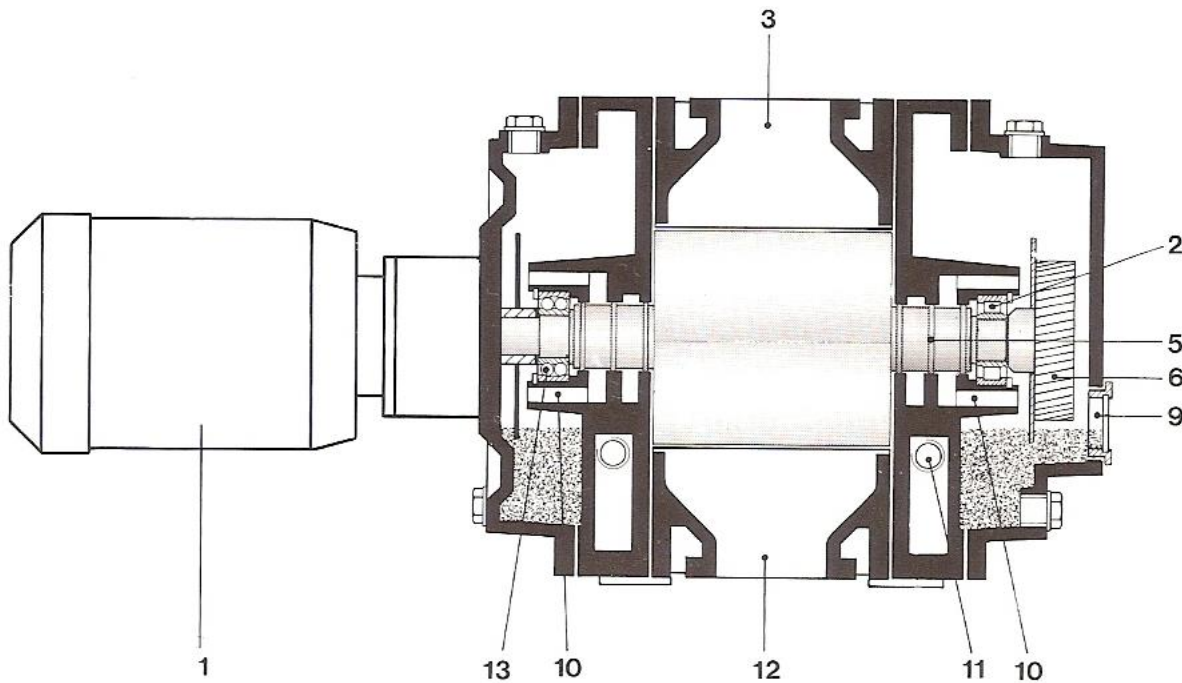
ROOTS

BOMBA MECÂNICA

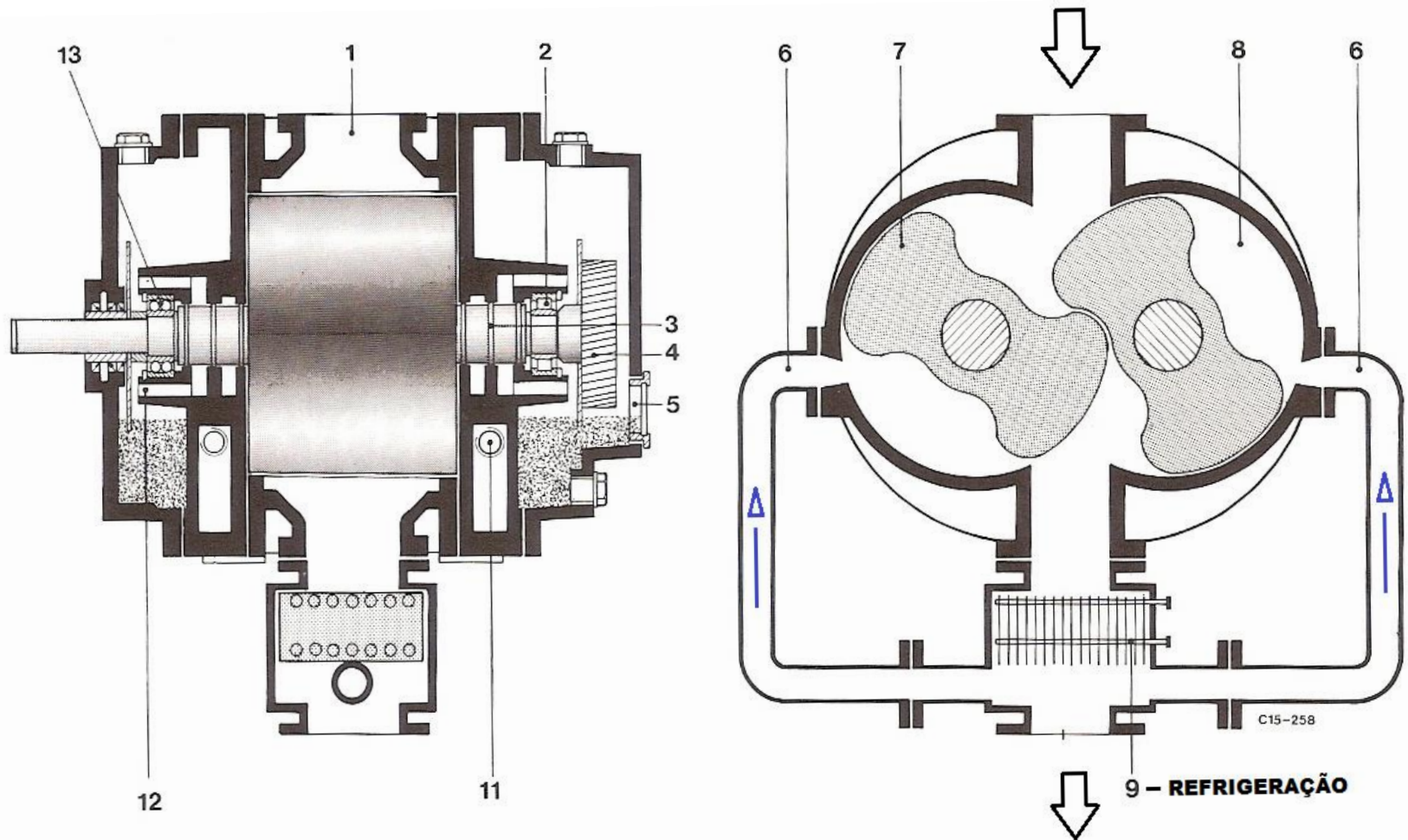


Variação da taxa de compressão K_{\max} com a Pressão P_s na saída da bomba.

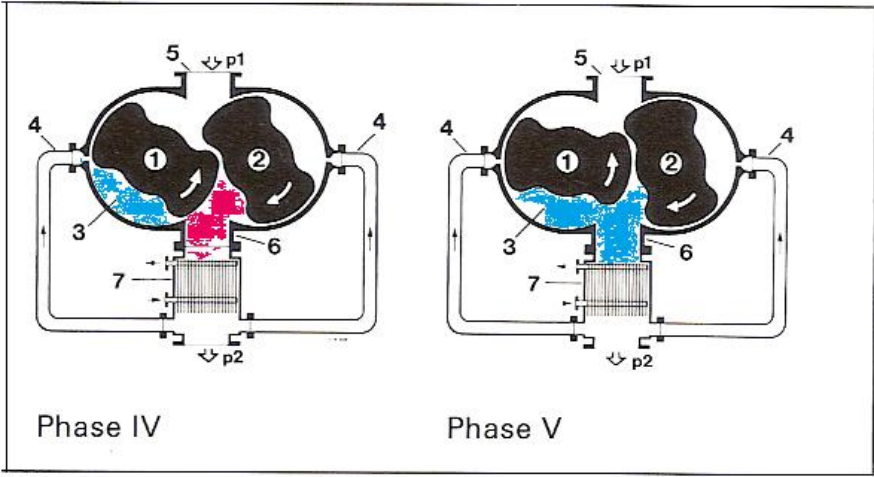
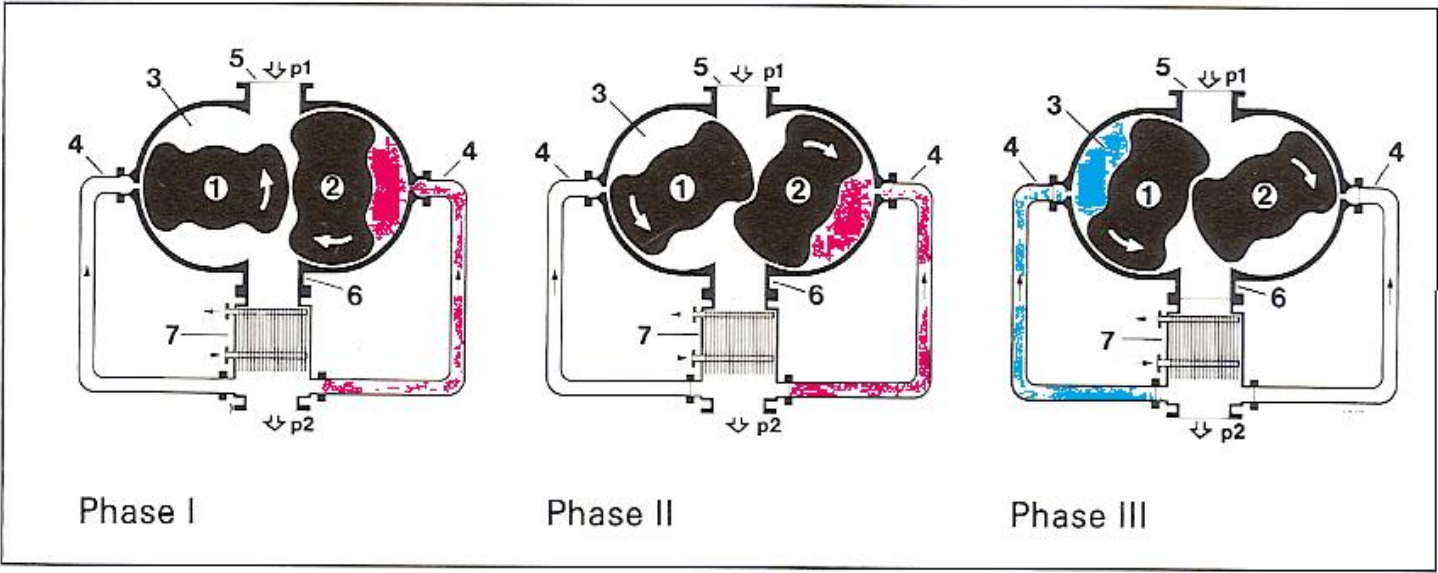
BOMBA ROOTS COM "BYPASS"



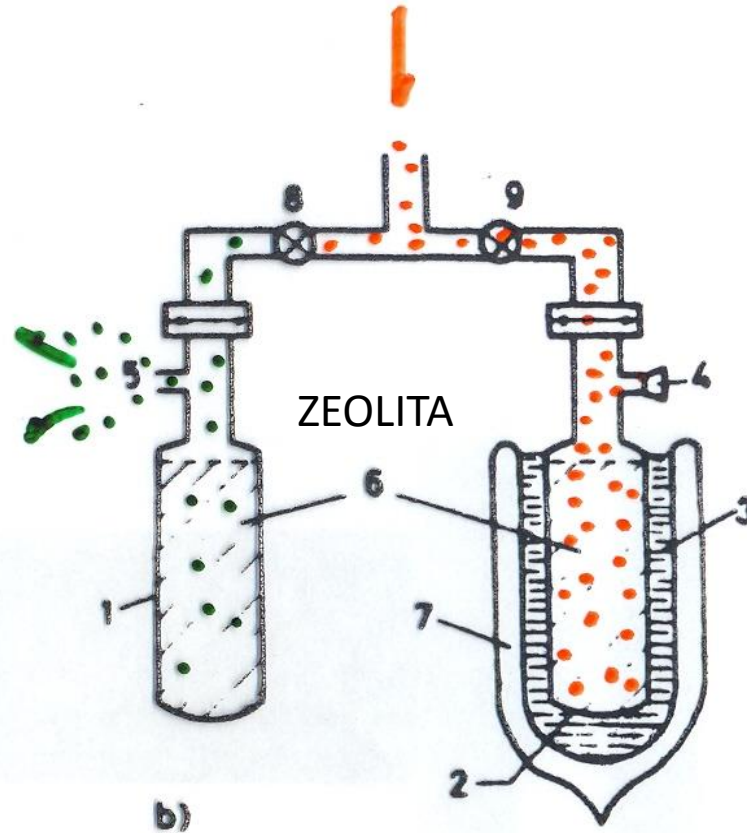
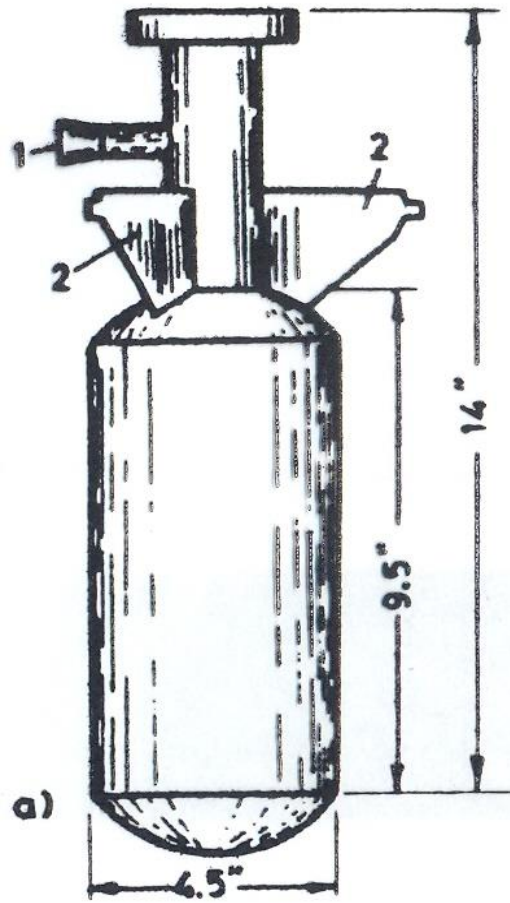
BOMBA ROOTS COM PURGA

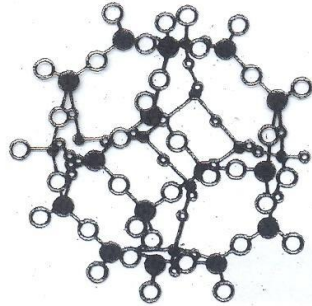


BOMBA ROOTS COM PURGA

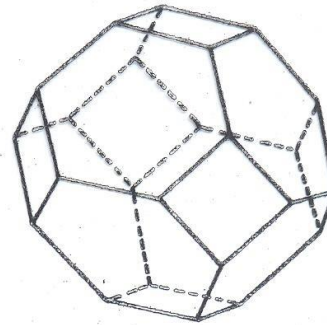


BOMBA DE SORÇÃO



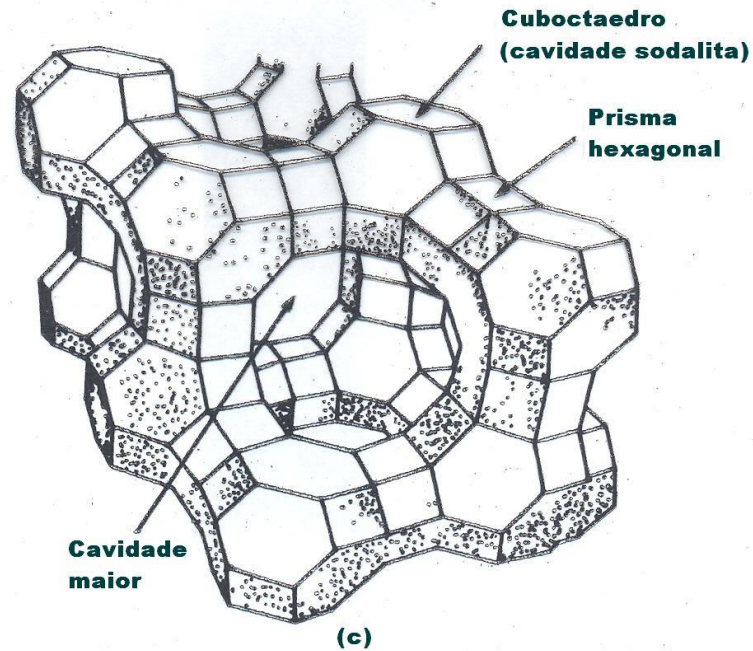


(a)



(b)

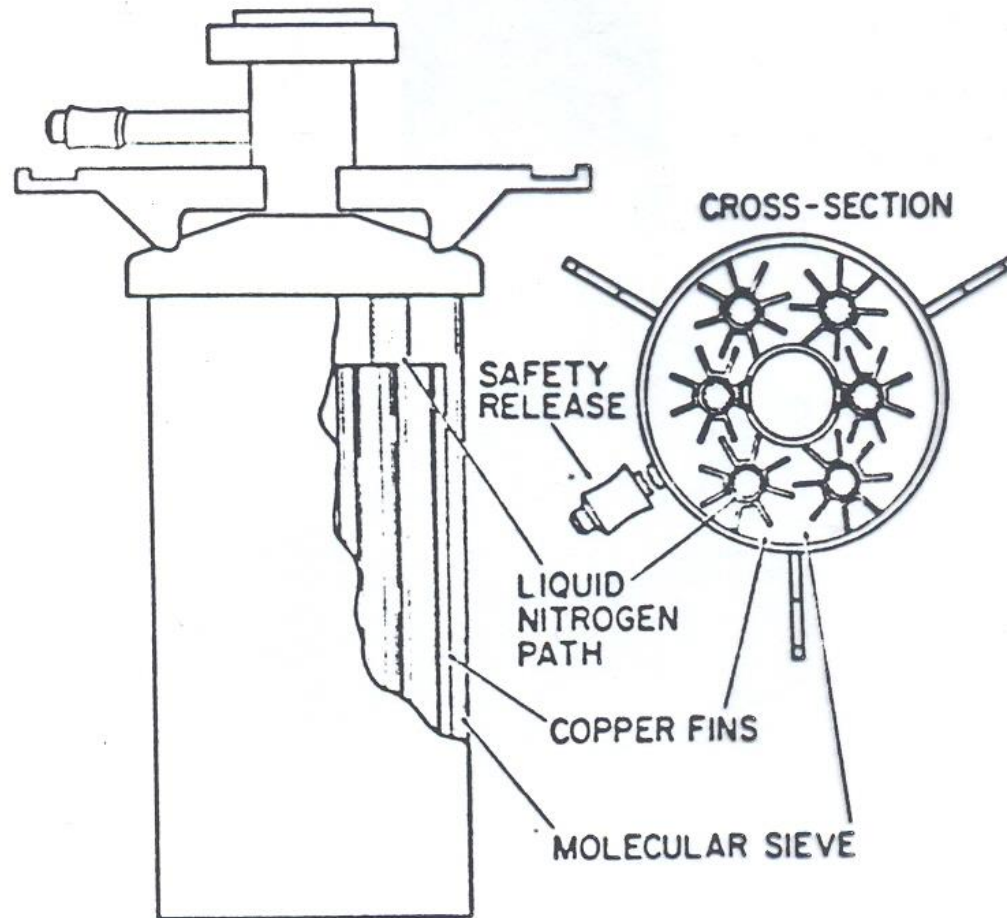
ZEÓLITA



(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).

BOMBA DE SORPÇÃO



Typical liquid-nitrogen-cooled sorption pump. Reprinted with permission from Ultek Division, Perkin-Elmer Corp., Palo Alto, CA 94303.





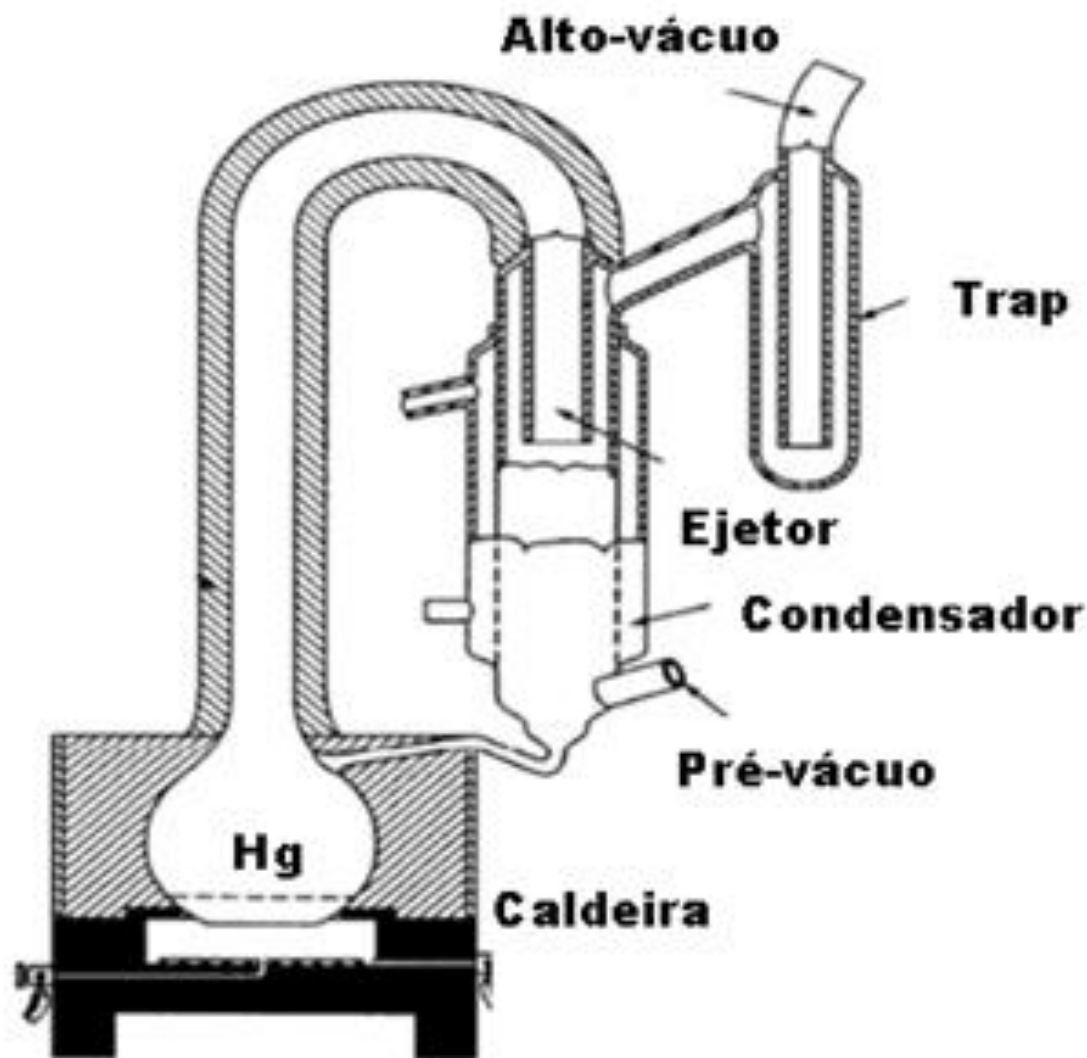


BOMBA DE DIFUSÃO A MERCÚRIO

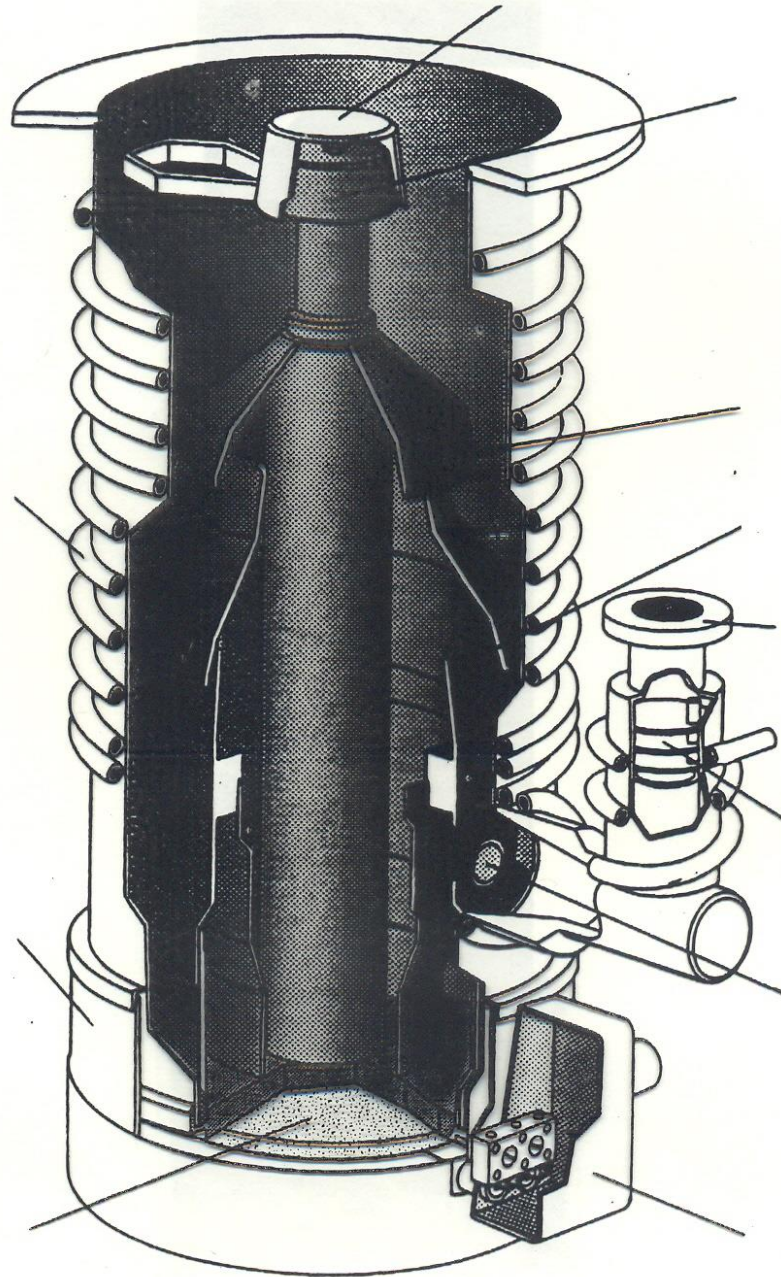
Primeiro modelo
de Langmuir

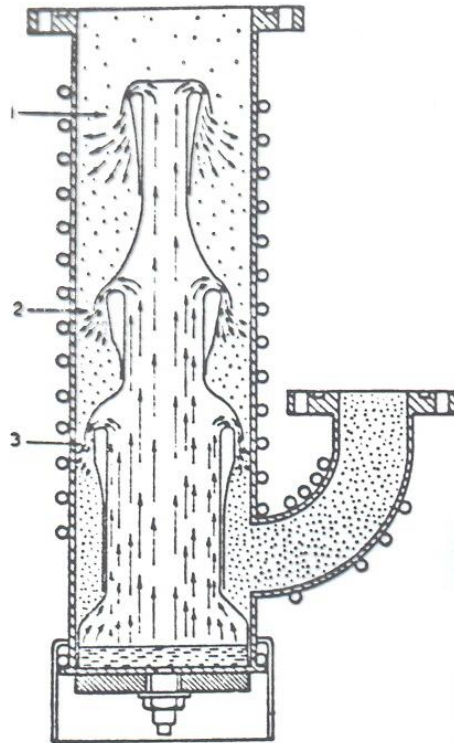
1916

$(2 \times 10^{-8}$ Torr)

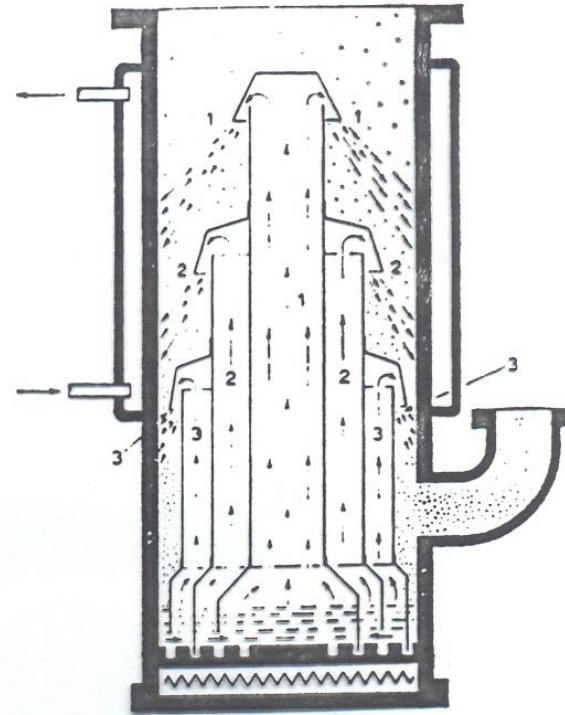


BOMBA DE DIFUSÃO





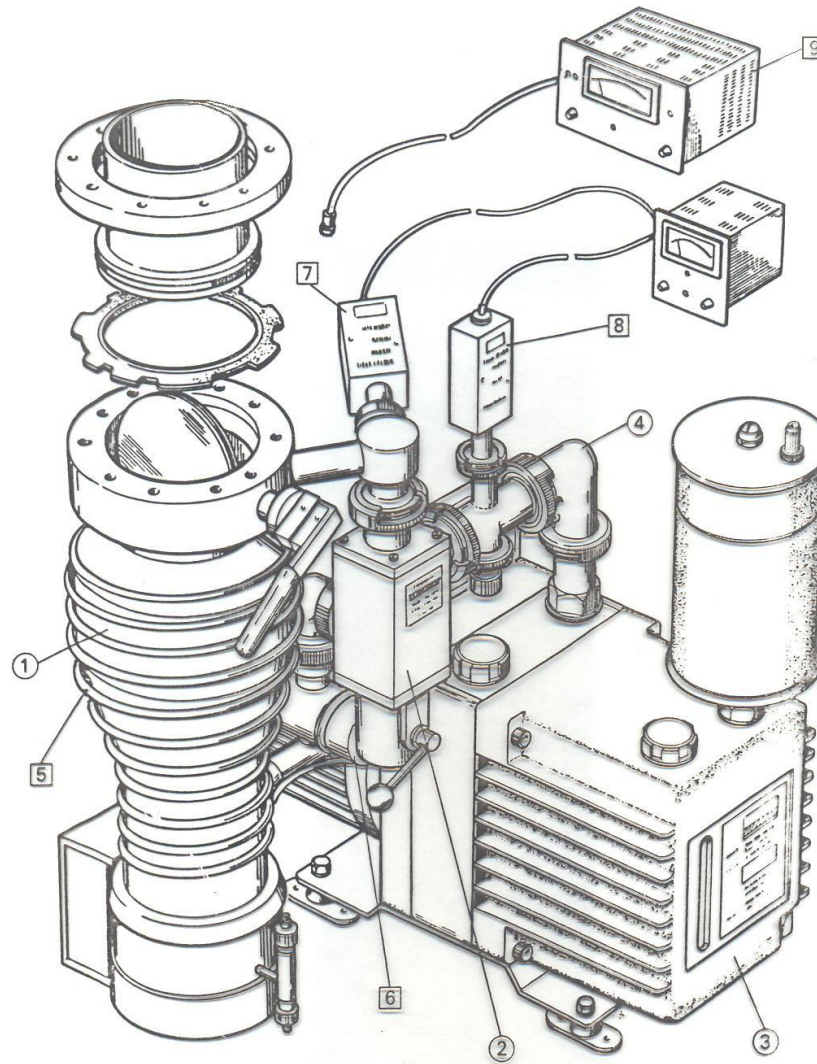
(a)



(b)

Esquemas de Bombas de Difusão de três estágios

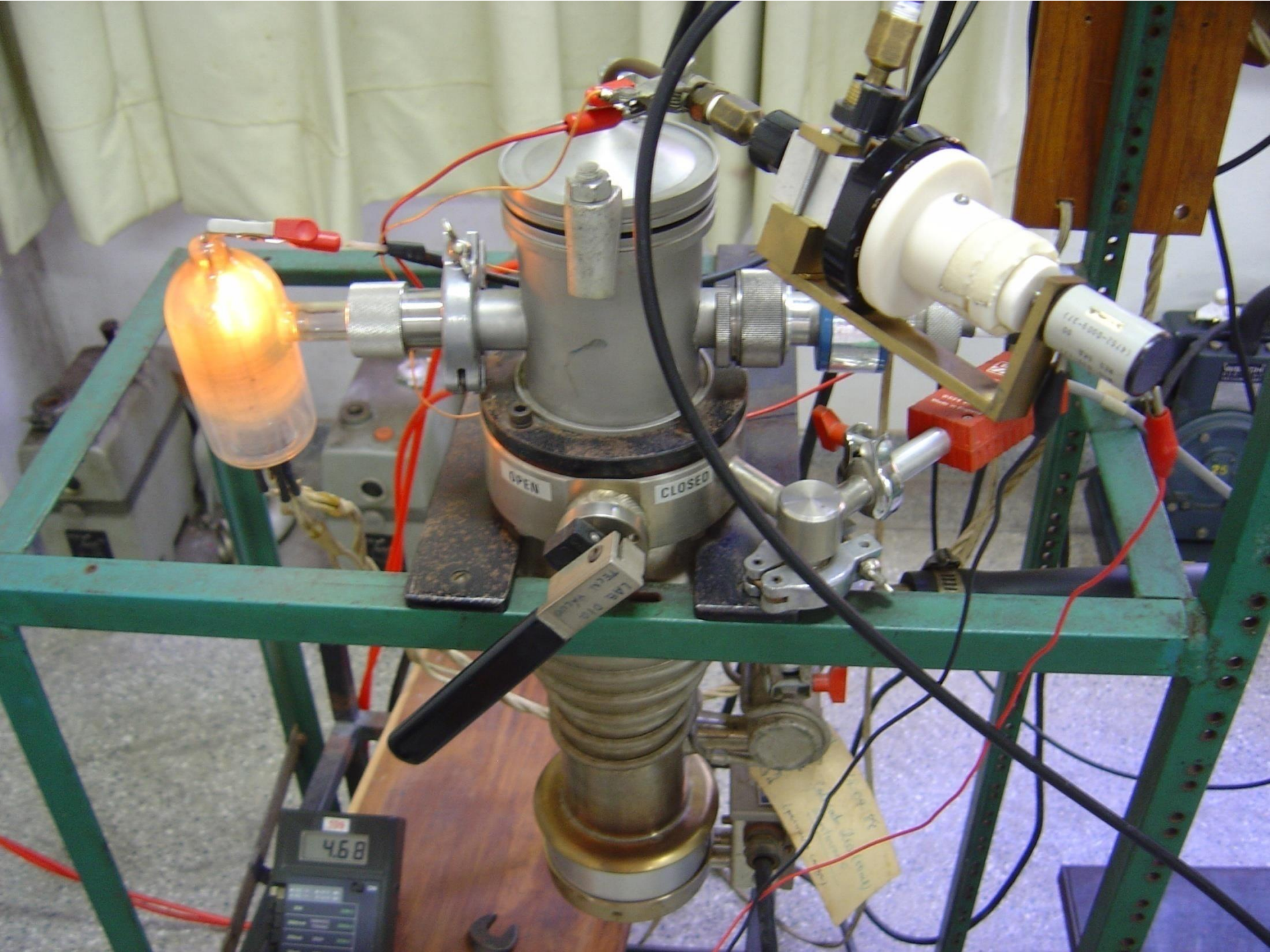
- a) desenho mais antigo; o óleo aquecido não sofre nenhum processo de purificação
- b) com tubos concêntricos permitindo a purificação do óleo por destilação fracionada, durante o funcionamento (o vapor de óleo mais aquecido e limpo sai pelo chapéu ("nozzle") 1.

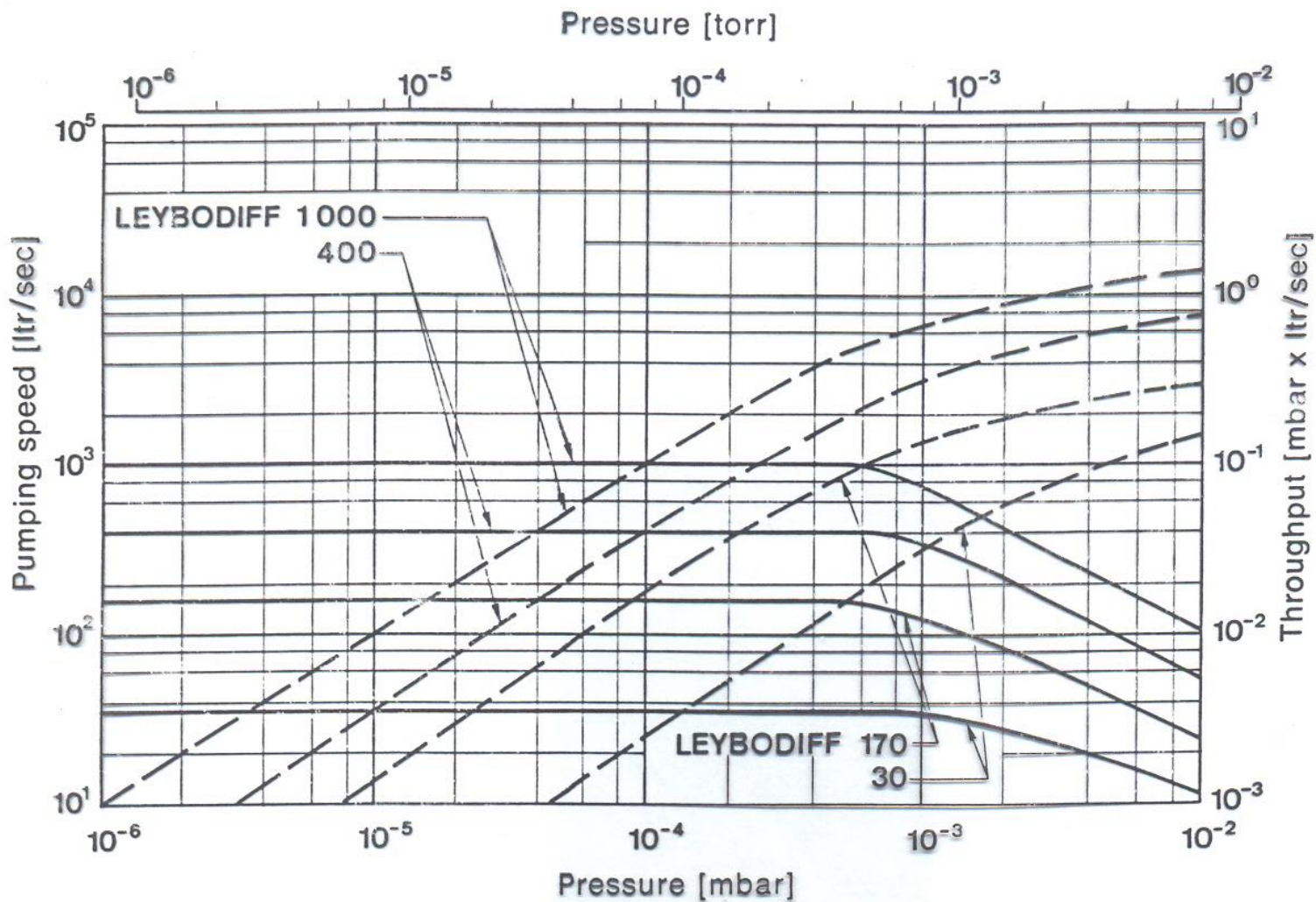


Conjunto para Alto Vácuo (Edwards)

- 1 - Bomba de Difusão com válvula acoplada ("Diffstak")**
- 2 - Válvula de isolamento (3 vias)**
- 3 - Bomba Mecânica (acoplamento direto)**
- 4 - Componentes modulares**

- 5 - Serpentina de refrigeração**
- 6 - Interruptor térmico**
- 7 - Medidor de pré-vácuo (Pirani)**
- 8 - Medidor de pré-vácuo (Pirani)**
- 9 - Medidor de alto-vácuo (Penning) (o sensor fica na câmara)**





Pumping speed (left) and throughput (right) of LEYBODIFF pumps as a function of intake pressure

