Ciência e Tecnologia do Vácuo 430323

N. H. Medina

Instituto de Física da Universidade de São Paulo

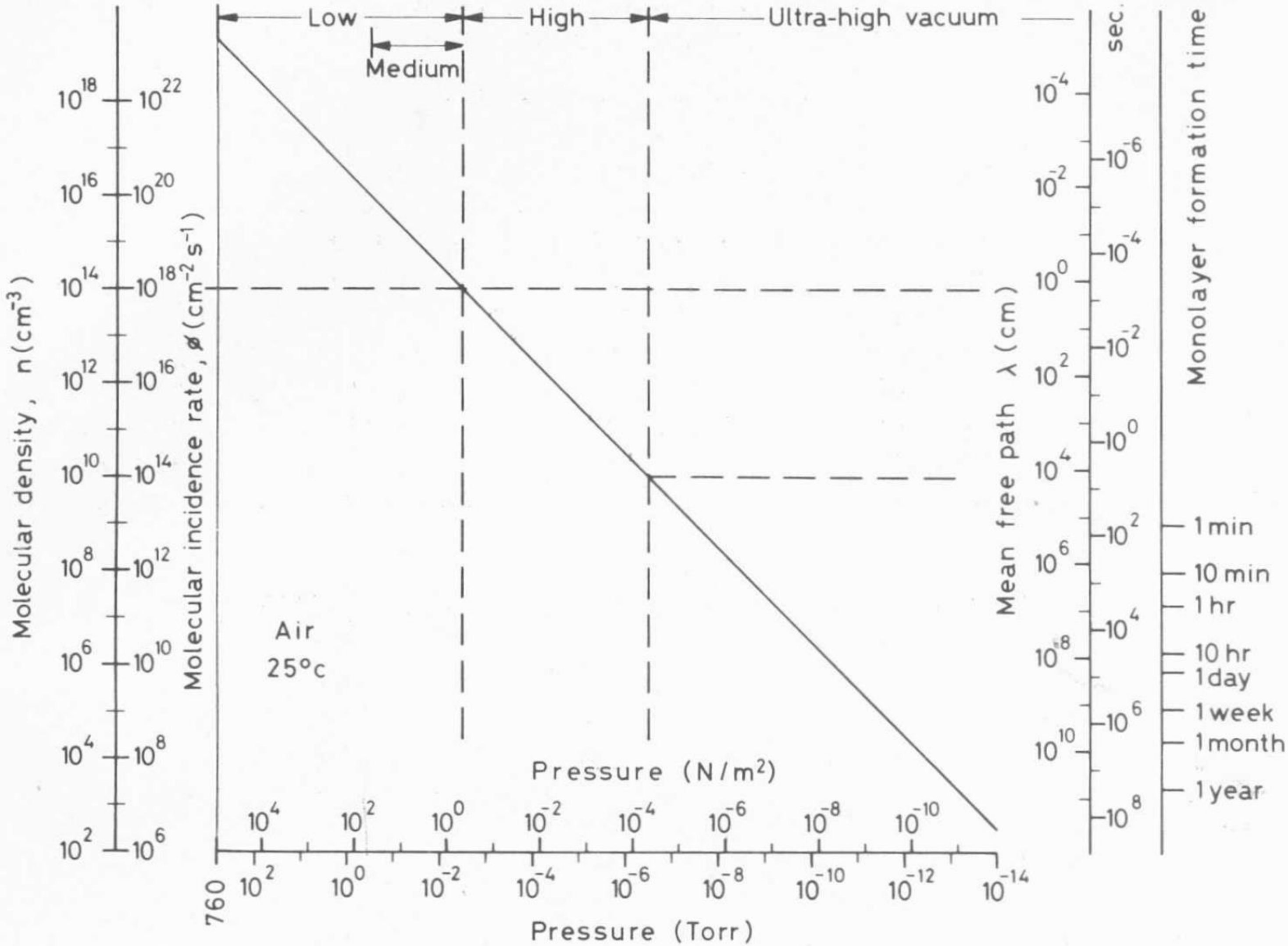

Fig. 1.1 Relationship of several concepts defining the degree of vacuum.

Vacuum Technology – A. Roth, 1990, 3a edição, North-Holland

Table 1.3.
Gas compositions.

Component	Atmosphere[1] Percent by volume	Atmosphere[1] Partial pressure Torr	Ultra-high vacuum Partial pressure Torr (2)	Ultra-high vacuum Partial pressure Torr (3)
N_2	78.08	5.95×10^{2}	2×10^{-11}	—
O_2	20.95	1.59×10^{2}	—	3×10^{-13}
Ar	0.93	7.05	6×10^{-12}	—
CO_2	0.033	2.5×10^{-1}	6.5×10^{-11}	6×10^{-12}
Ne	1.8×10^{-3}	1.4×10^{-2}	5.2×10^{-11}	—
He	5.24×10^{-4}	4×10^{-3}	3.6×10^{-1}	—
Kr	1.1×10^{-4}	8.4×10^{-4}	—	—
H_2	5.0×10^{-5}	3.8×10^{-4}	1.79×10^{-9}	2×10^{-11}
Xe	8.7×10^{-6}	6.6×10^{-5}	—	—
H_2O	1.57	1.19×10^{1}	1.25×10^{-10}	9×10^{-13}
CH_4	2×10^{-4}	1.5×10^{-3}	7.1×10^{-11}	3×10^{-13}
O_3	7×10^{-6}	5.3×10^{-5}	—	—
N_2O	5×10^{-5}	3.8×10^{-4}	—	—
CO	—	—	1.4×10^{-10}	9×10^{-12}

(1) Norton (1962) p. 11, (2) Dennis and Heppel (1968) p. 105, (3) Singleton (1966) p. 355.

Vacuum Technology – A. Roth, 1990, 3a edição, North-Holland

Table 1.5.
Stages in the history of vacuum techniques.

Year	Author	Work (Discovery)
1643	Evangelista Torricelli	Vacuum in the 760 mm mercury column
1650	Blaise Pascal	Variation of Hg column with altitude
1654	Otto von Guericke	Vacuum piston pumps, Magdeburg hemispheres
1662	Robert Boyle	Pressure–volume law of ideal gases
1679	Edme Mariotte	
1775	A.L. Lavoisier	Atmospheric air : a mixture of nitrogen and oxygen
1783	Daniel Bernoulli	Kinetic theory of gases
1802	J.A. Charles J. Gay–Lussac	Volume temperature law of gases
1810	Medhurst	Propose first vacuum post lines
1811	Amedeo Avogadro	Constant molecular density of gases
1843	Clegg and Samuda	First vacuum railways (Dublin)
1850	Geissler and Toepler	Mercury column vacuum pump
1859	J.K. Maxwell	Gas molecule velocity laws
1865	Sprengel	Mercury drop vacuum pump
1874	H. McLeod	Compression vacuum gauge
1879	T.A. Edison	Carbon filament, incandescent lamp
1879	W. Crookes	Cathode ray tube
1881	J. Van der Waals	Equation of state of real gases
1893	James Dewar	Vacuum insulated flask
1895	Wilhelm Roentgen	X-rays
1902	A. Fleming	Vacuum diode
1904	Arthur Wehnelt	Oxide-coated cathode
1905	Wolfgang Gaede	Rotary vacuum pump
1906	Marcello Pirani	Thermal conductivity vacuum gauge
1907	Lee de Forest	Vacuum triode .
1909	W.D. Coolidge	Powder metallurgy of tungsten, Tungsten filament lamp
1909	M. Knudsen	Molecular flow of gases
1913	W. Gaede	Molecular vacuum pump
1915	W.D. Coolidge	X-ray tube
1915	W. Gaede	Diffusion pump
1915	Irying Langmuir	Gas filled incandescent lamp
1915	Saul Dushman	The kenotron
1916	Irving Langmuir	Condensation diffusion pump
1916	O.E. Buckley	Hot cathode ionization gauge
1923	F. Holweck	Molecular pump
1935	W. Gaede	Gas-ballast pump
1936	Kenneth Hickman	Oil diffusion pump
1937	F.M. Penning	Cold cathode ionization gauge
1950	R.T. Bayard and D. Alpert	Ultra-high vacuum gauge
1953	H.J. Schwartz, R.G. Herb	Ion pumps

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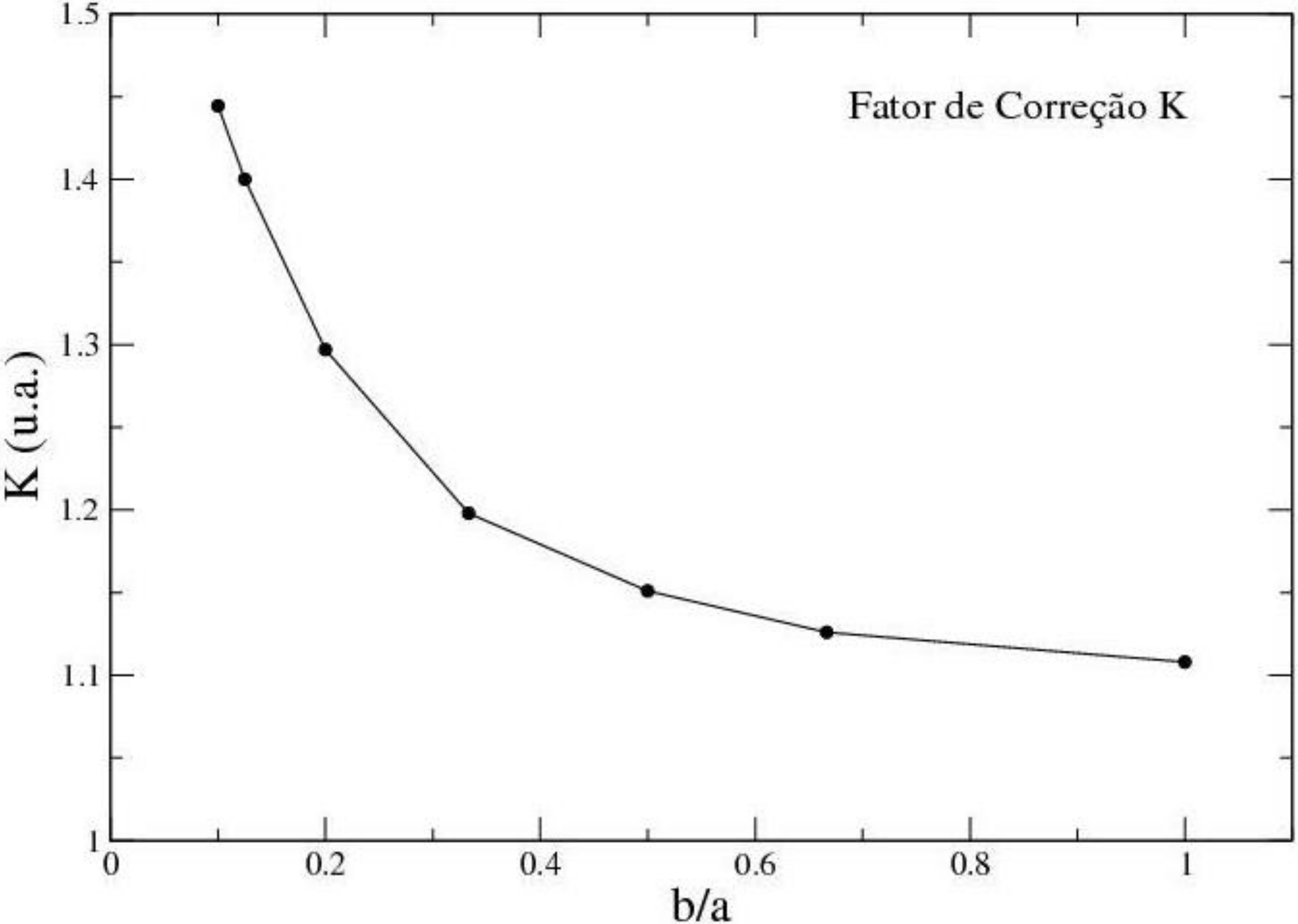


Fator de Correção K
K (u.a.)
b/a
1.5
1.4
1.3
1.2
1.1
1
0
0.2
0.4
0.6
0.8
1

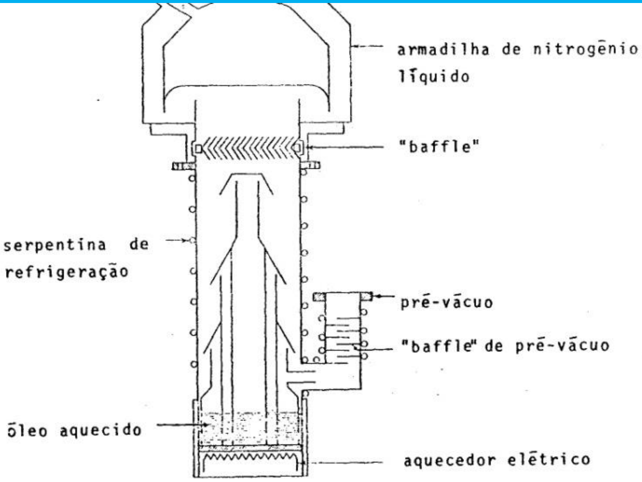


Fig. 29 - Bomba de Difusão com "baffle" chevron e armadilha de nitrogênio líquido ("cold trap")

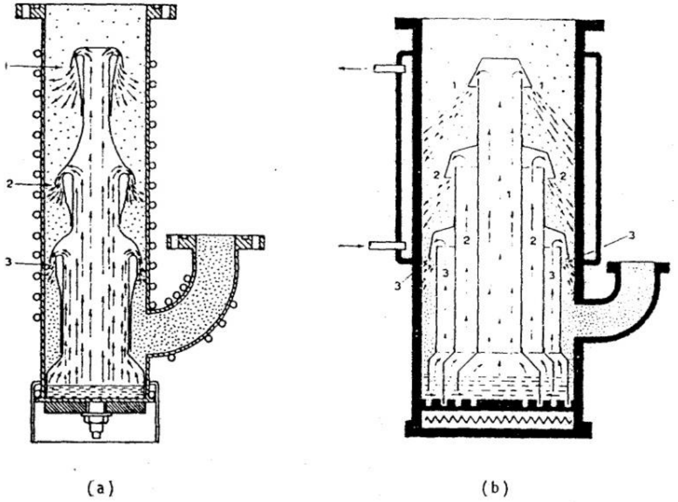


Fig. 30 - Esquemas de Bombas de Difusão de três estágios

a) desenho mais antigo; o óleo aquecido não sofre nenhum precesso 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.

Bomba de Difusão

Jato de vapor empurra as moléculas da câmara criando um gradiente de pressão.

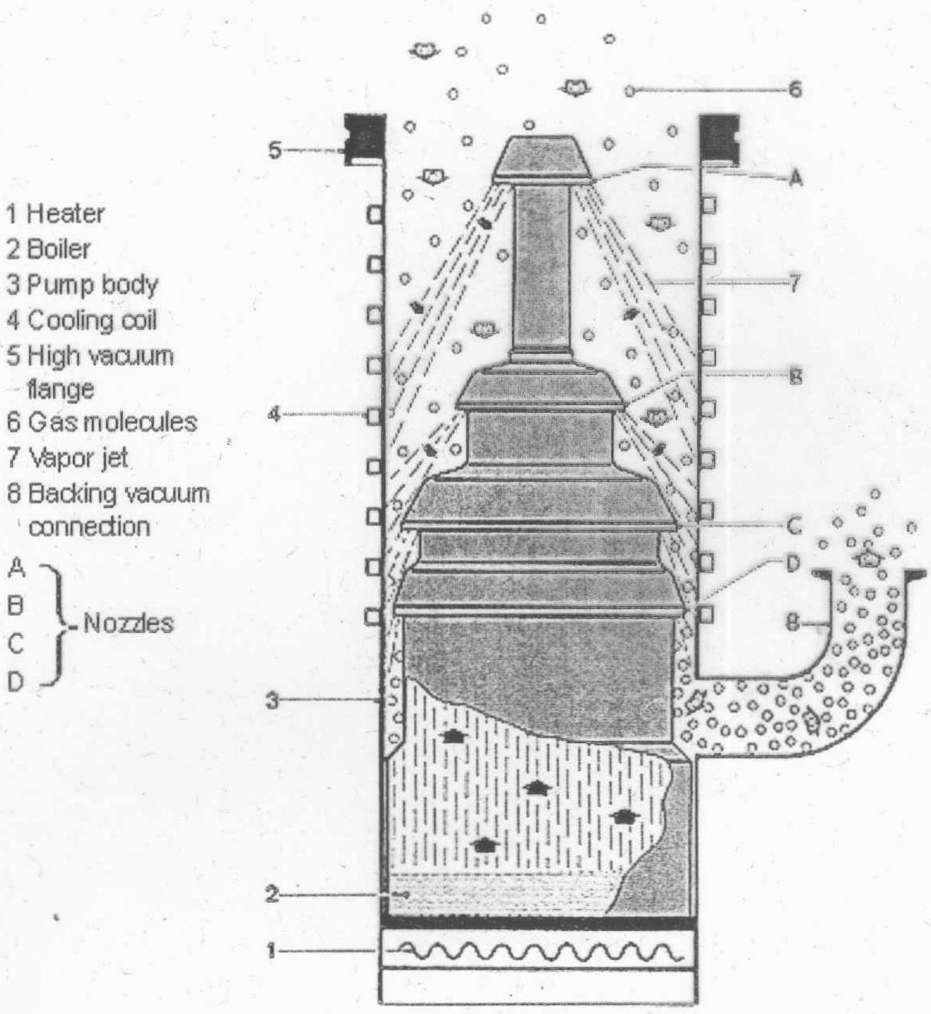


Fig. 2.44
Mode of operation of a diffusion pump

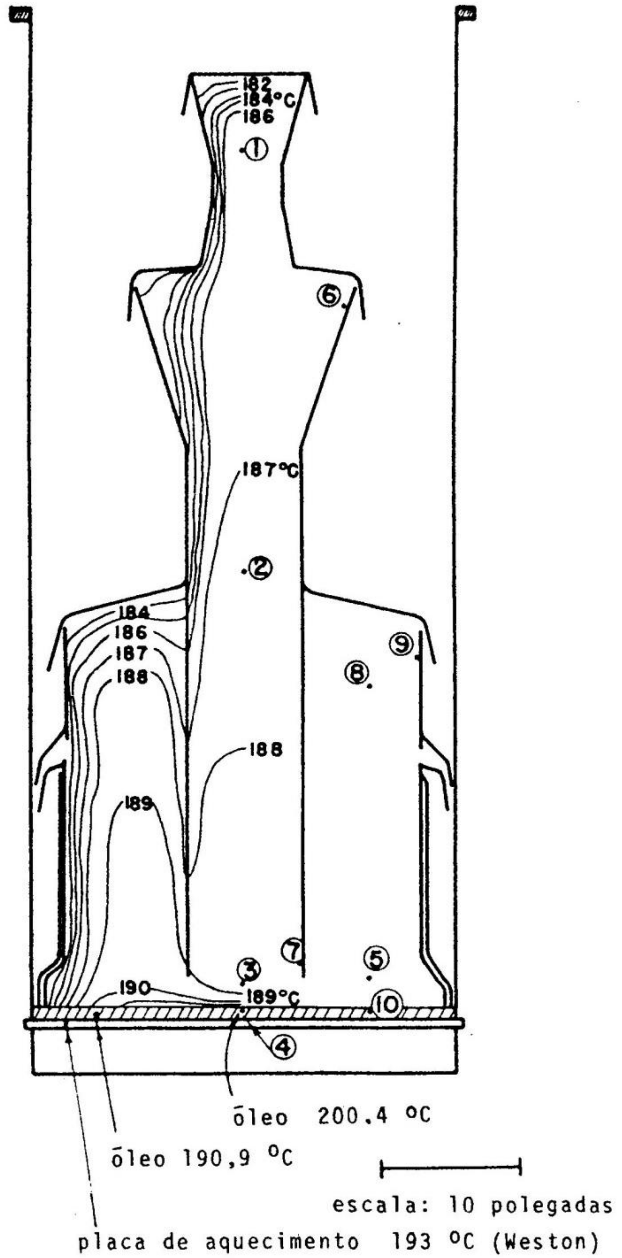
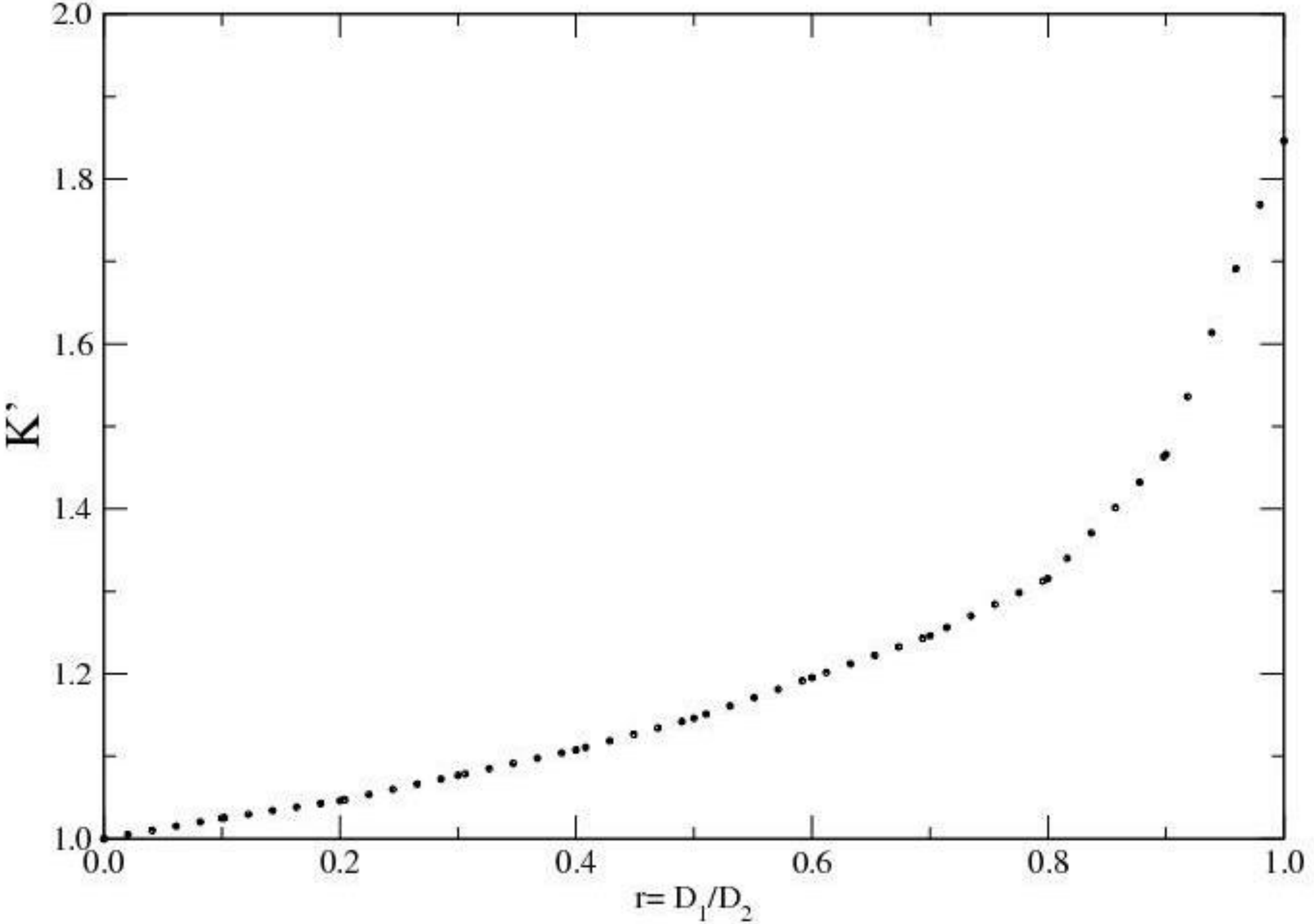
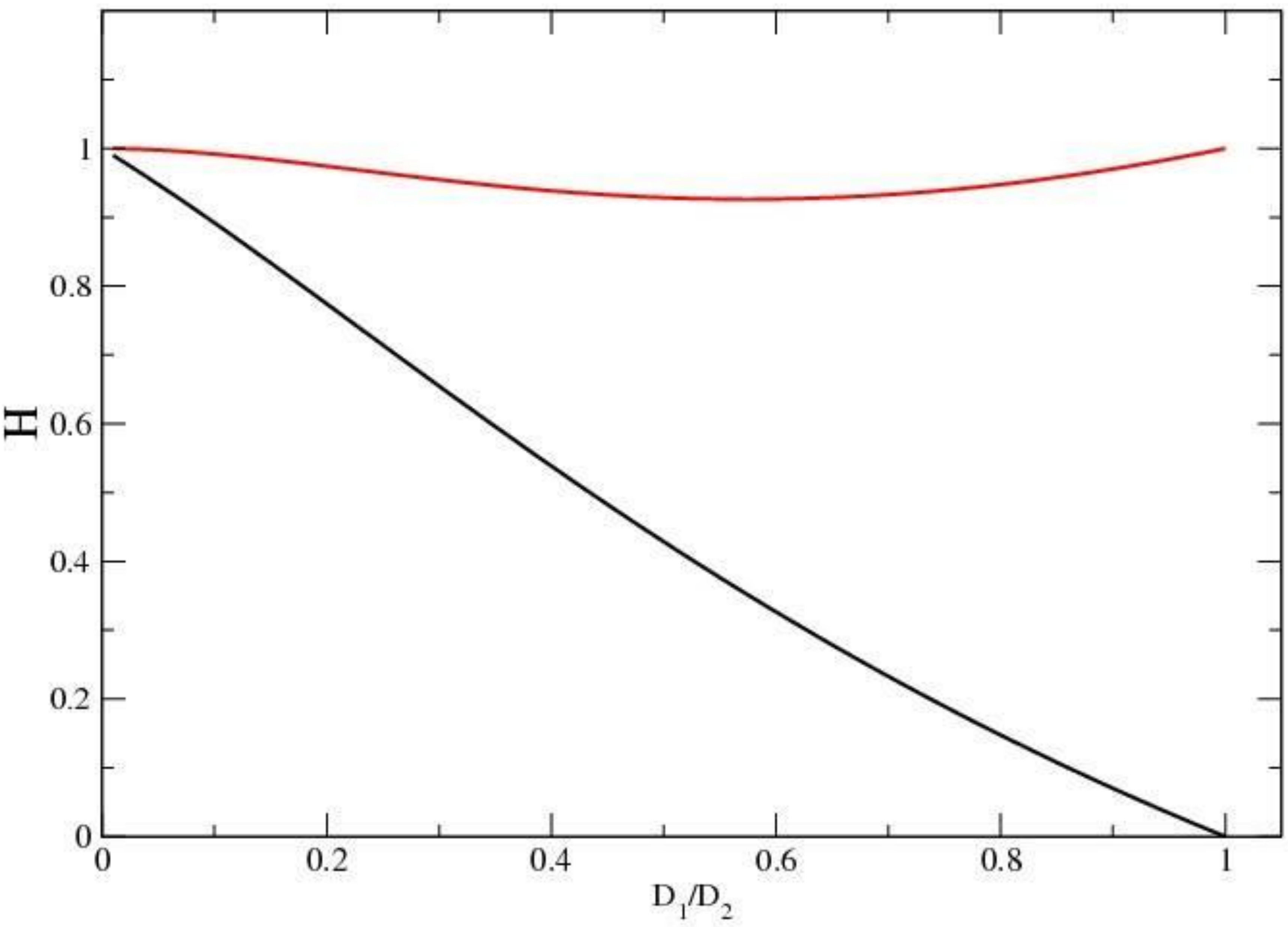


Fig. 31 - Diagrama isotérmico de uma Bomba de Difusão de 32". Os pontos numerados representam a localização dos termopares utilizados nas medições das temperaturas.



2.0
1.8
1.6
1.4
1.2
1.0
K'
0.0
0.2
0.4
0.6
0.8
1.0
r= D1/D2



H
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
D_1/D_2

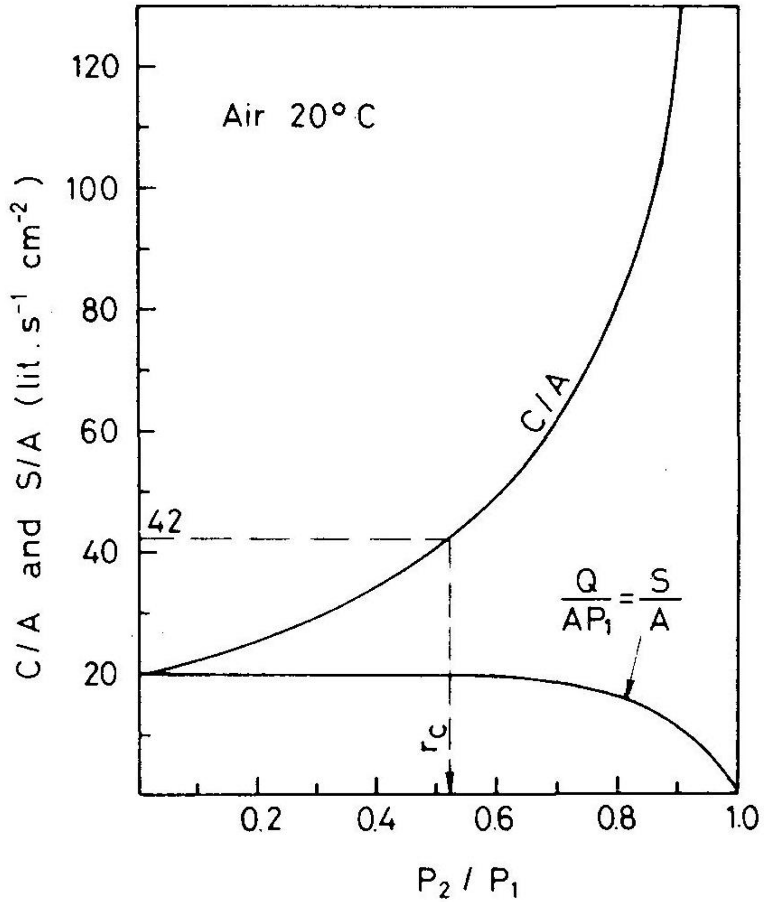


Fig. 3.6 Conductance C and pumping speed S of apertures (viscous flow). A is the cross section area of the aperture.

This equation is plotted for air in fig. 3.36, by using as a parameter the value

$$D^4/L = (128/\pi)\ \eta\ E$$

and considering $P_i = 10^6$ dyne/cm² (760 Torr), and $P = 10^2$ dyne/cm² (7.6×10^{-2} Torr), i.e. the pressure range in which usually the flow is viscous. If a volume of $V = 100$ liter is evacuated by a pump of $S_p = 2$ lit/sec through a pipe $D = 2$ cm and $L = 200$ cm, then $D^4/L = 8 \times 10^{-2}$. On the curve 8×10^{-2}, for $S_p = 2$, it results $t/V = 6$ sec/liter. Thus the time required for 100 liter is $t = 600$ sec. If the volume is connected directly to the pump, the line $D^4/L = \infty$ gives $t/V = 4.5$ sec/liter, thus $t = 450$ sec.

It is interesting to mention that if the pump is connected directly to the vessel, $L = 0$, thus $E = \infty$, eq. (3.252) becomes

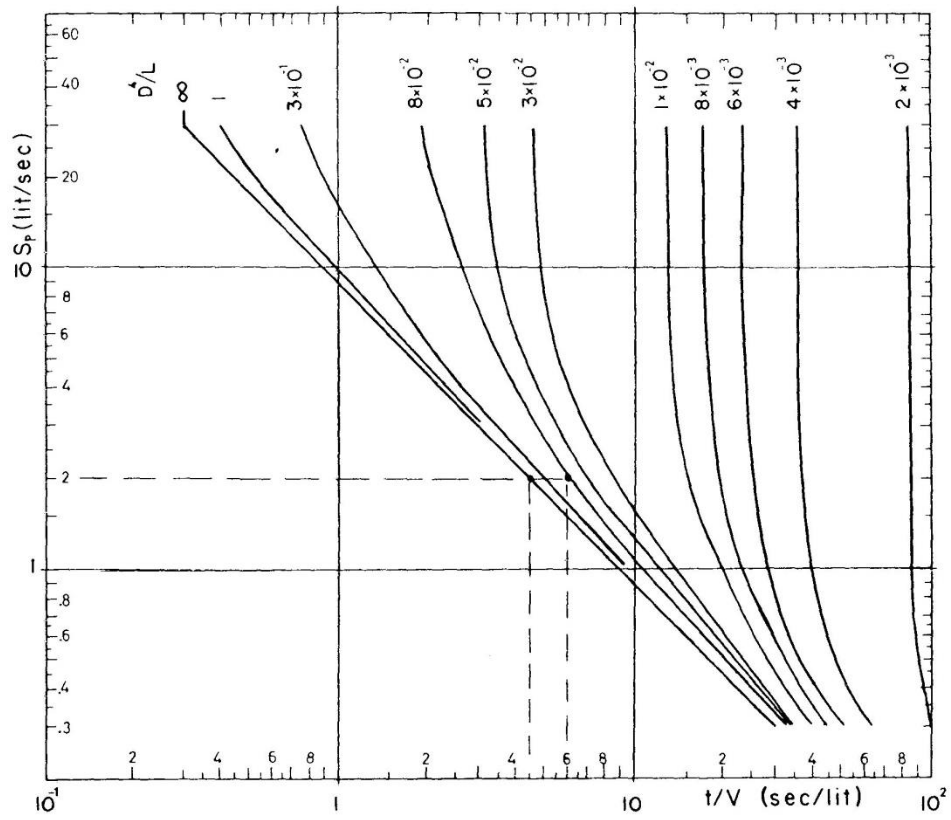


Fig. 3.36 Time required to decrease the pressure from 760 Torr to 7.6×10^{-2} Torr in a volume $V(l)$, connected by a pipe of diameter D(cm) and length L(cm) to a pump of pumping speed $S_p(l/s)$. After Delafosse and Mongodin (1961).

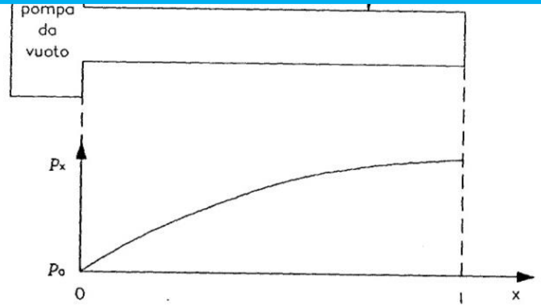


Figura 4.2 - Andamento della pressione in una camera da vuoto tubolare, chiusa ad una estremità e collegata con una pompa all'altra.

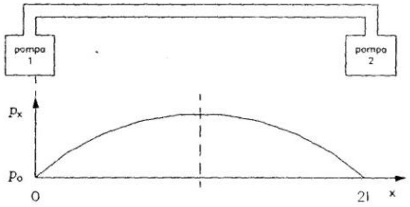


Figura 4.3 - Andamento della pressione in una camera da vuoto tubolare pompata ad entrambe le estremità.

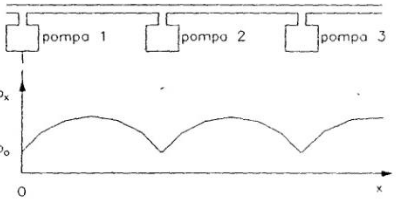


Figura 4.4 - Andamento della pressione in una camera da vuoto tubolare pompata con una serie di pompe disposte ad intervalli regolari di spazio e di uguali caratteristiche.

Bruno Ferrario

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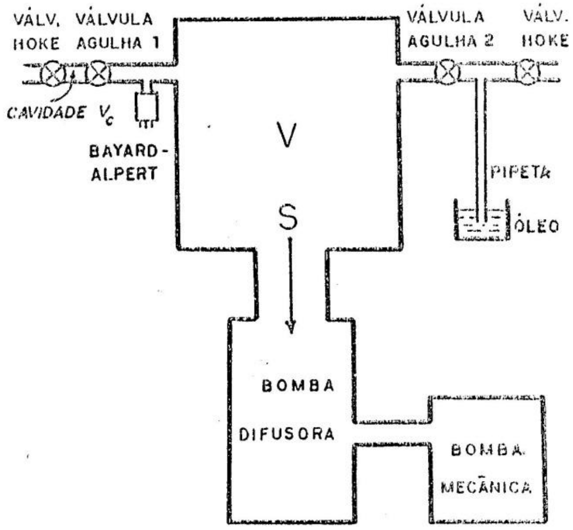

Fig. 4 - Esquema de montagem para simulação de vazamentos reais e virtuais.

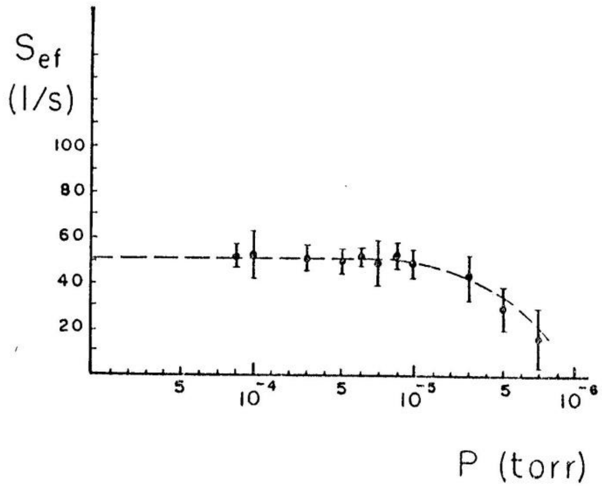

Fig. 6 - Velocidade Efetiva da Bomba Difusora.

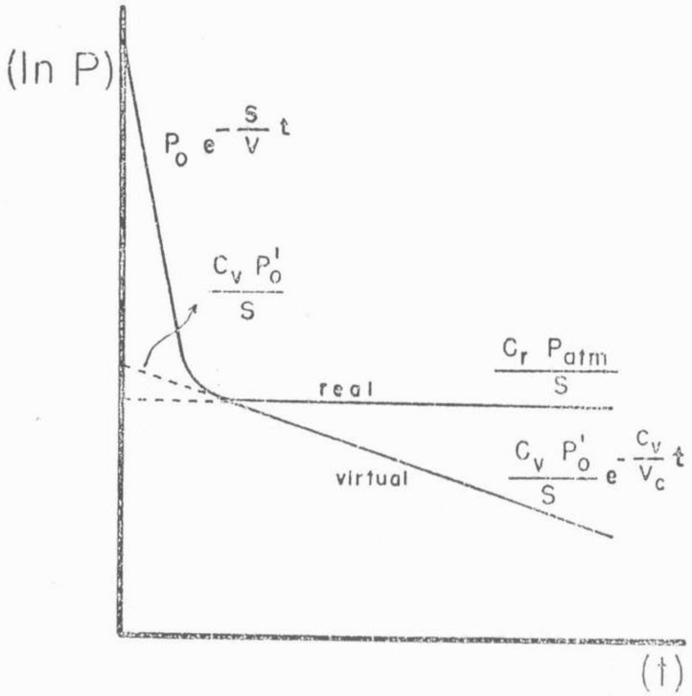

Fig. 2 - Vazamentos: real e virtual.

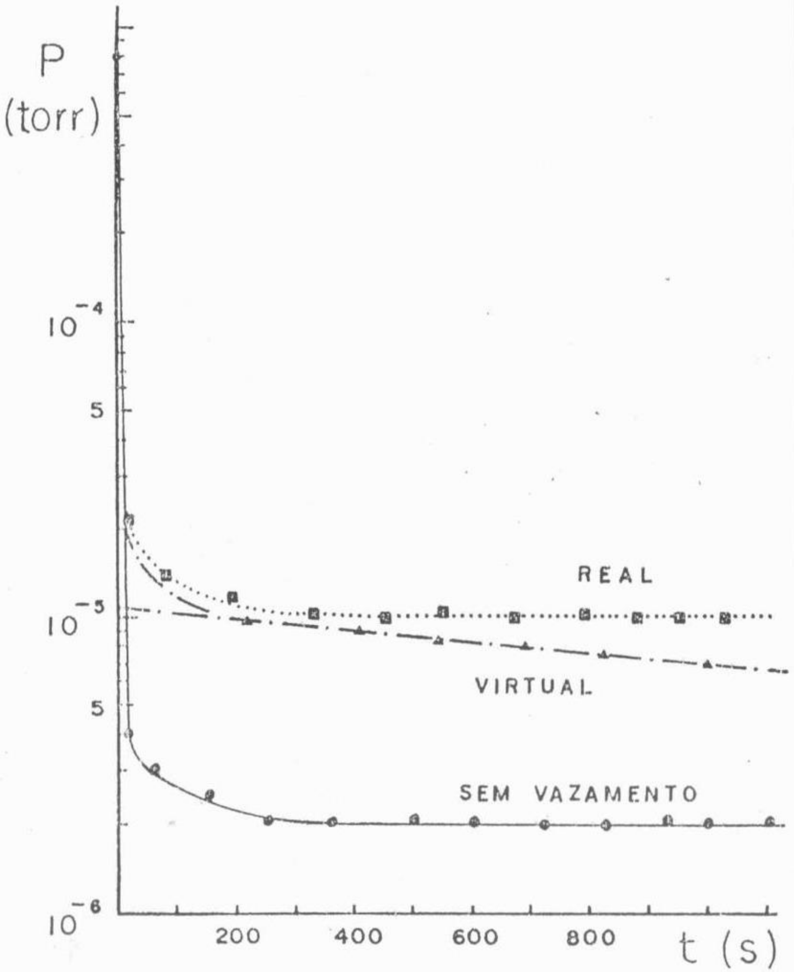

Fig. 5 - Medidas de Simulação de Vazamentos.

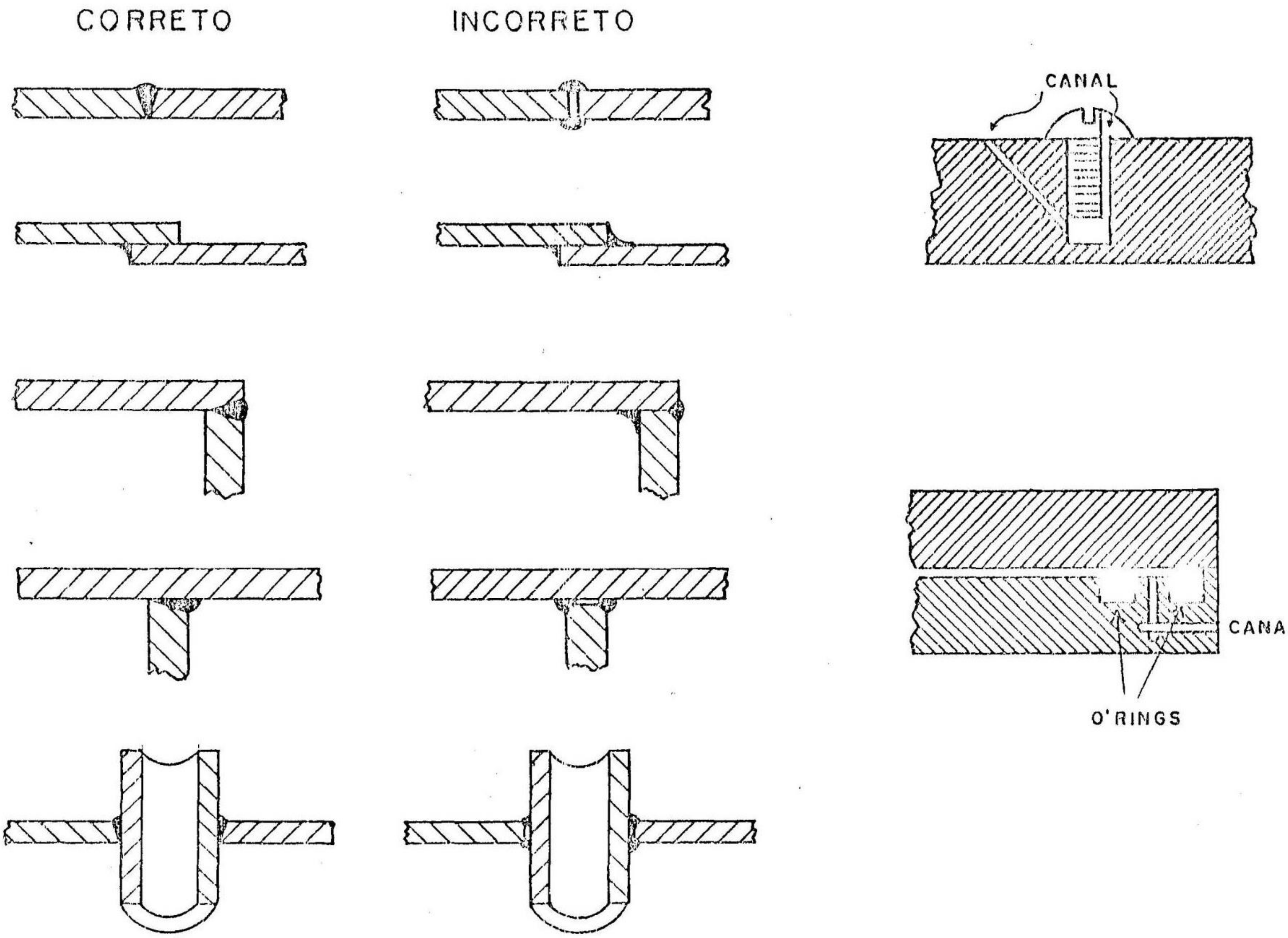

Fig. 8 - Exemplos de Vazamentos Virtuais e suas correções.