

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

MEDIDORES

16 - agosto - 2016

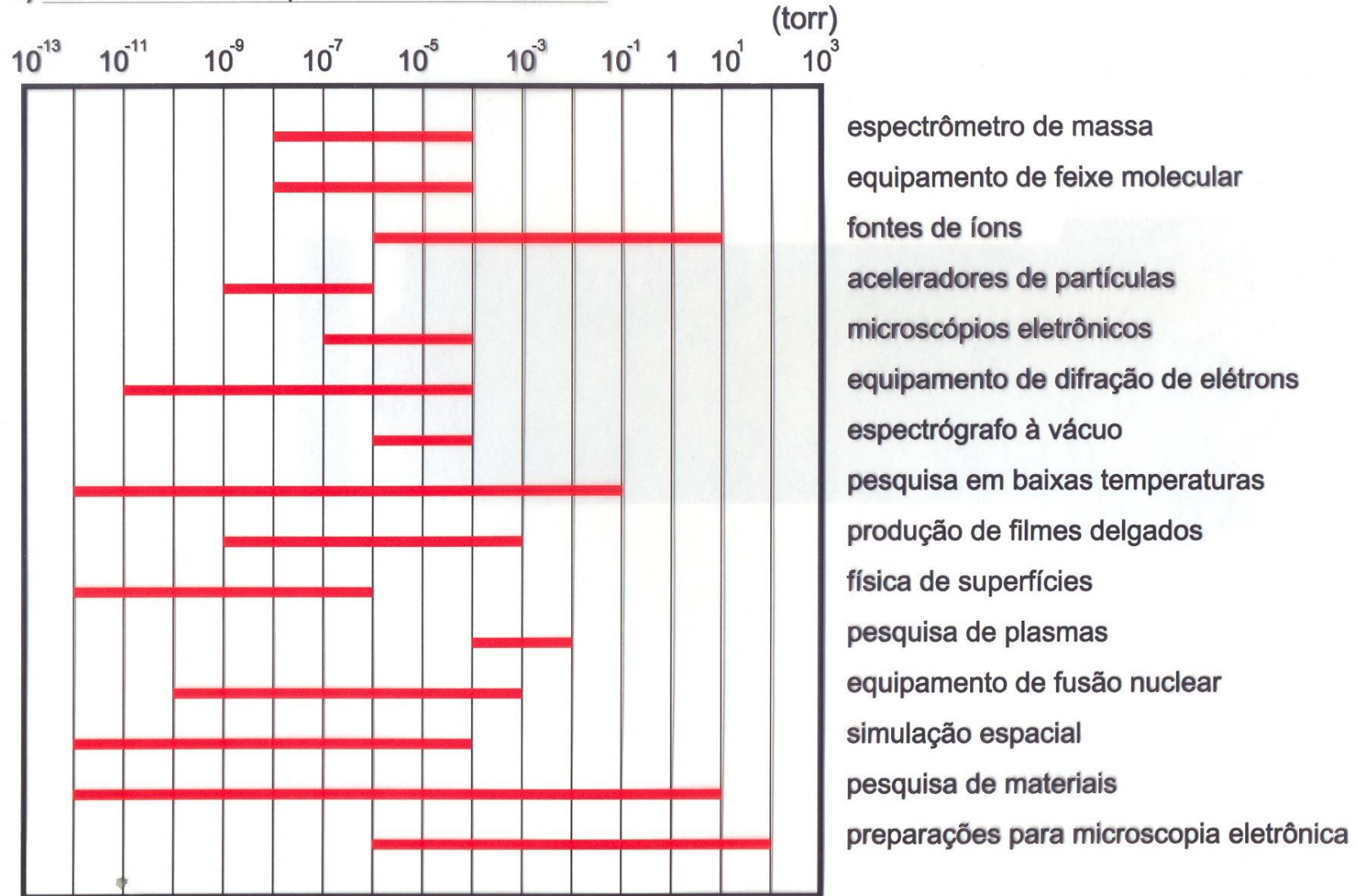
UNIVERSIDADE DE SÃO PAULO - INSTITUTO DE FÍSICA

TECNOLOGIA DO VÁCUO

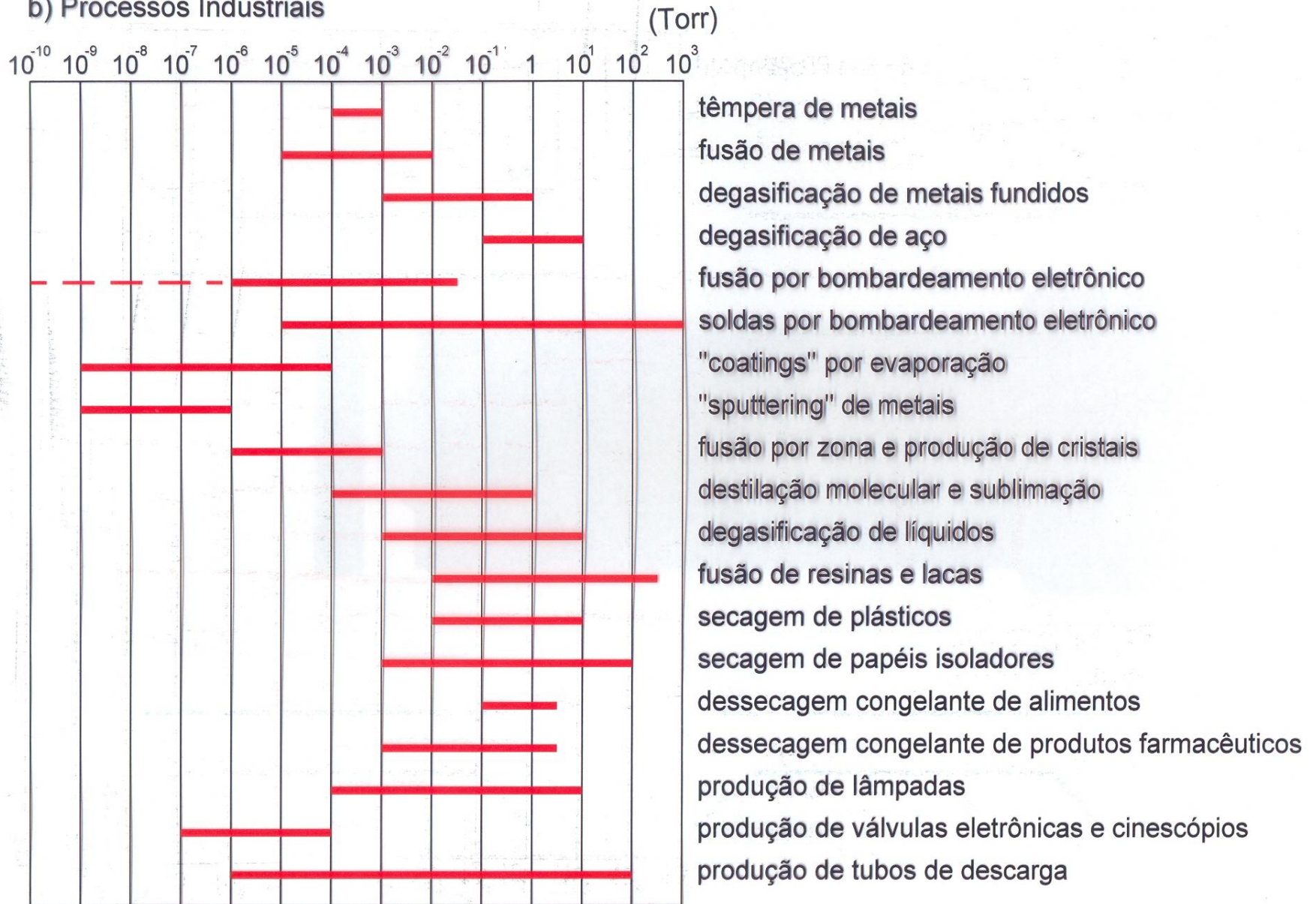
O QUE É VÁCUO	>>>	UNIDADES
COMO MEDIR PRESSÃO/VÁCUO	>>>	MEDIDORES
COMO PRODUZIR VÁCUO	>>>	BOMBAS
MATERIAIS E COMPONENTES		
VAZAMENTOS	>>>	COMO DETETAR

ALGUMAS APLICAÇÕES DO VÁCUO E SUAS FAIXAS DE PRESSÃO

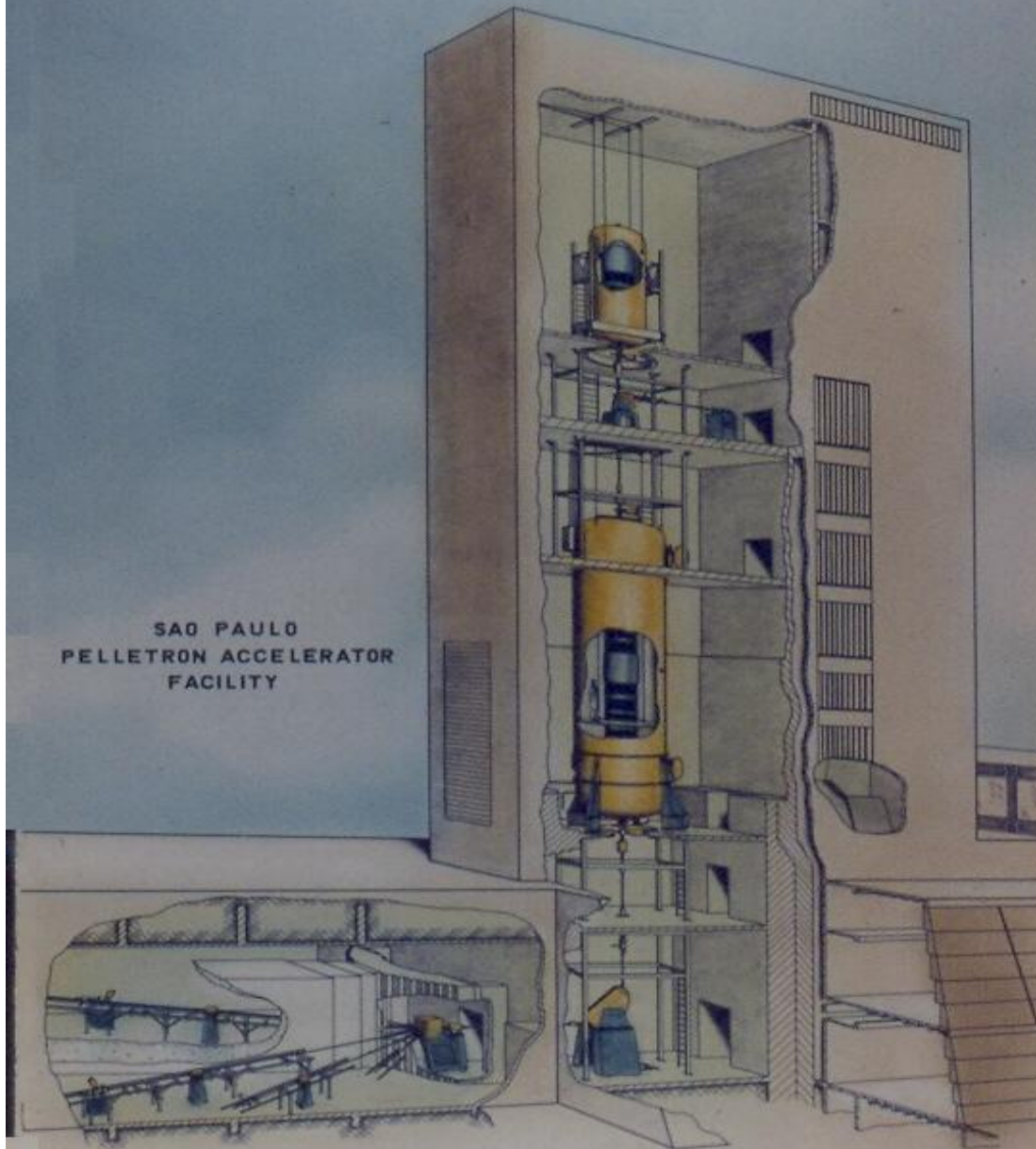
a) Laboratório de Pesquisa em Física e Química

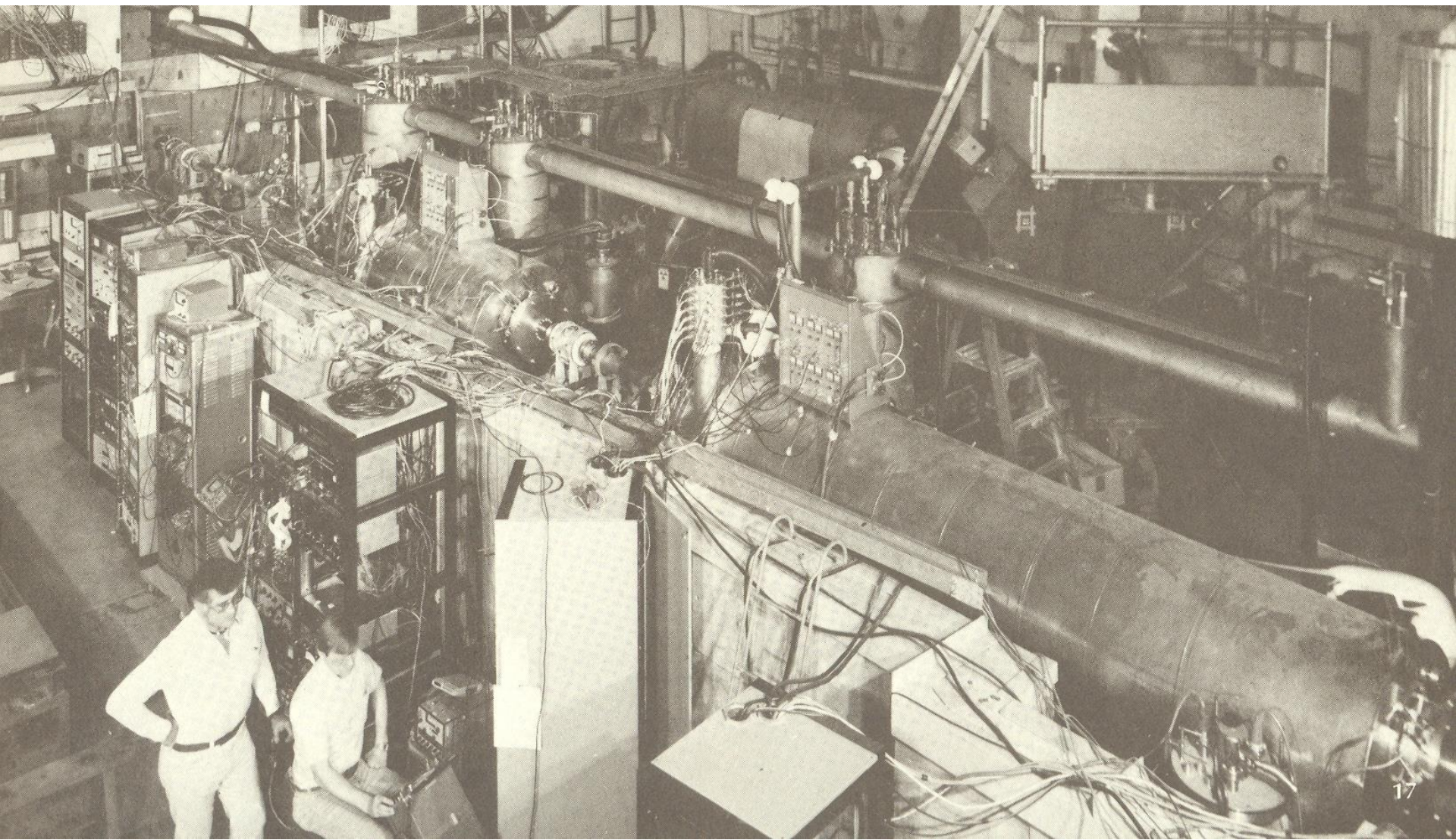


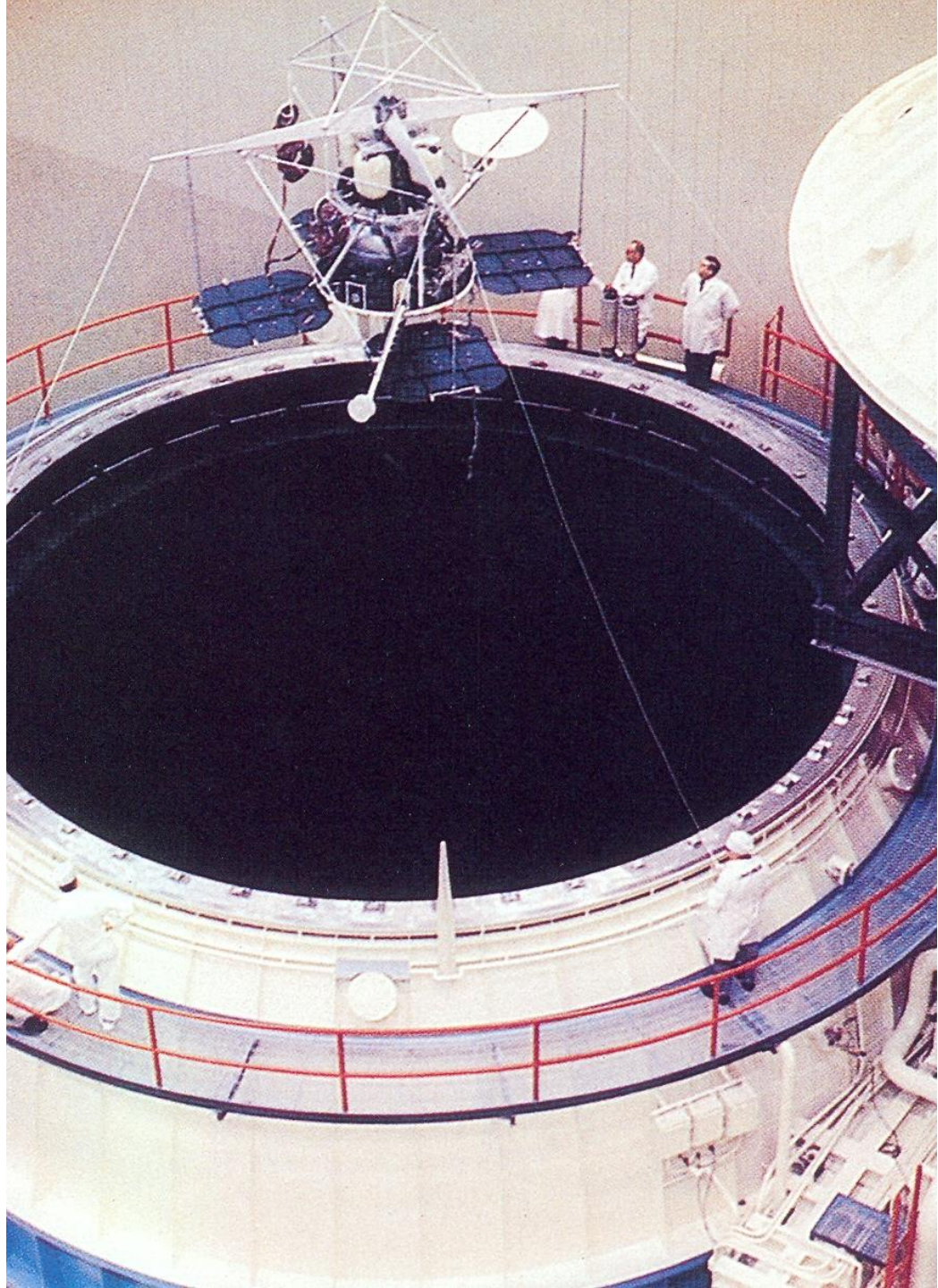
b) Processos Industriais



SAO PAULO
PELLETRON ACCELERATOR
FACILITY





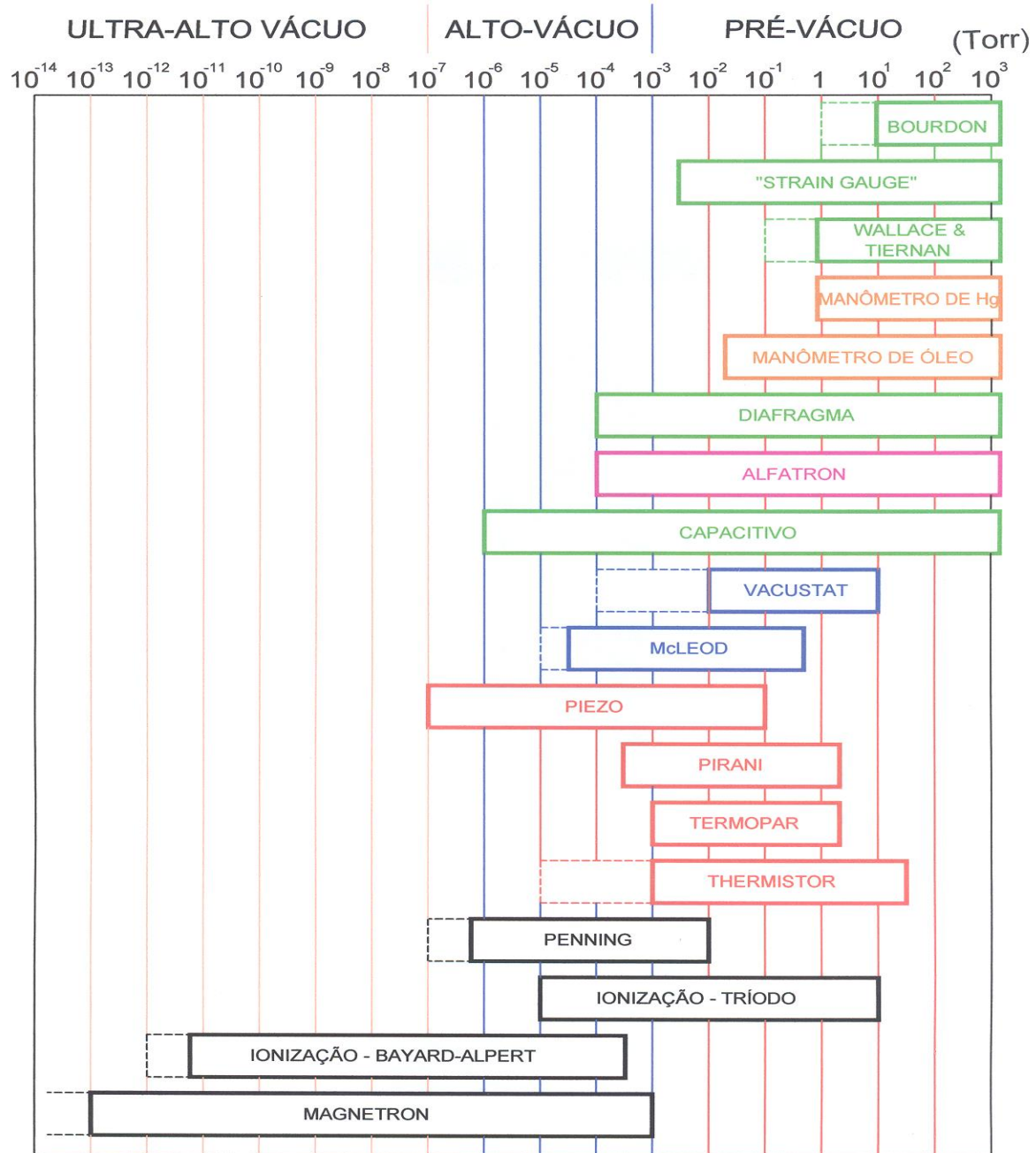


UNIDADES DE PRESSÃO (VÁCUO)

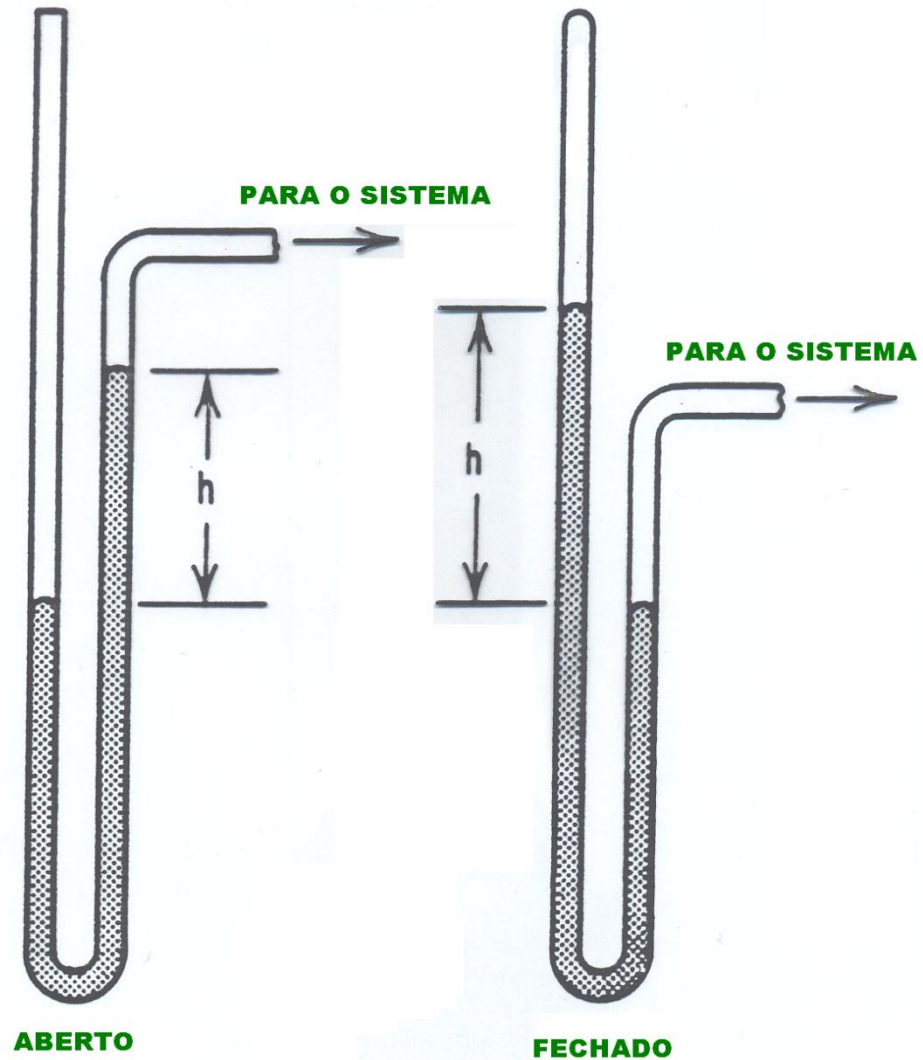
	bar	mbar	Pa	atm	Torr
bar	1	10^3	10^5	0,986923	750,062
mbar	1×10^{-3}	1	10^2	$0,986923 \times 10^{-3}$	0,750062
Pa	10^{-5}	10^{-2}	1	$0,986923 \times 10^{-5}$	$0,750062 \times 10^{-2}$
atm	1,01325	$1,01325 \times 10^3$	$1,01325 \times 10^5$	1	760
Torr	$1,333224 \times 10^{-3}$	1,333224	$1,333224 \times 10^2$	$1,315789 \times 10^{-3}$	1

De acordo com as novas regras do "International System of Units", a unidade oficial de pressão passa a ser o pascal ($\text{Pa} = \text{N} \times \text{m}^{-2}$), no lugar do bar, Torr e atm.

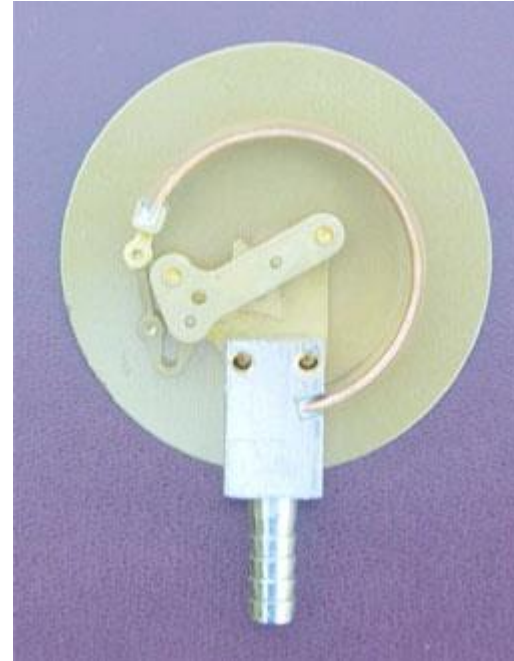
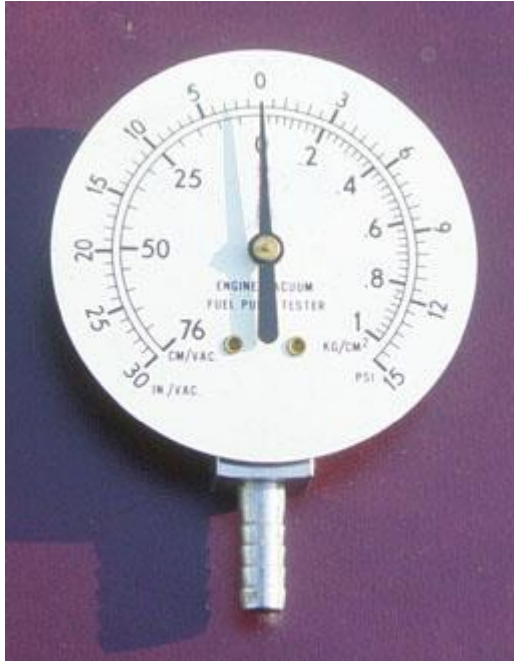
APSI	Torr	HgV	HgAb	mbar	% de vácuo
14,7	760	0,0	29,9	1013	0
13,7	709	2,0	27,9	945	7
12,2	633	5,0	24,9	844	17
9,8	506	10,0	19,9	675	33
7,3	379	15,0	14,9	505	50
5,9	303	18,0	11,9	404	60
4,9	252	20,0	9,9	336	67
3,9	201	22,0	7,9	268	74
2,4	125	25,0	4,9	167	84
0,95	49	28,0	1,9	65	94
0,44	23	29,0	0,9	31	97
0,21	11	29,5	0,4	15	99
0,0	0,0	29,9	0,0	0,0	100



TUBO EM "U"



BOURDON



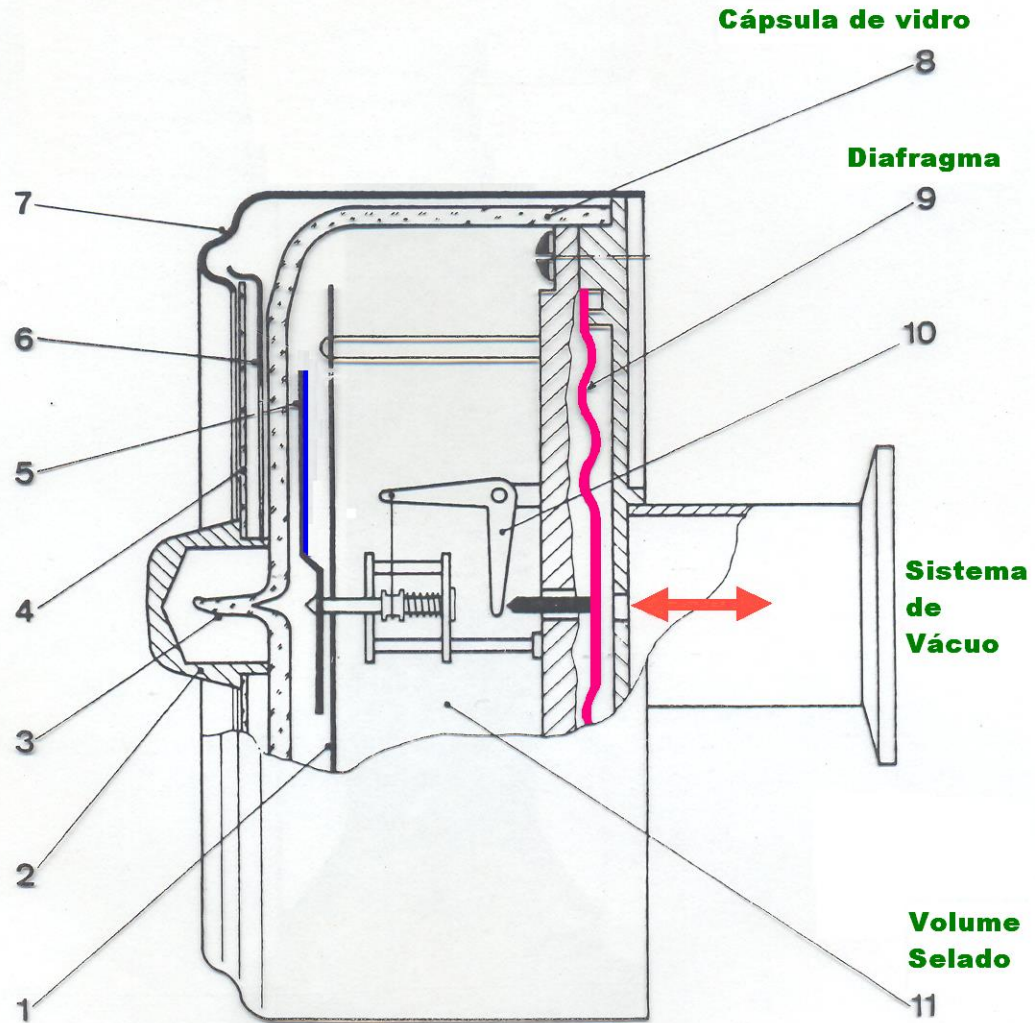
MANOVACUÔMETRO



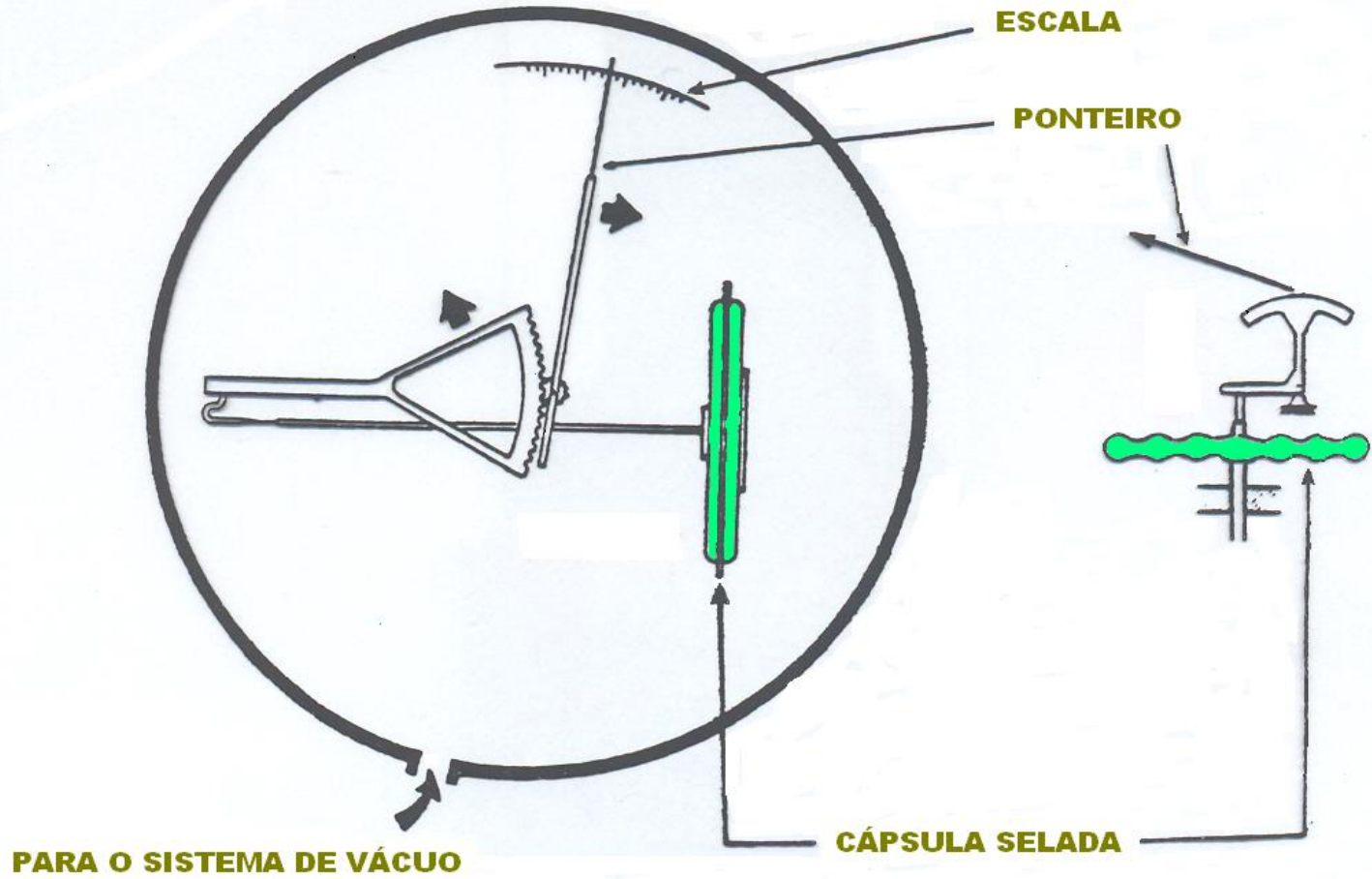
VÁCUO

PRESSÃO

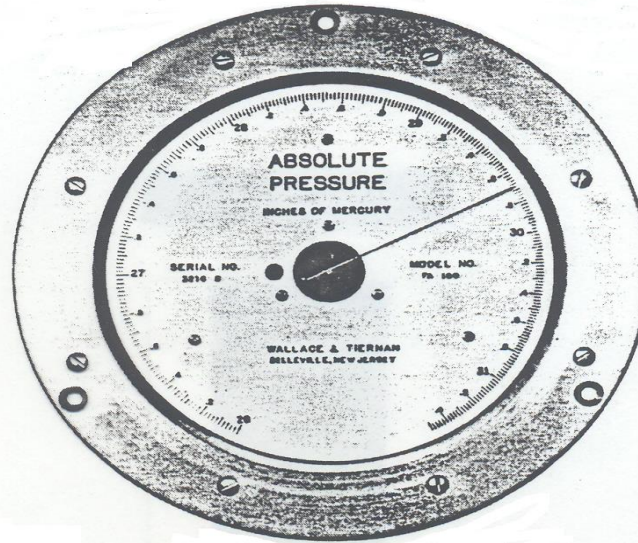
DIAFRAGMA



WALLACE & TIERNAN

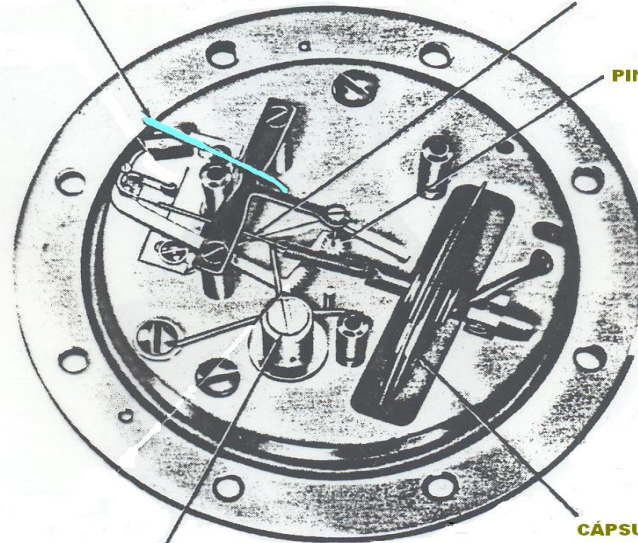


WALLACE &
TIERNAN



PONTEIRO

ALAVANCA DE TRANSMISSÃO

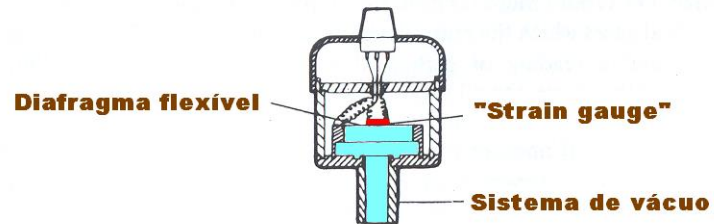


PINHÃO

AJUSTE DE ZERO

CÁPSULA SELADA

“STRAIN GAUGE”



PIEZO (DIAFRAGMA)

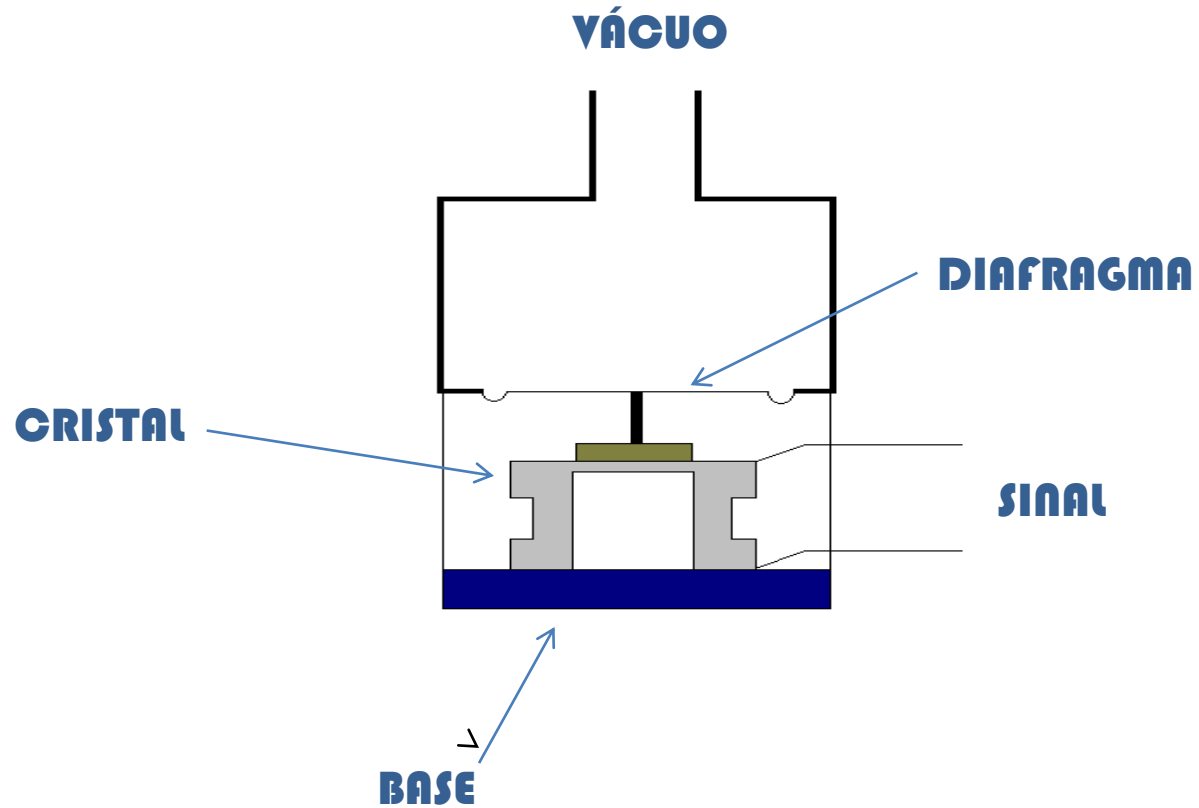


LEITURA + INTERFACE

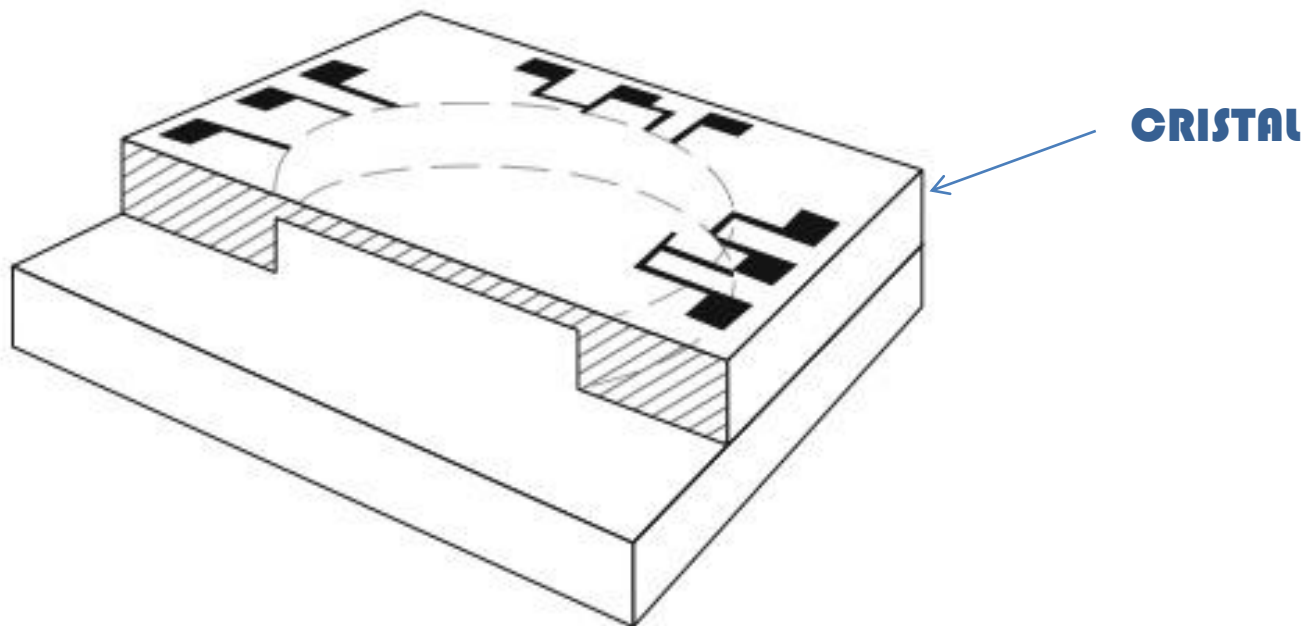


SENSOR + ELETRÔNICA

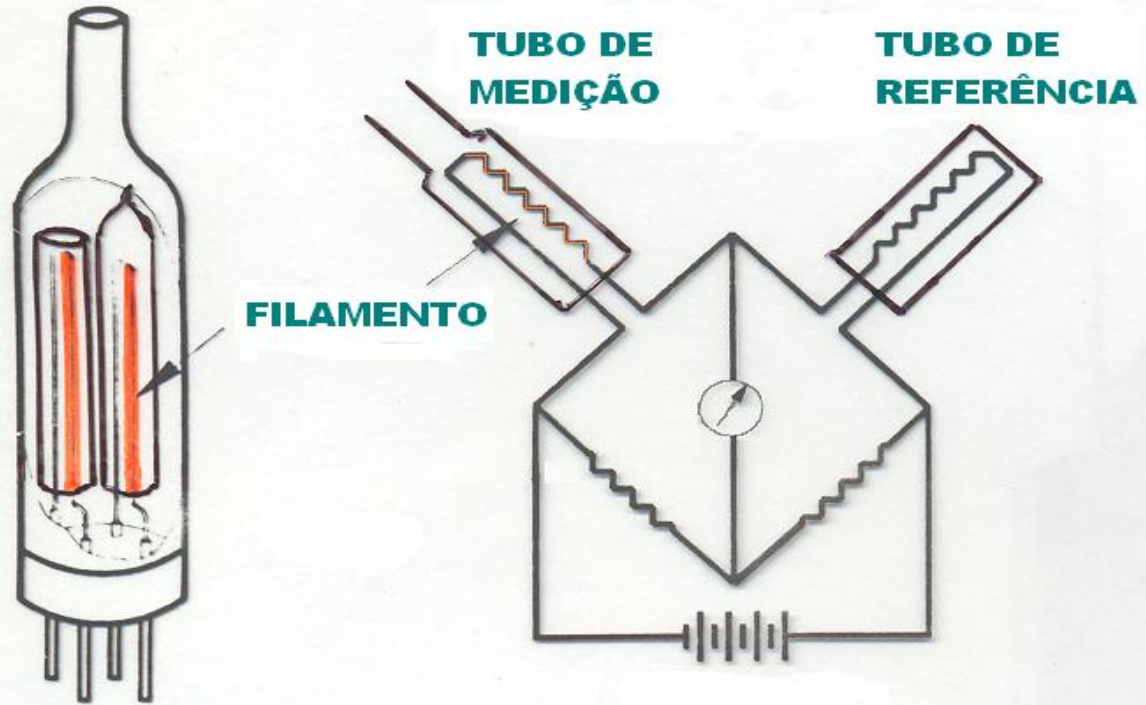
PIEZO (DIAFRAGMA)



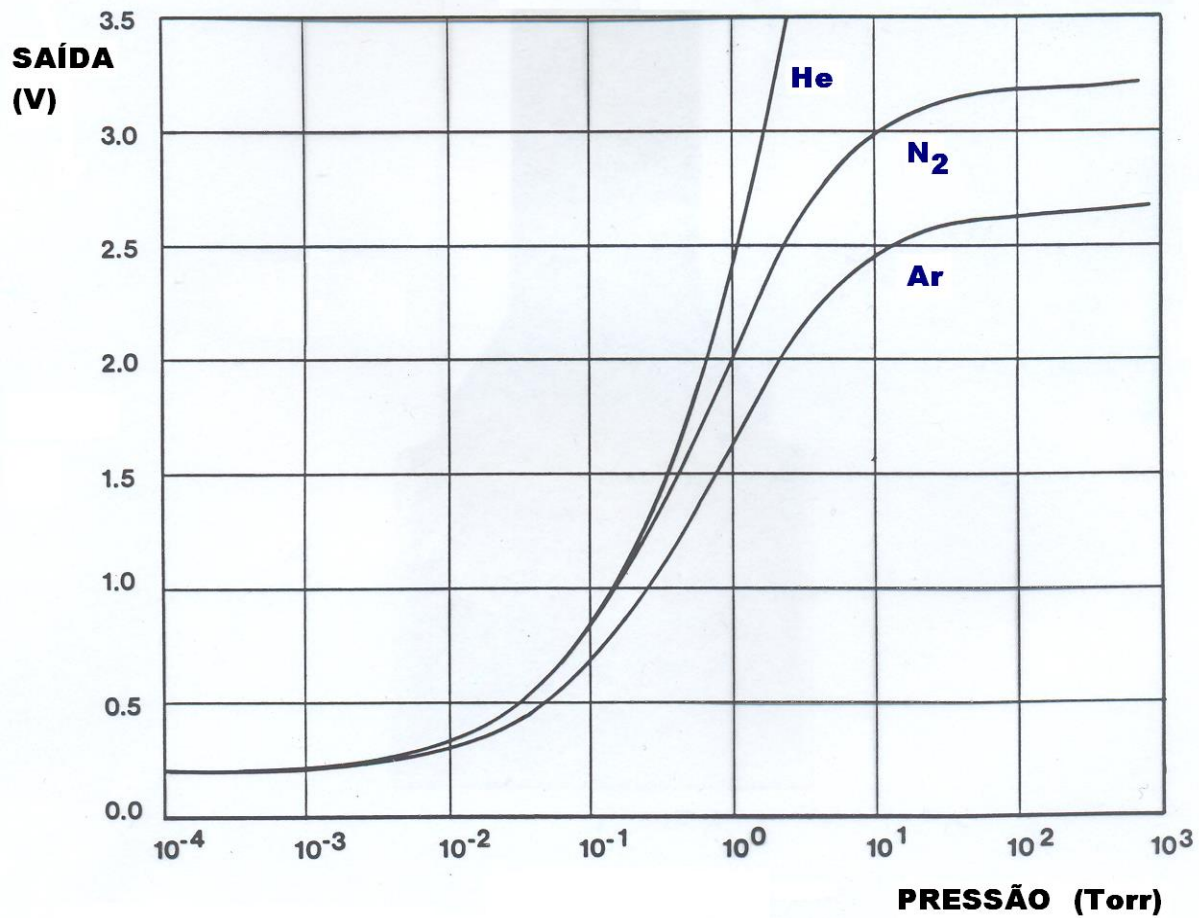
PIEZO – SENSOR DE CRISTAL DE QUARTZO



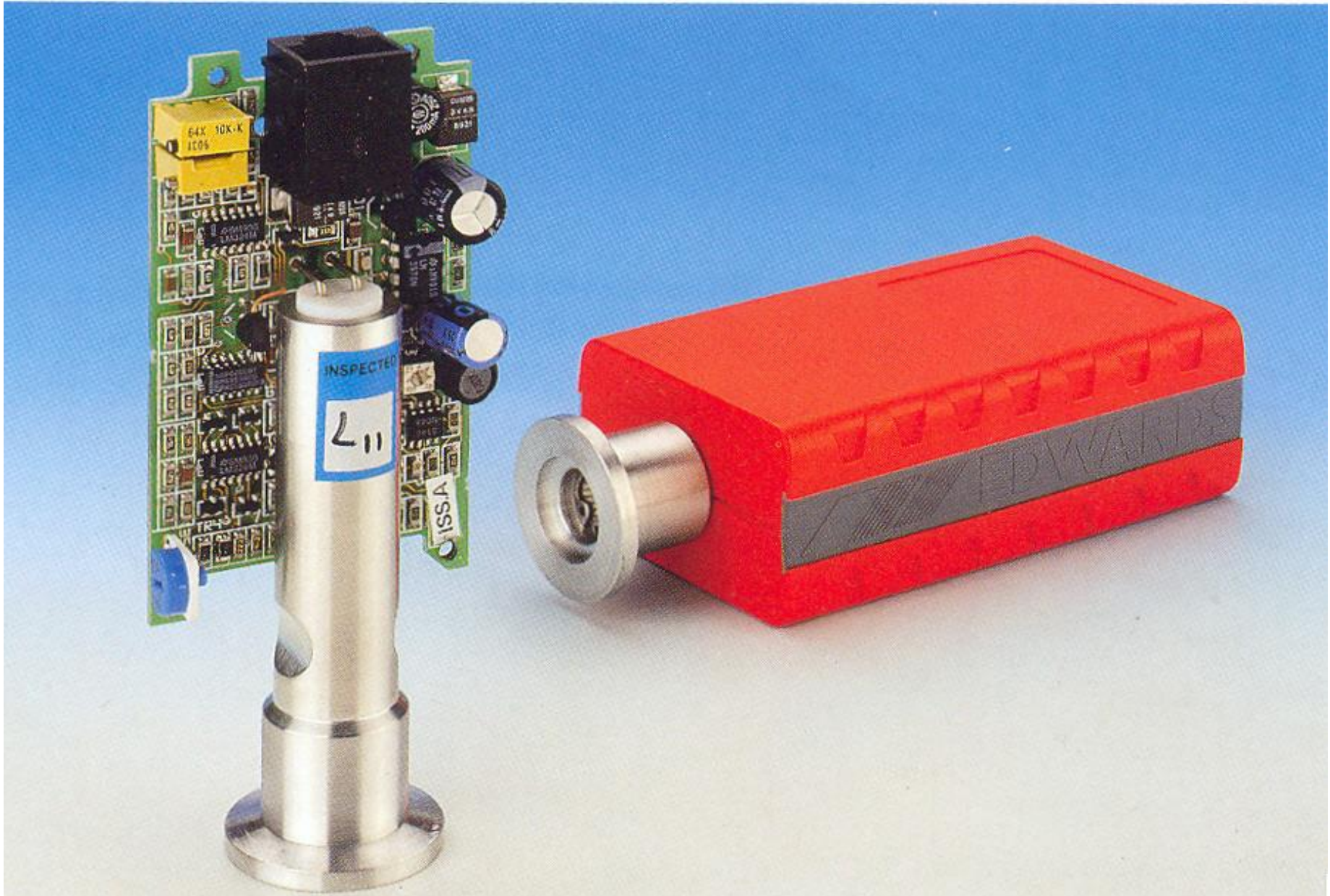
PIRANI



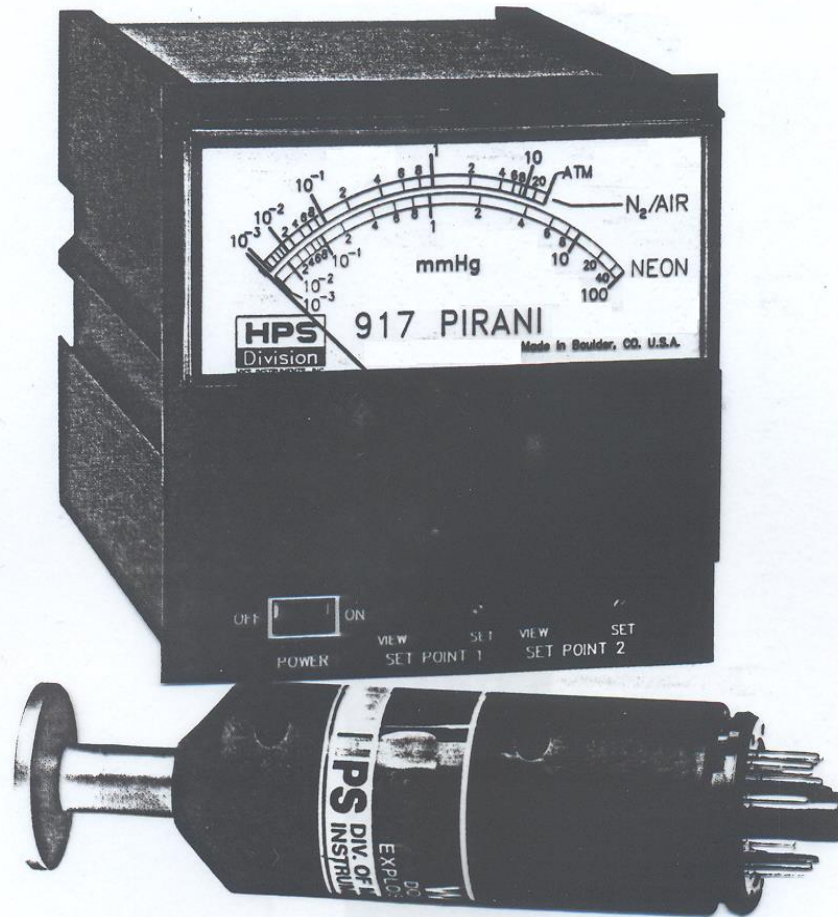
PIRANI – CURVA DE RESPOSTA



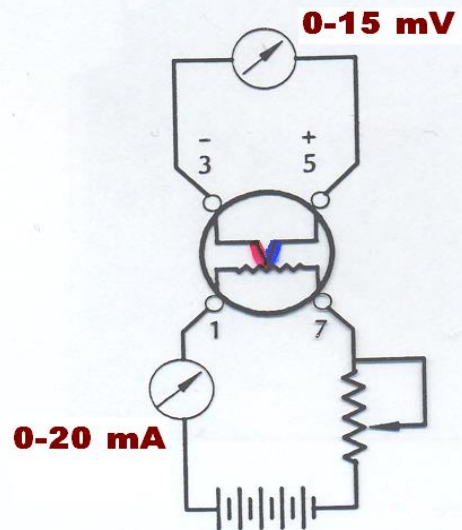
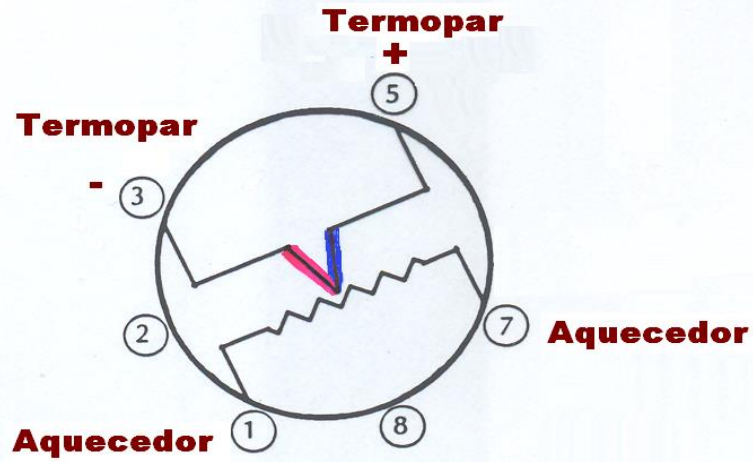
PIRANI (EDWARDS)



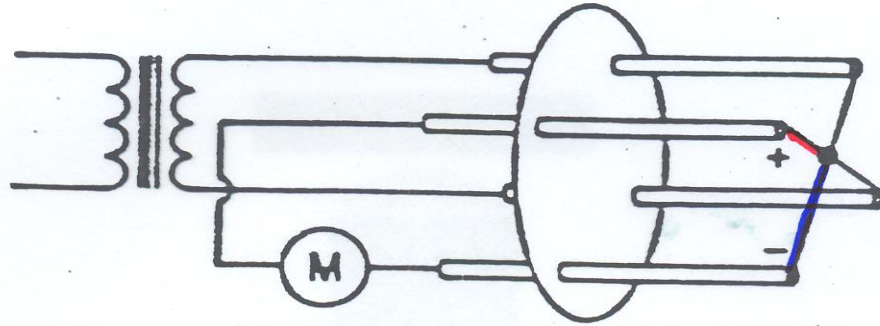
PIRANI (HPS)



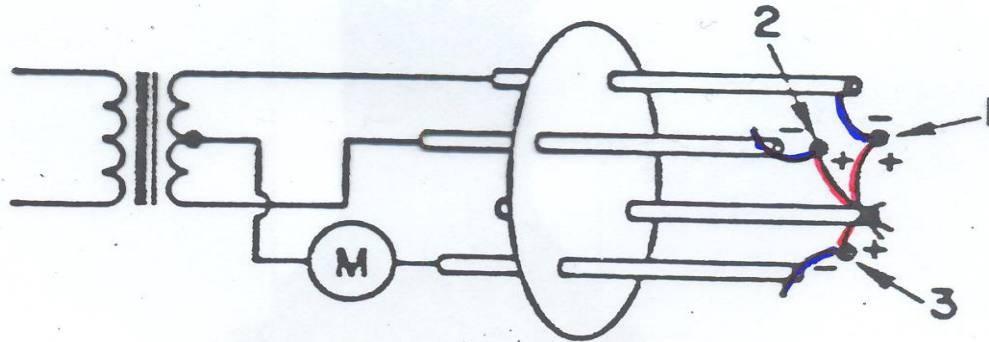
TERMOPAR



TERMOPAR

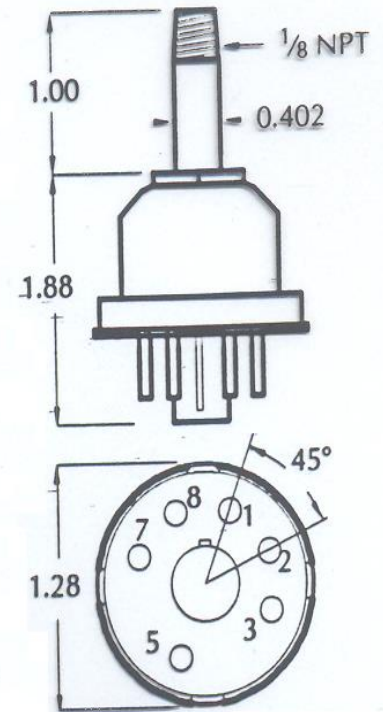
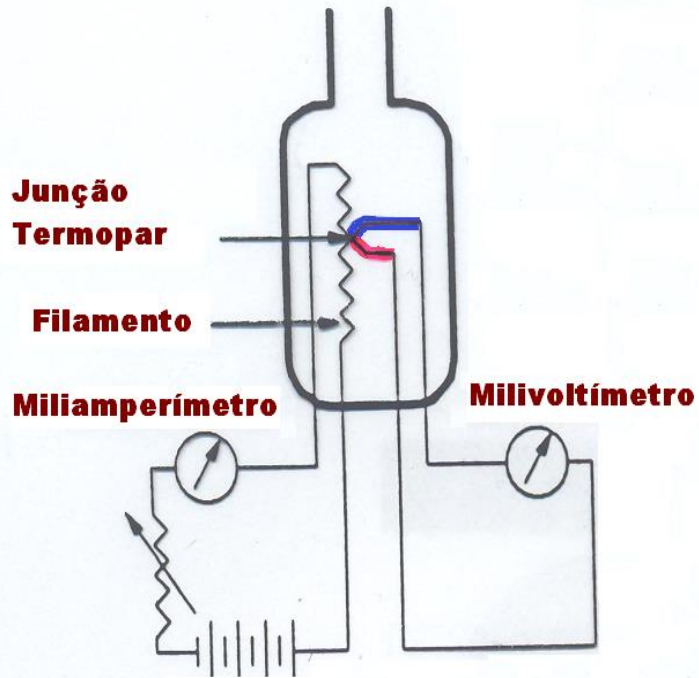
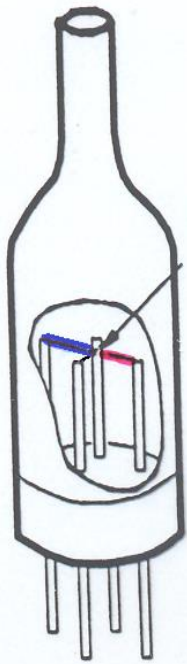


(A)

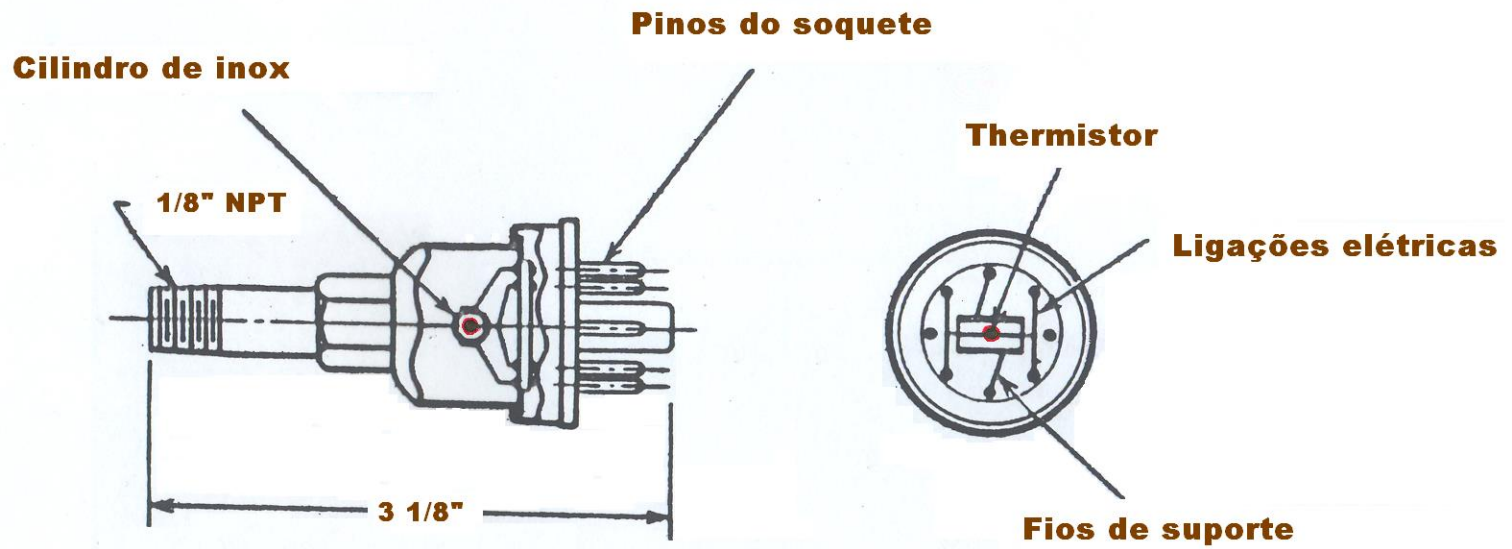


(B)

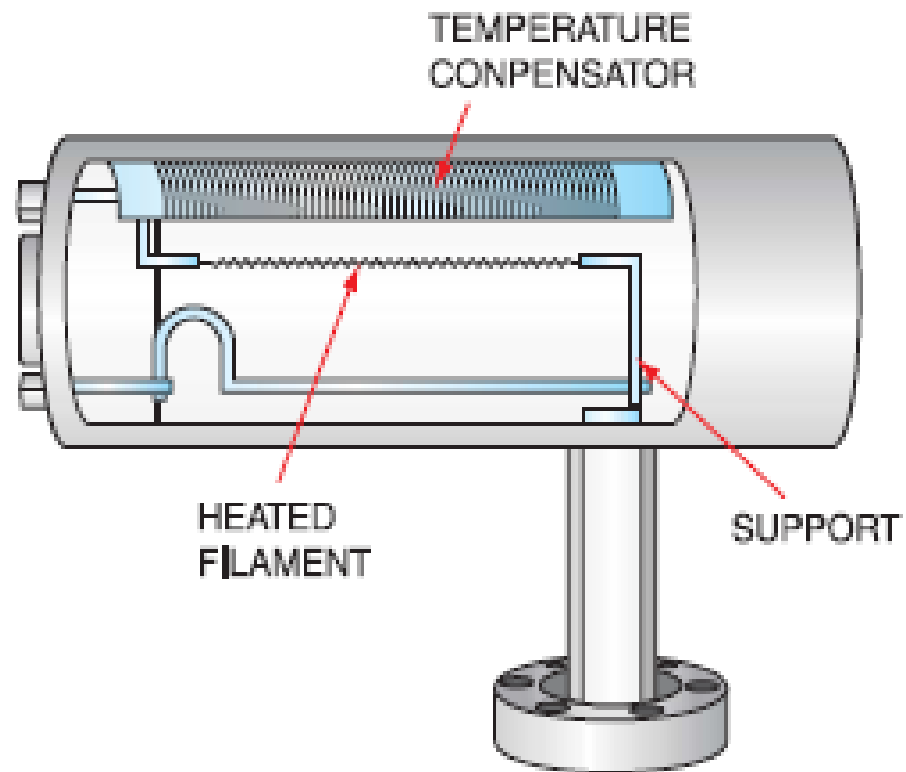
TERMOPAR



THERMISTOR



CONVECTRON



CONVECTRON



LEYBOLD



PFEIFFER



MKS



GRANVILLE PHILLIPS

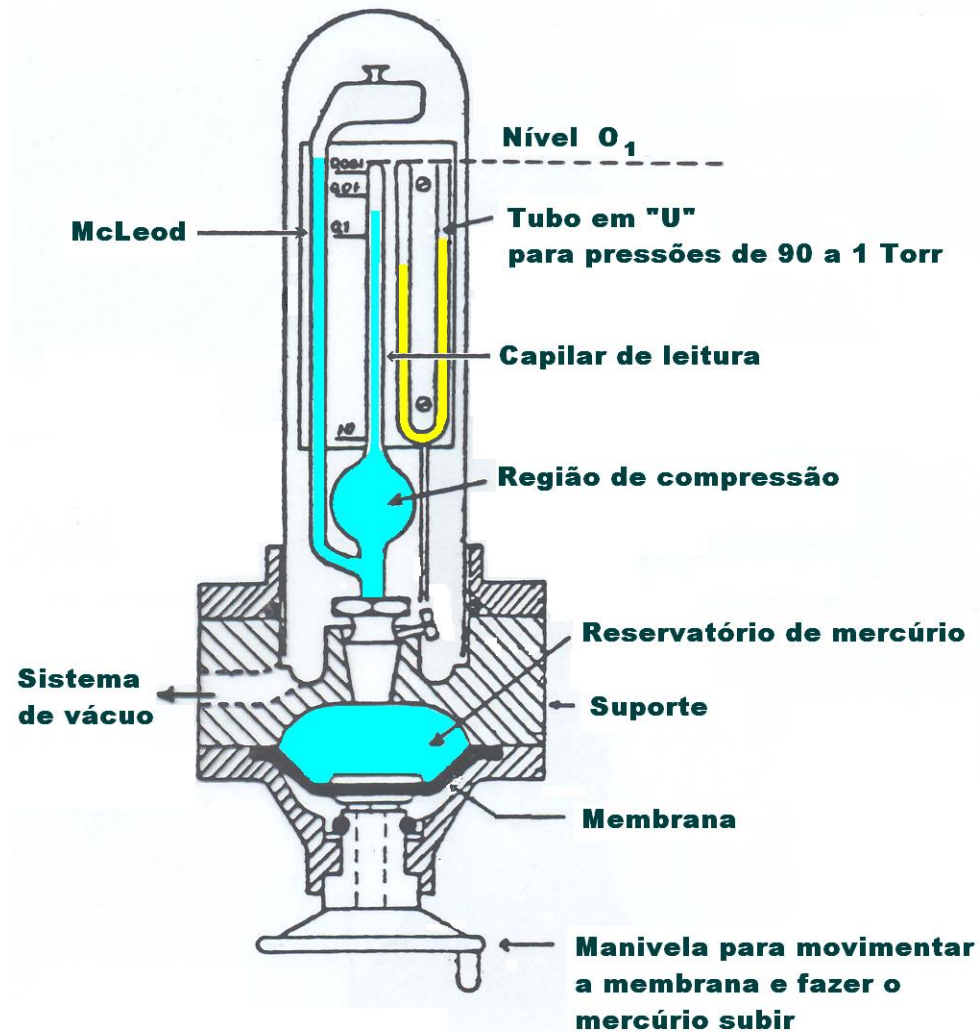


EDWARDS



AGILENT VARIAN

KAMMERER (McLEOD)



McLEOD



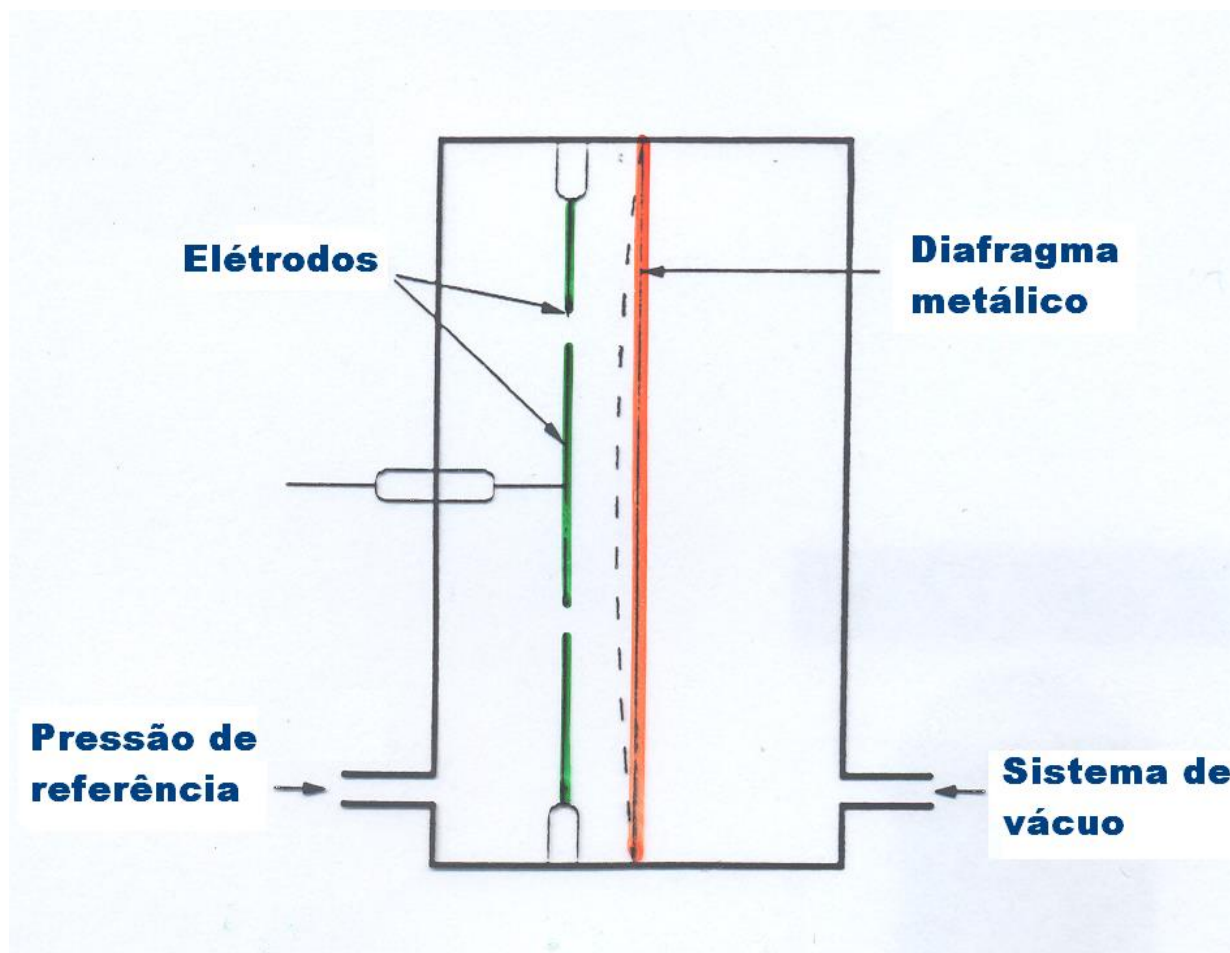
VACUSTAT 2
Made in England



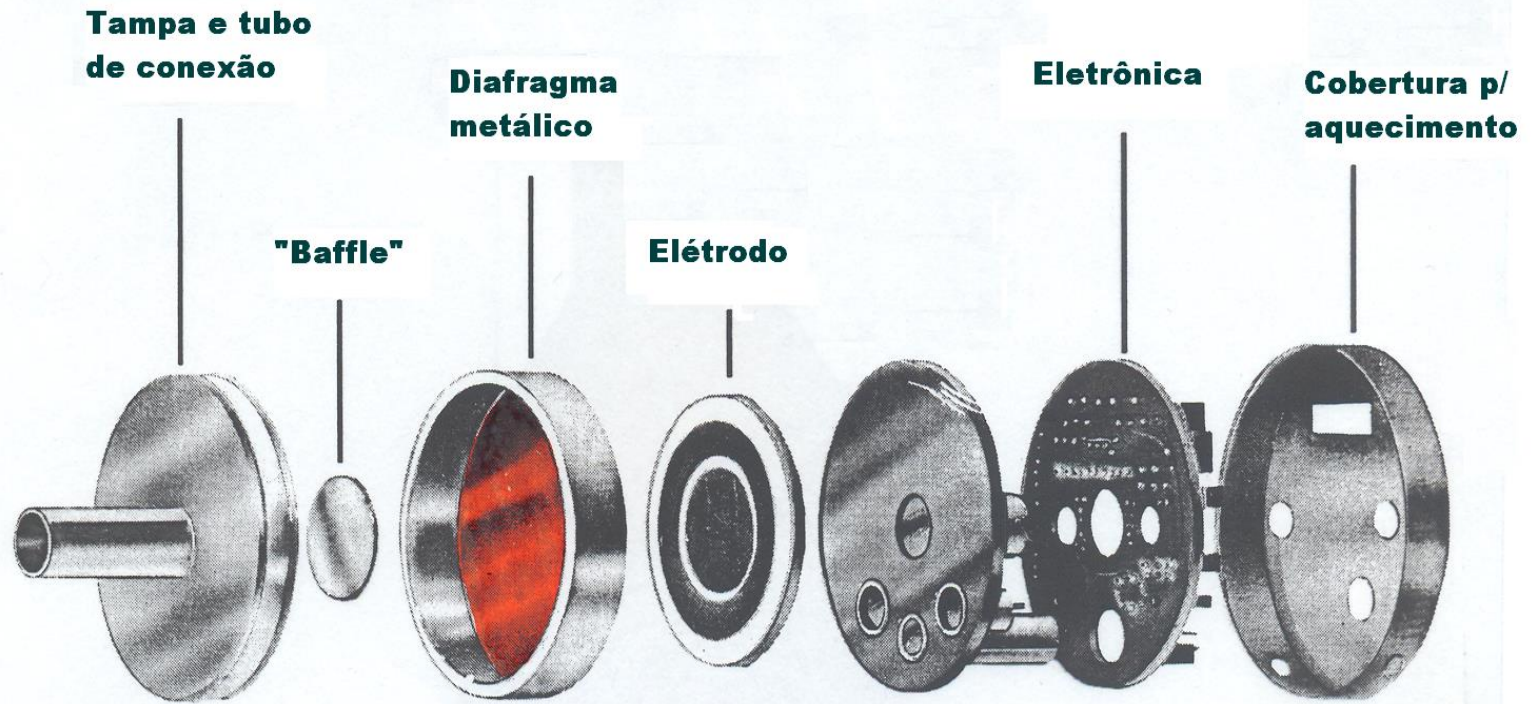
Edwards



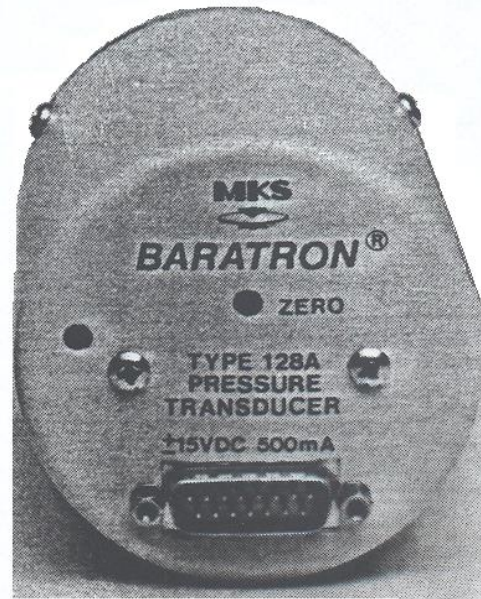
CAPACITIVO



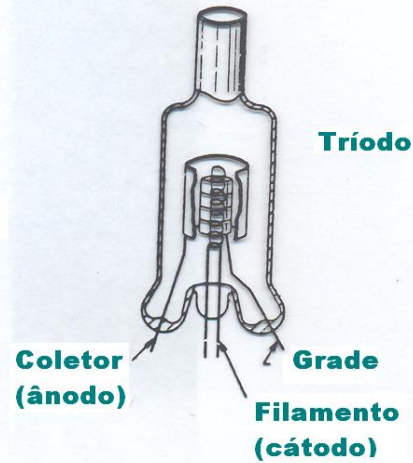
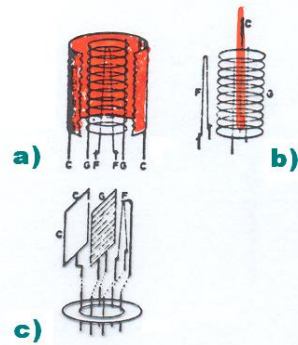
CAPACITIVO



CAPACITIVO (BARATRON)

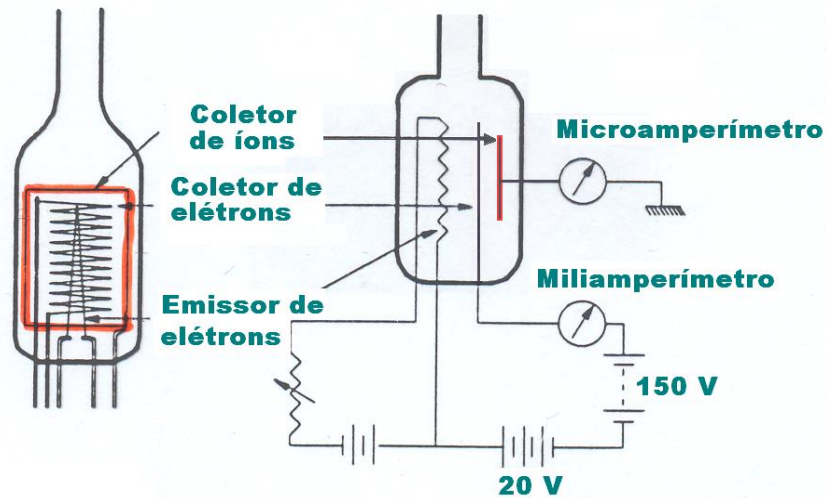


IONIZAÇÃO – CÁTODO QUENTE

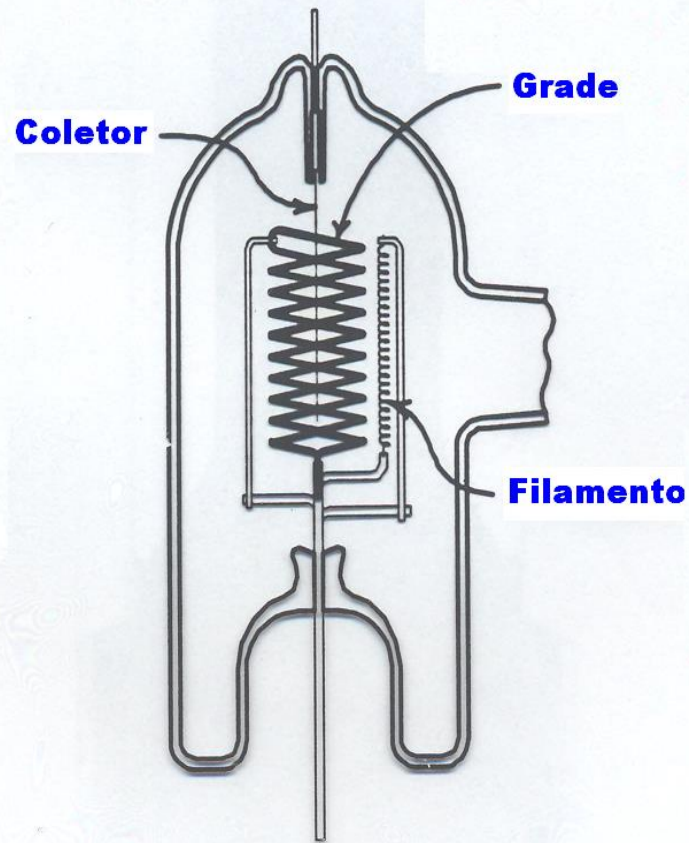


a) e c) Tríodo
b) Bayard-Alpert

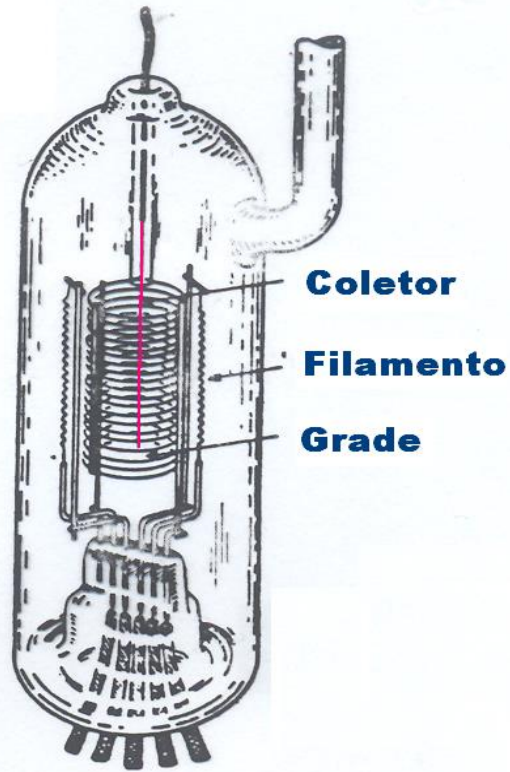
F - filamento
C - coletor
G - grade



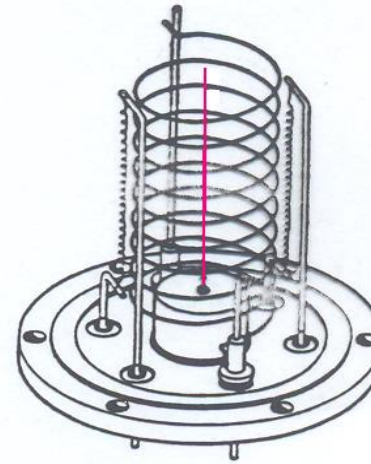
IONIZAÇÃO – BAYARD-ALPERT



IONIZAÇÃO – BAYARD-ALPERT

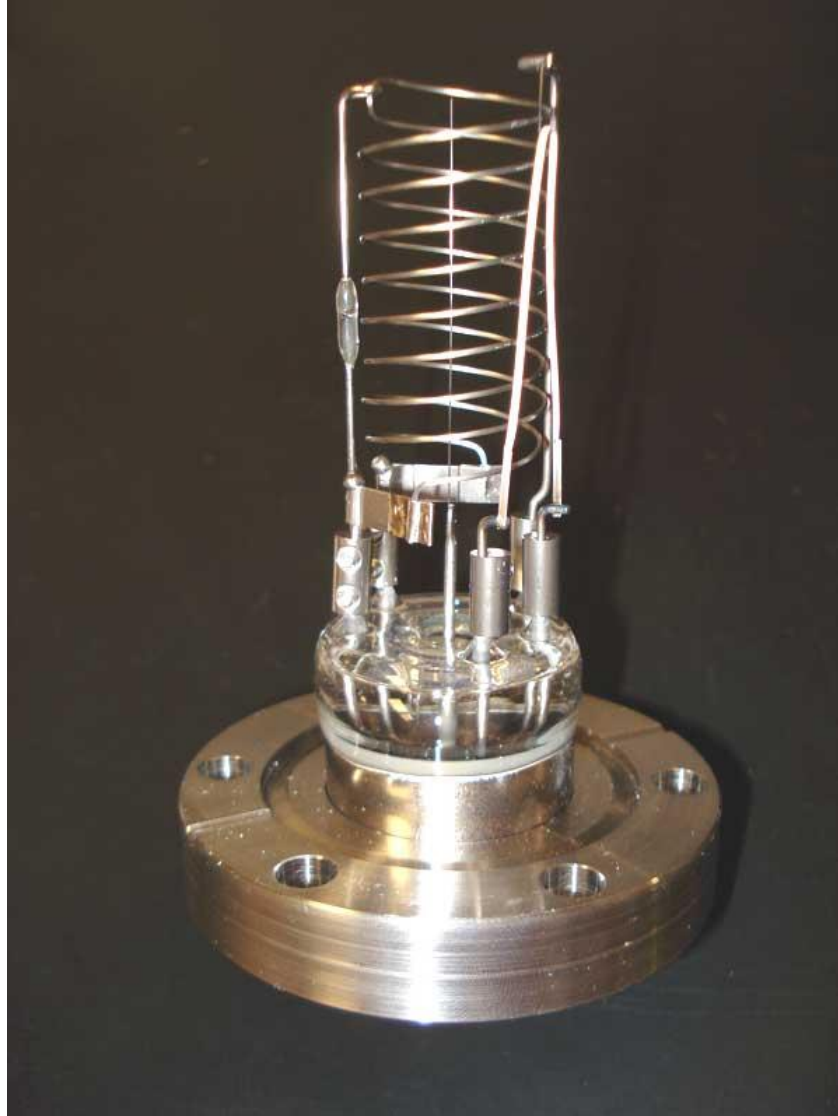


Ampola de vidro



Com flange de metal ("nude")

BAYARD-ALPERT (“NUDE”)



BAYARD-ALPERT

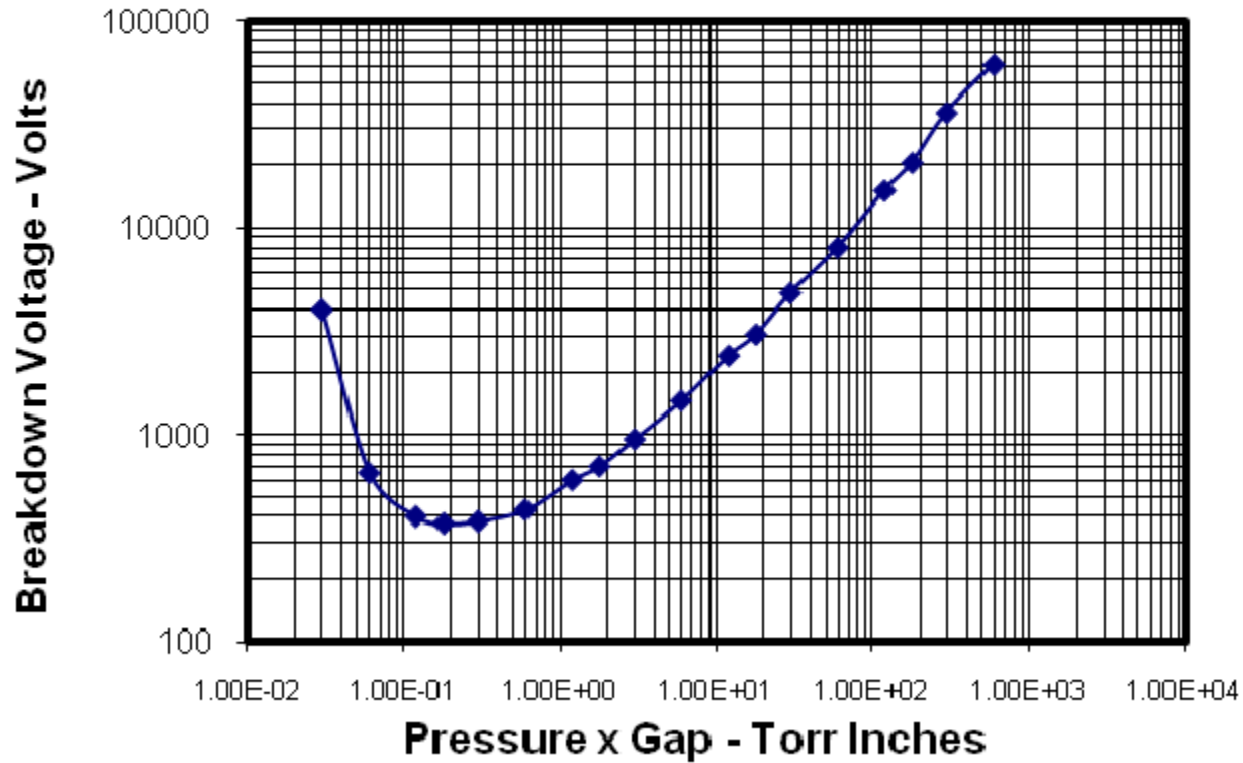


IONIZAÇÃO – SENSIBILIDADE P/ VÁRIOS GASES

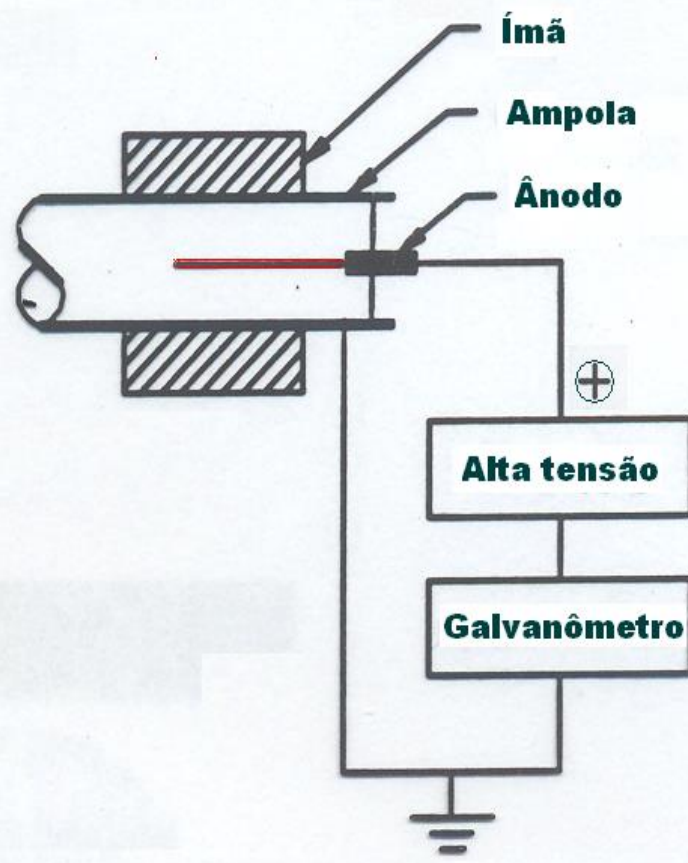
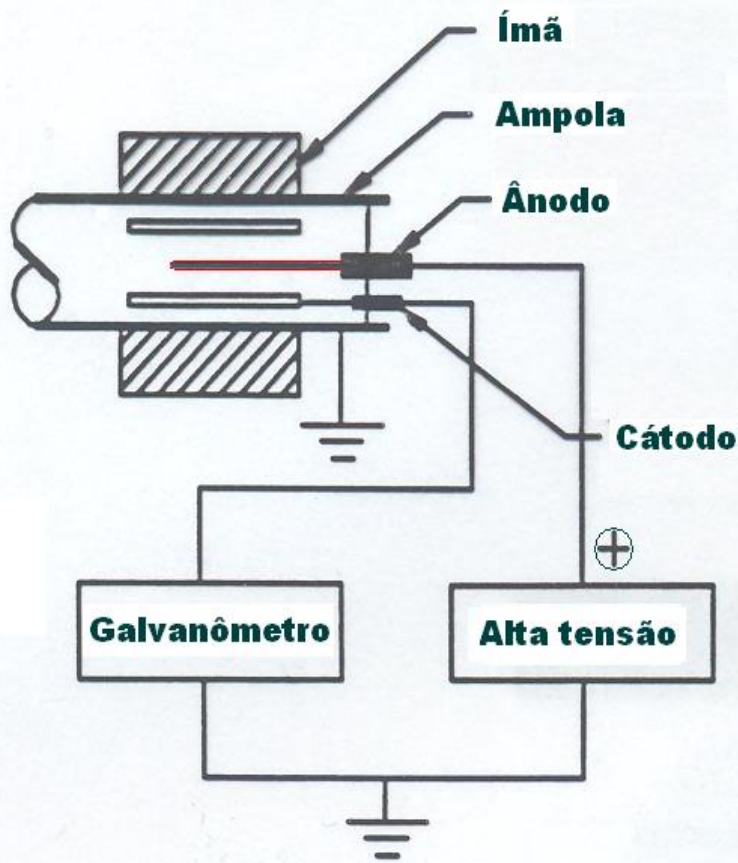
$$r = \frac{\text{Sensibilidade para gás}}{\text{Sensibilidade para argônio}}$$

Gás	Reynolds	Dushman and Young	Wagener and Johnson	Riddiford	Schulz
He	0.10–0.13	0.13	...	0.24	0.14
Ne	0.12–0.24	0.20	...	...	0.22
Ar	1.00	1.00	...	1.00	1.00
Kr	...	1.56	...	...	...
Xe	...	2.29	...	...	...
H ₂	...	0.39	0.44	0.36	0.28
N ₂	0.73–0.81	0.84	0.84	0.94	0.67
O ₂	...	...	0.71	1.07	...
Hg	1.73–2.50	2.89	...	...	...
Dry air	...	...	...	0.76	...
CO	...	...	0.90	...	...
CO ₂	...	...	1.15	...	...
H ₂ O	...	...	0.75	...	...
SF ₆	...	...	...	...	1.7

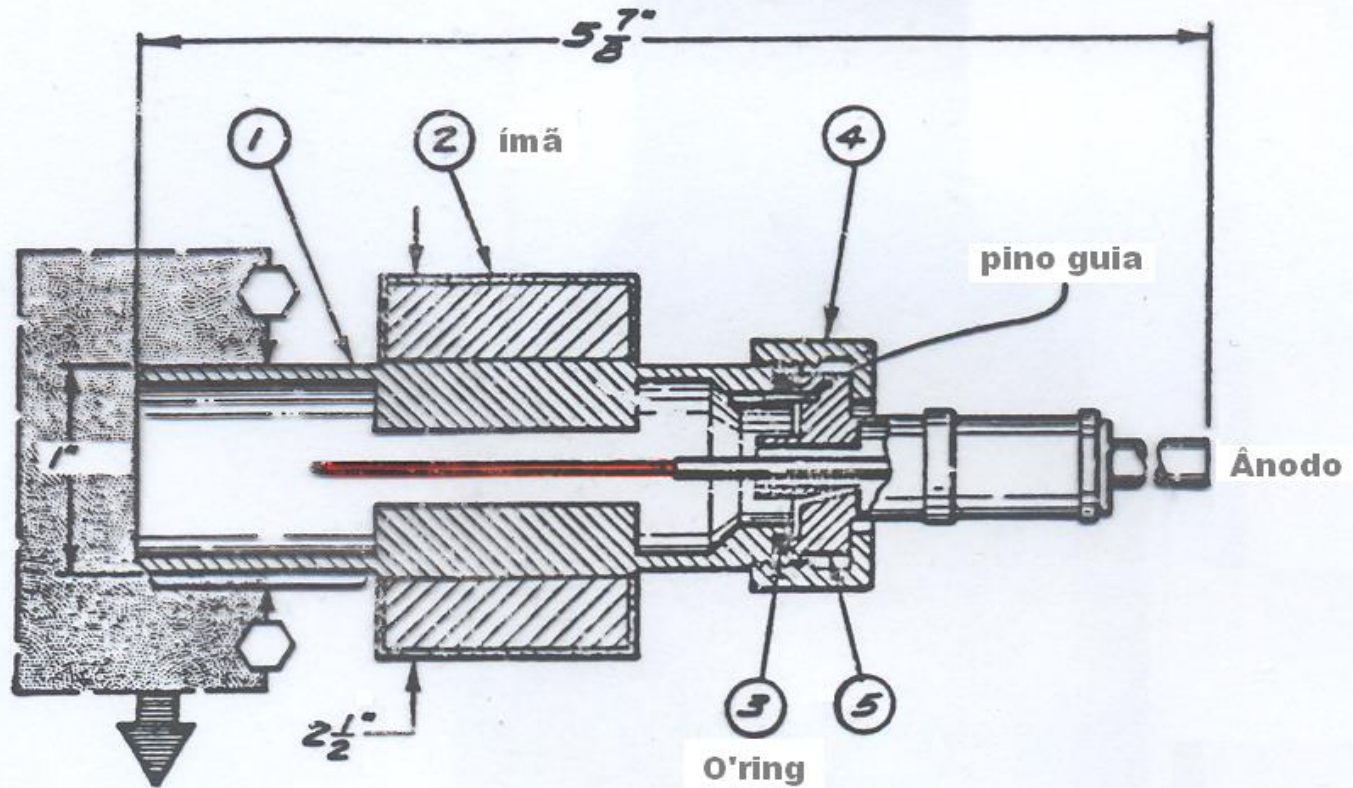
**Breakdown Voltage vs. Pressure x Gap
(Air)**



IONIZAÇÃO – CÁTODO FRIO



PENNING (CVC)

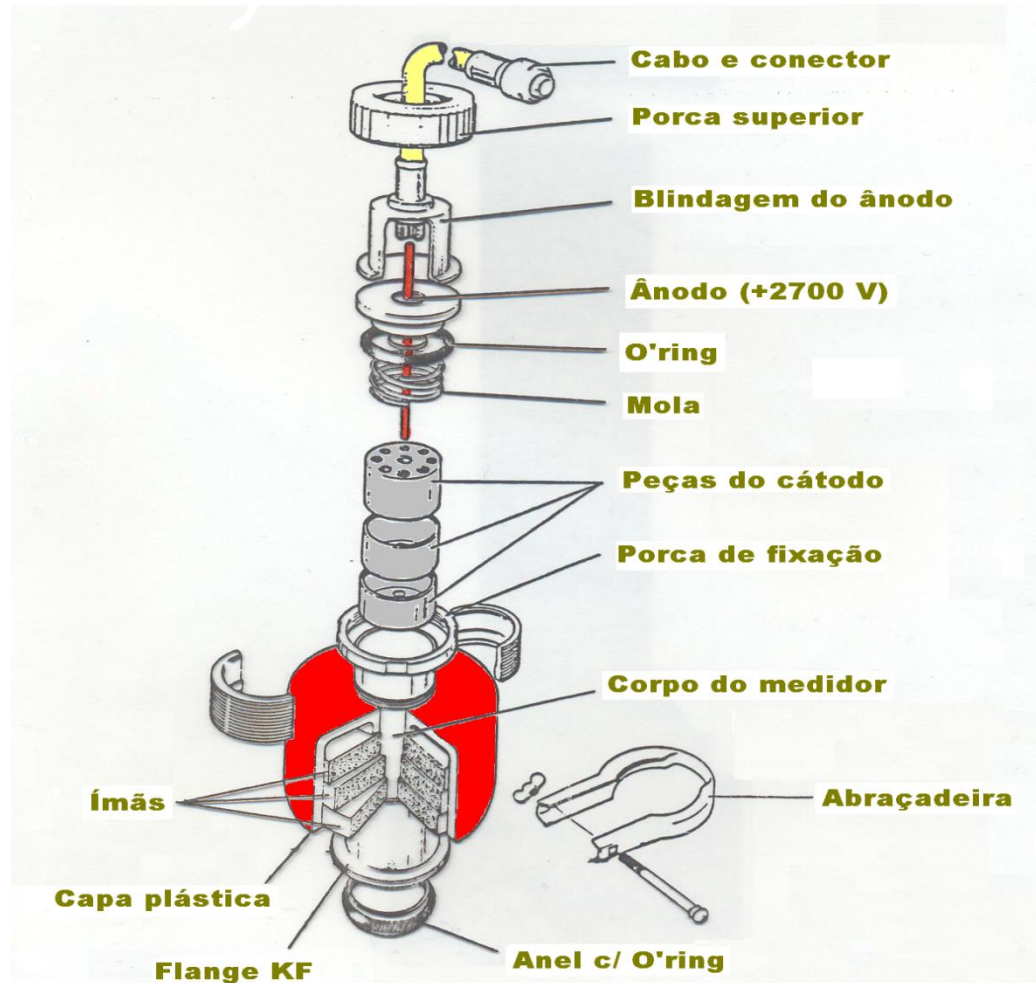


acoplamento ao sistema (O'ring dinâmico)

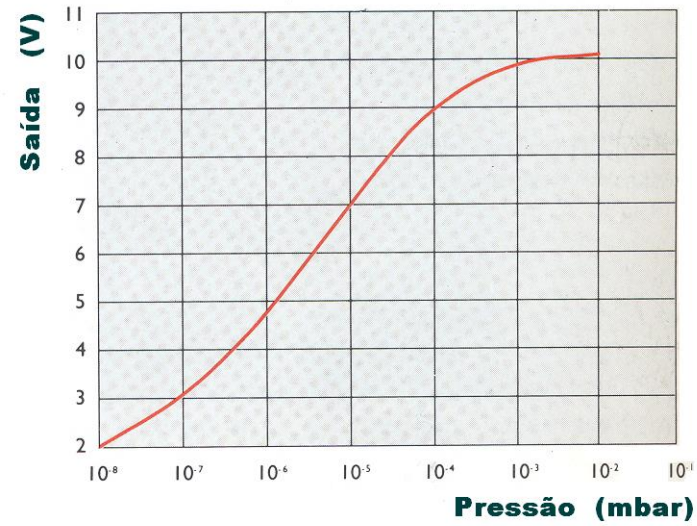
MAGNETRON INVERTIDO (PENNING) EDWARDS ACTIVE



PENNING (EDWARDS CP25)



PENNING (MAGNETRON INVERTIDO) EDWARDS

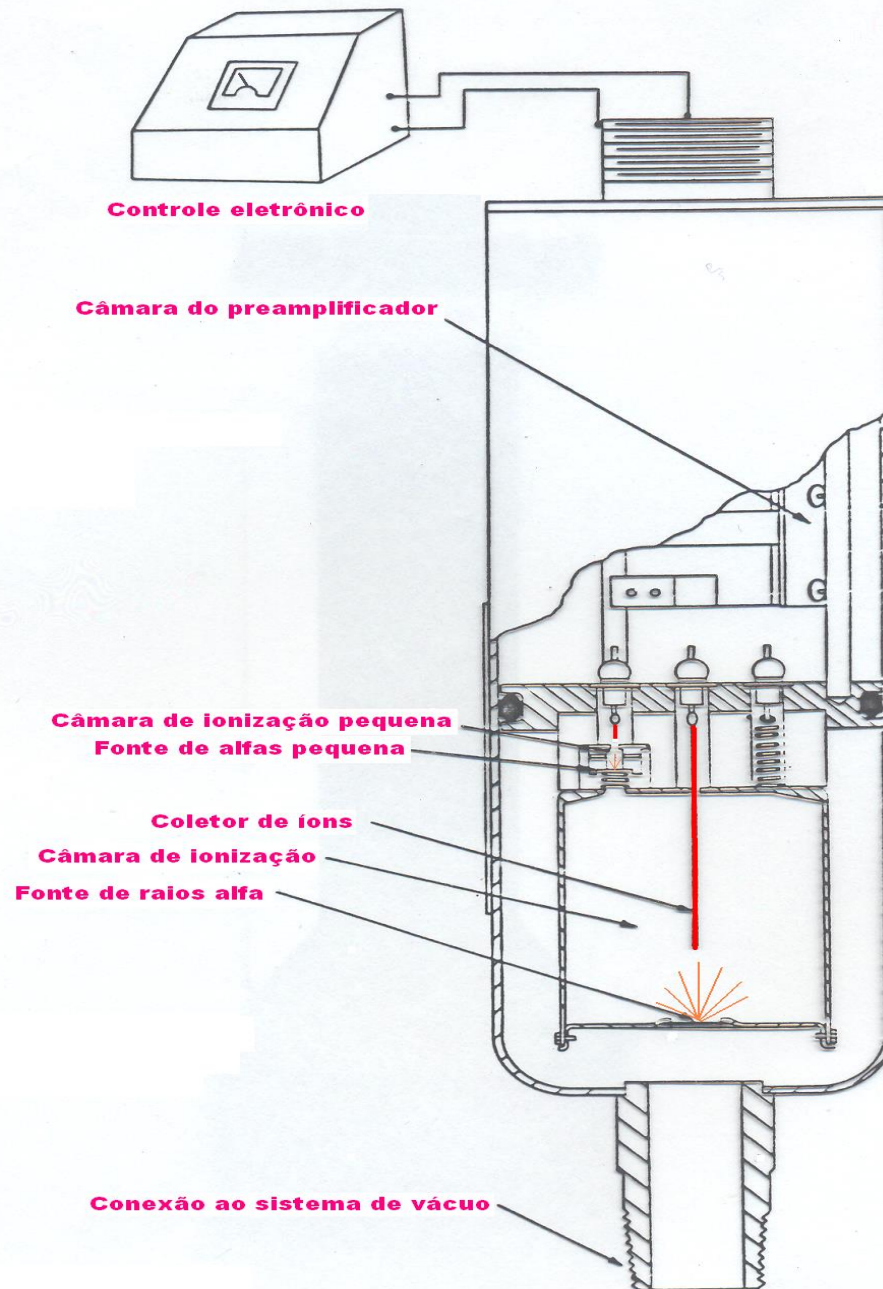




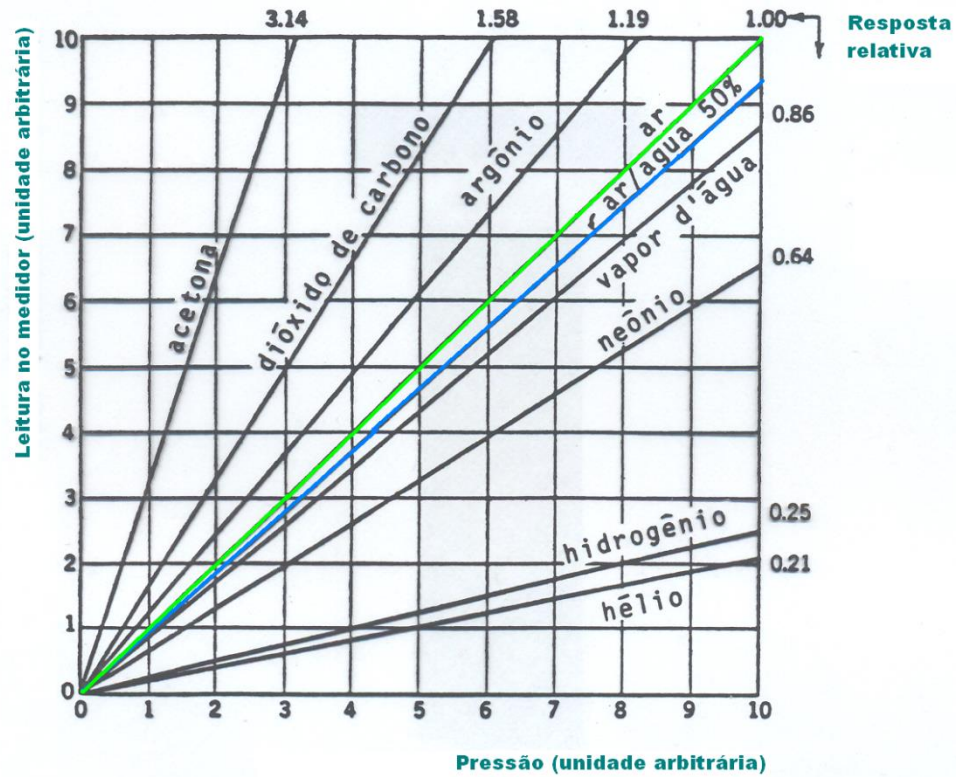
PIRANI EDWARDS ACTIVE



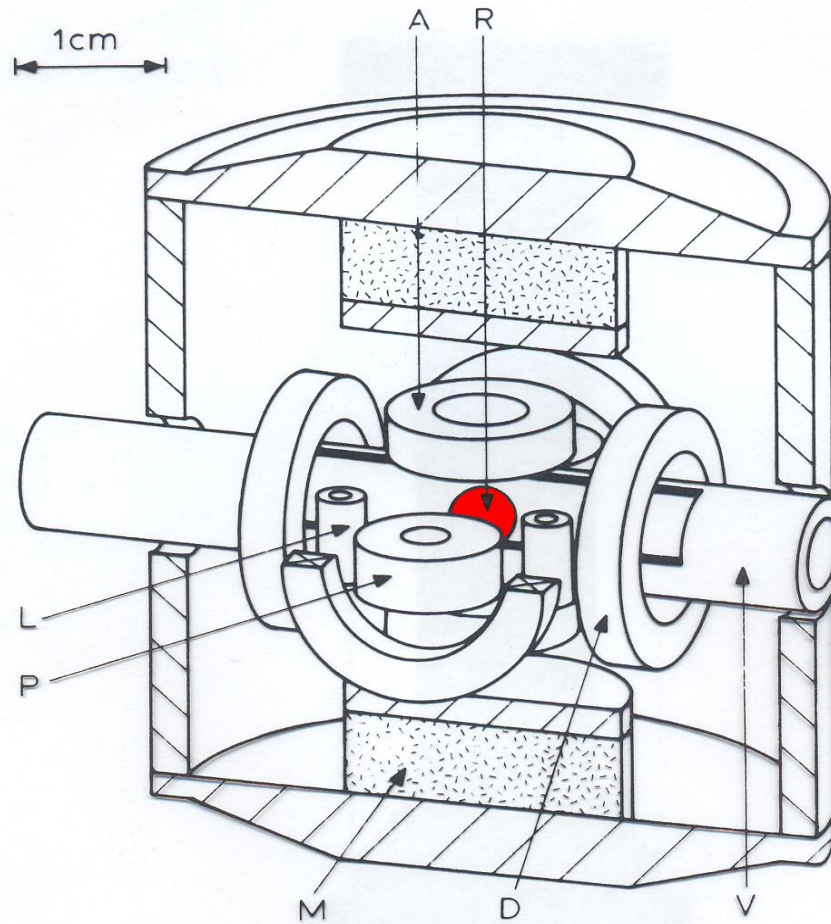
ALPHATRON



ALPHATRON



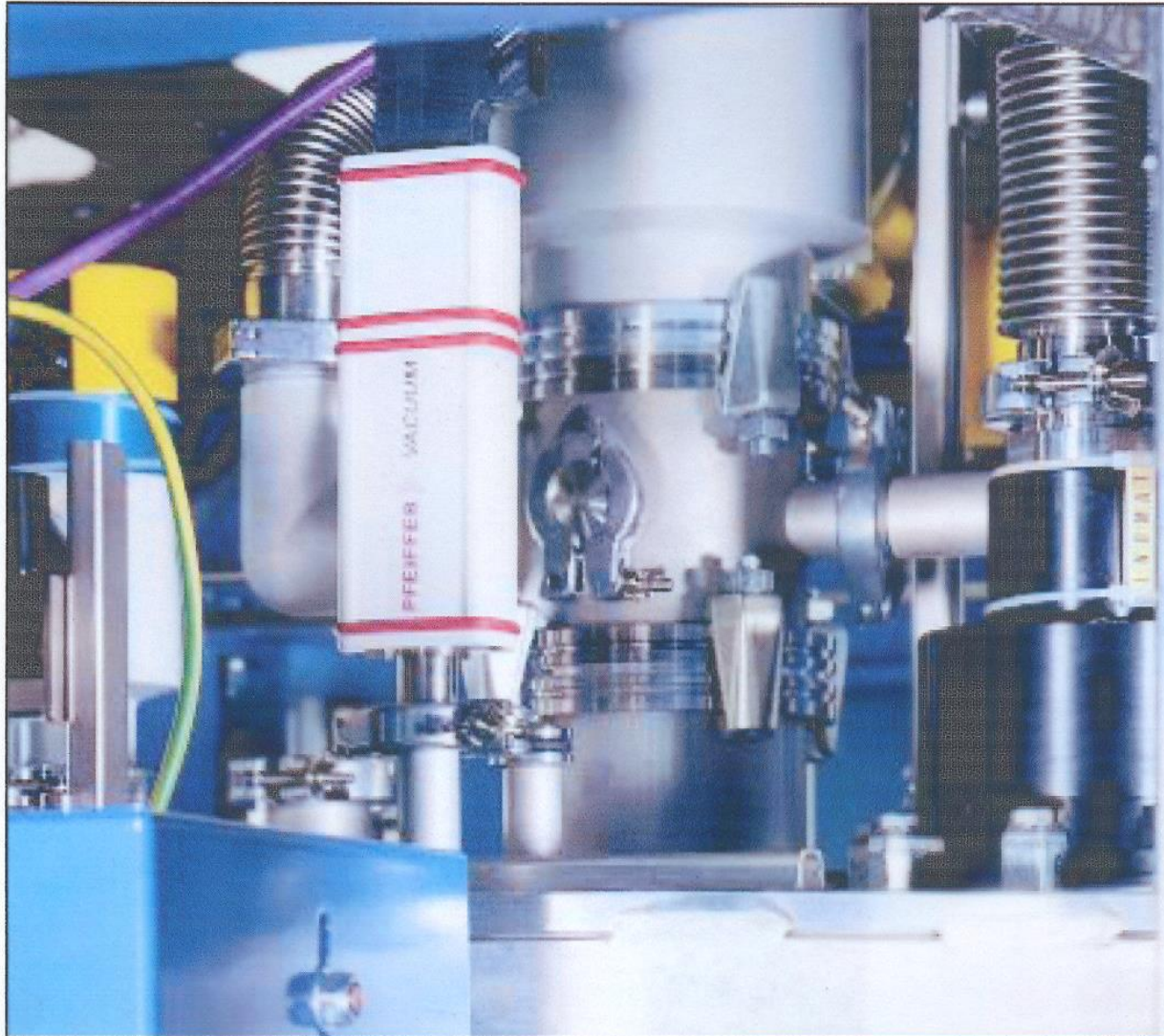
VISCOSÍMETRO



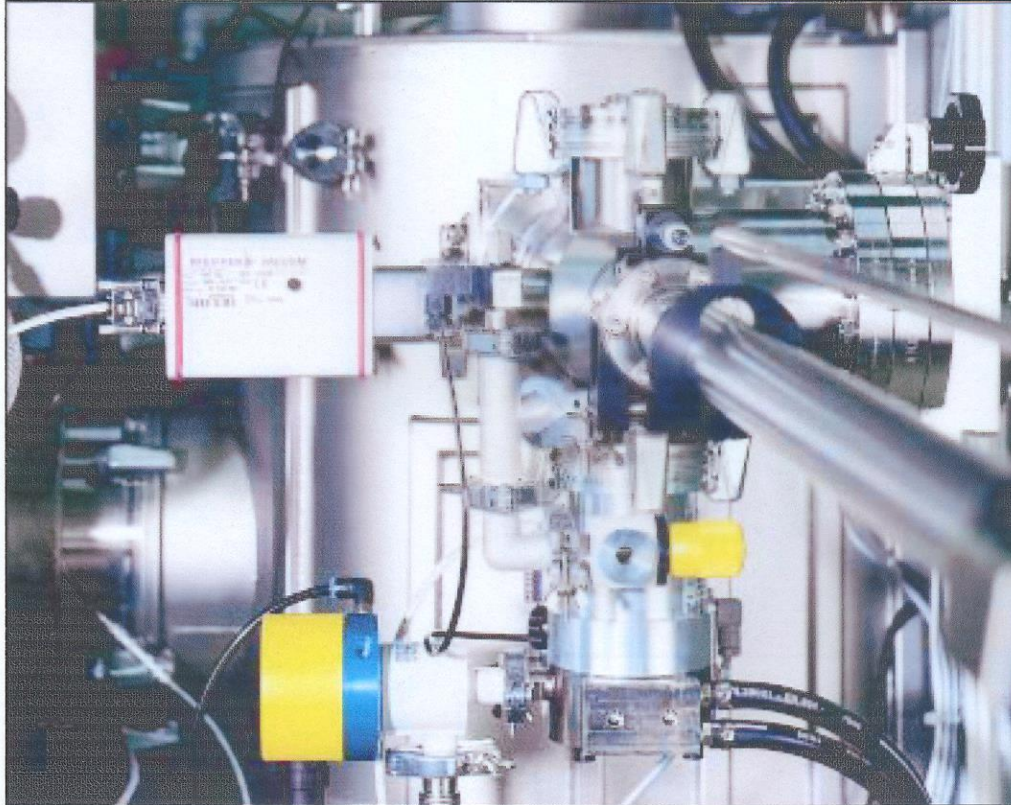
SISTEMA PADRÃO LEYBOLD



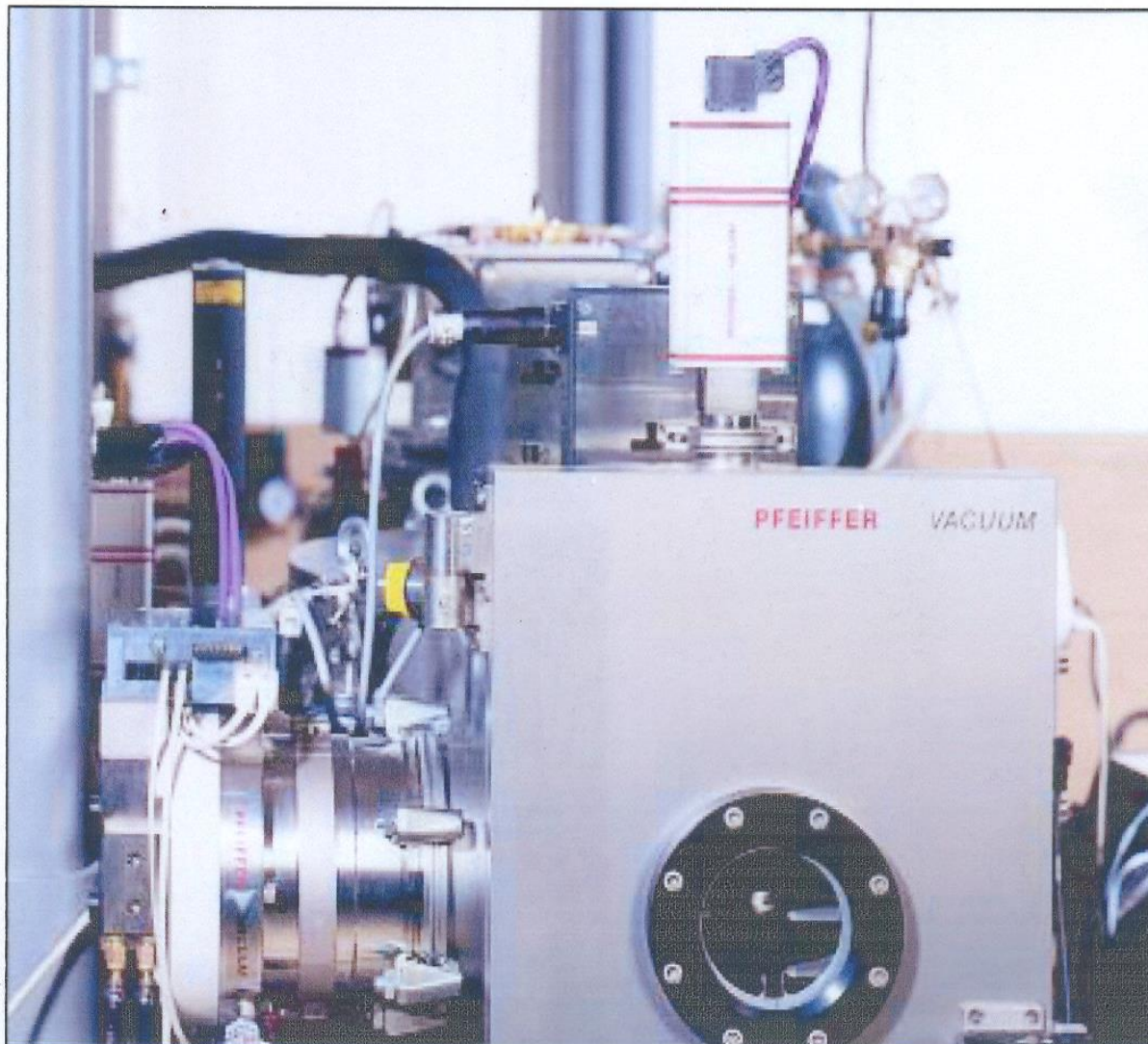
PIEZO/PIRANI RPT-100 PFEIFFER



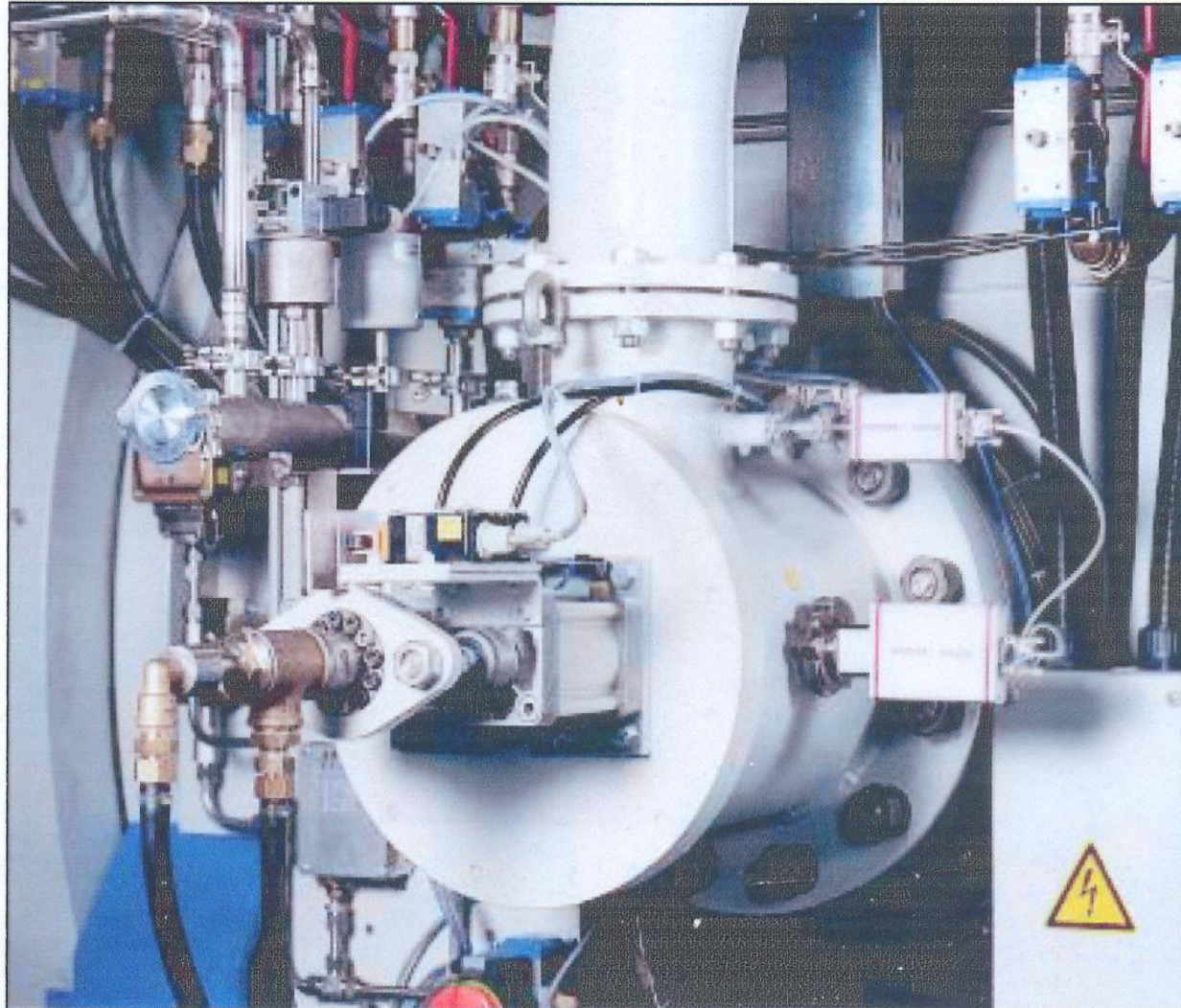
PIRANI/BAYARD-ALPERT HPT-100 PFEIFFER



PIRANI/BAYARD-ALPERT E PIEZO/PIRANI PFEIFFER



PIRANI/BAYARD-ALPERT E PIEZO PFEIFFER



MEDIDORES PFEIFFER

