TECNOLOGIA DO VÁCUO

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

- 01 - março – 2016
- UNIVERSIDADE DE S. PAULO – INSTITUTO DE FÍSICA

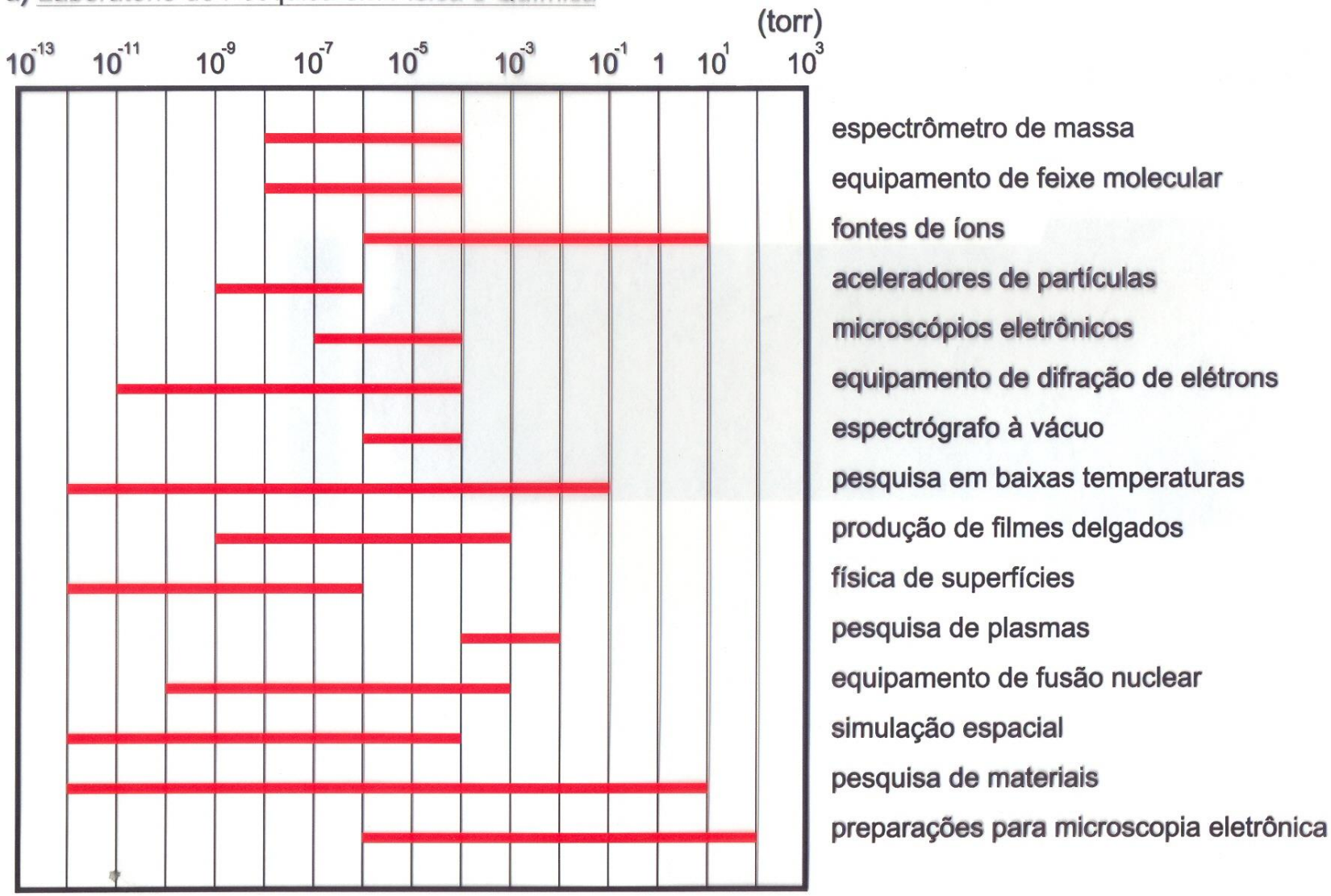
UNIDADES DE PRESSÃO (VÁCUO)

	bar	mbar	Pa	atm	Torr
bar	1	10^{3}	10^{5}	0,986923	750,062
mbar	$1x10^{-3}$	1	10^{2}	$0,986923x10^{-3}$	0,750062
Pa	10^{-5}	10^{-2}	1	$0,986923x10^{-5}$	$0,750062x10^{-2}$
atm	1,01325	$1,01325x10^{3}$	$1,01325x10^{5}$	1	760
Torr	$1,333224x10^{-3}$	1,333224	$1,333224x10^{2}$	$1,315789x10^{-3}$	1

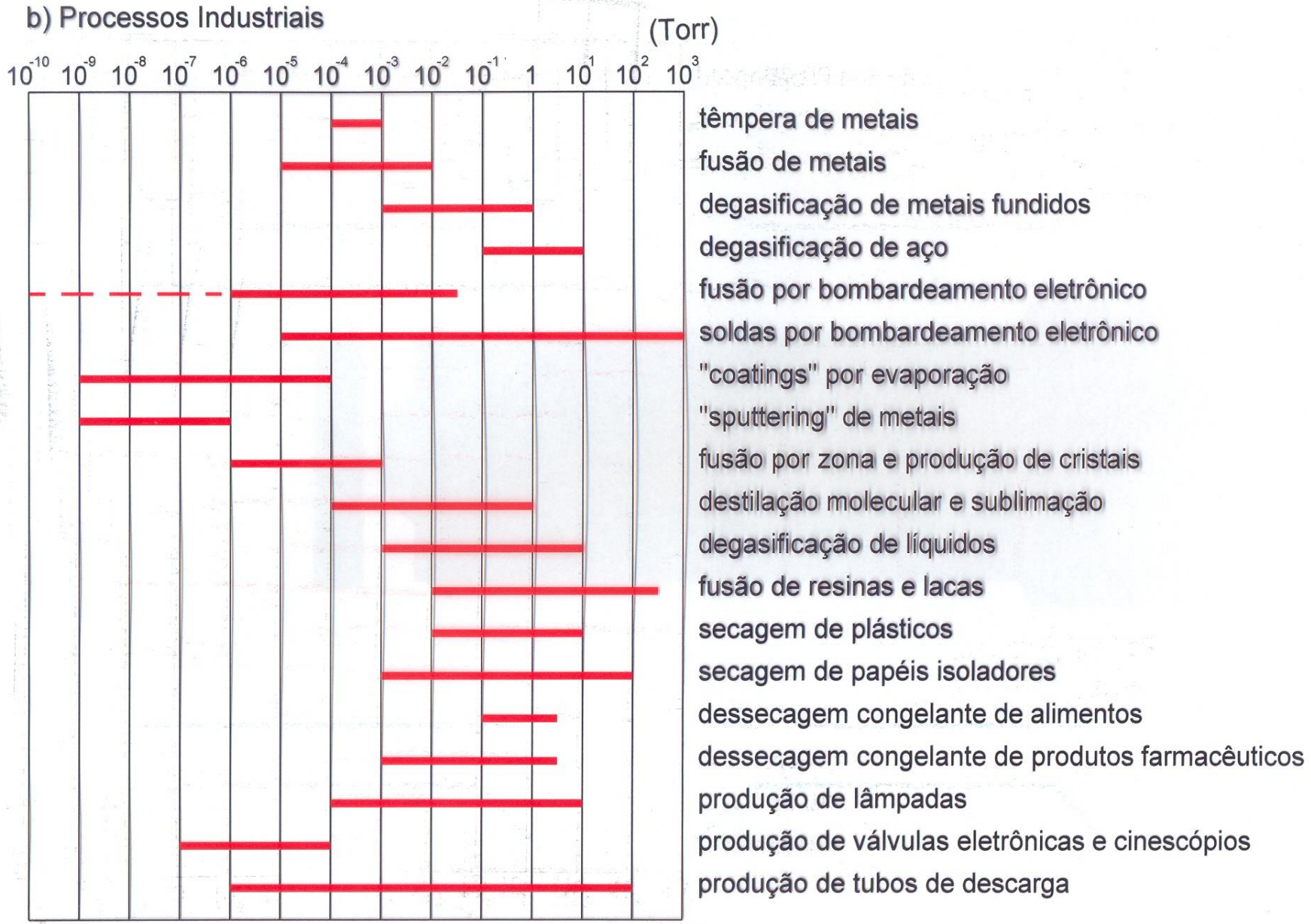
De acordo com as novas regras do "International System of Units", a unidade oficial de pressão passa a ser o pascal ($Pa = N \times m^{-2}$), no lugar do bar, Torr e atm.

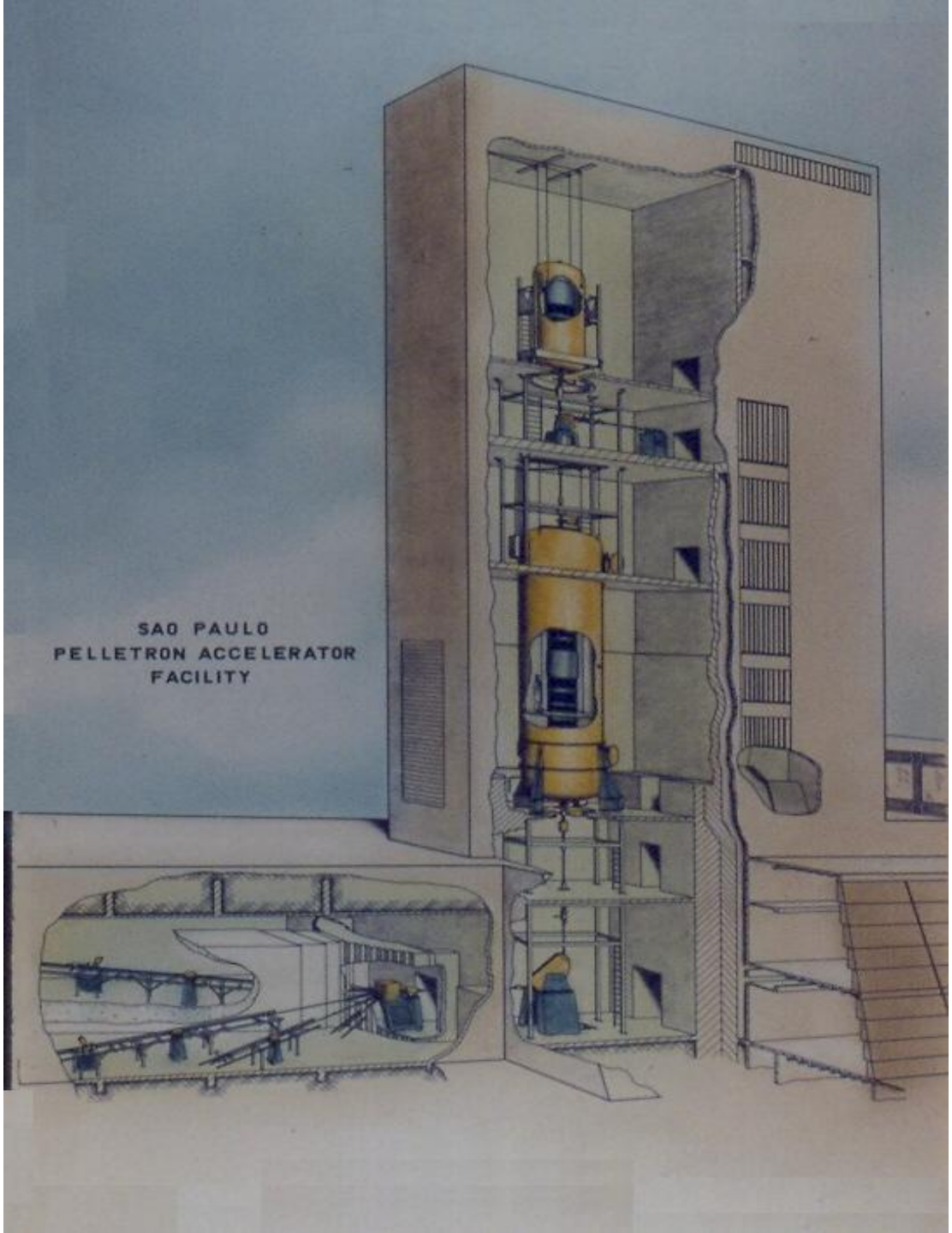
ALGUMAS APLICAÇÕES DO VÁCUO E SUAS FAIXAS DE PRESSÃO

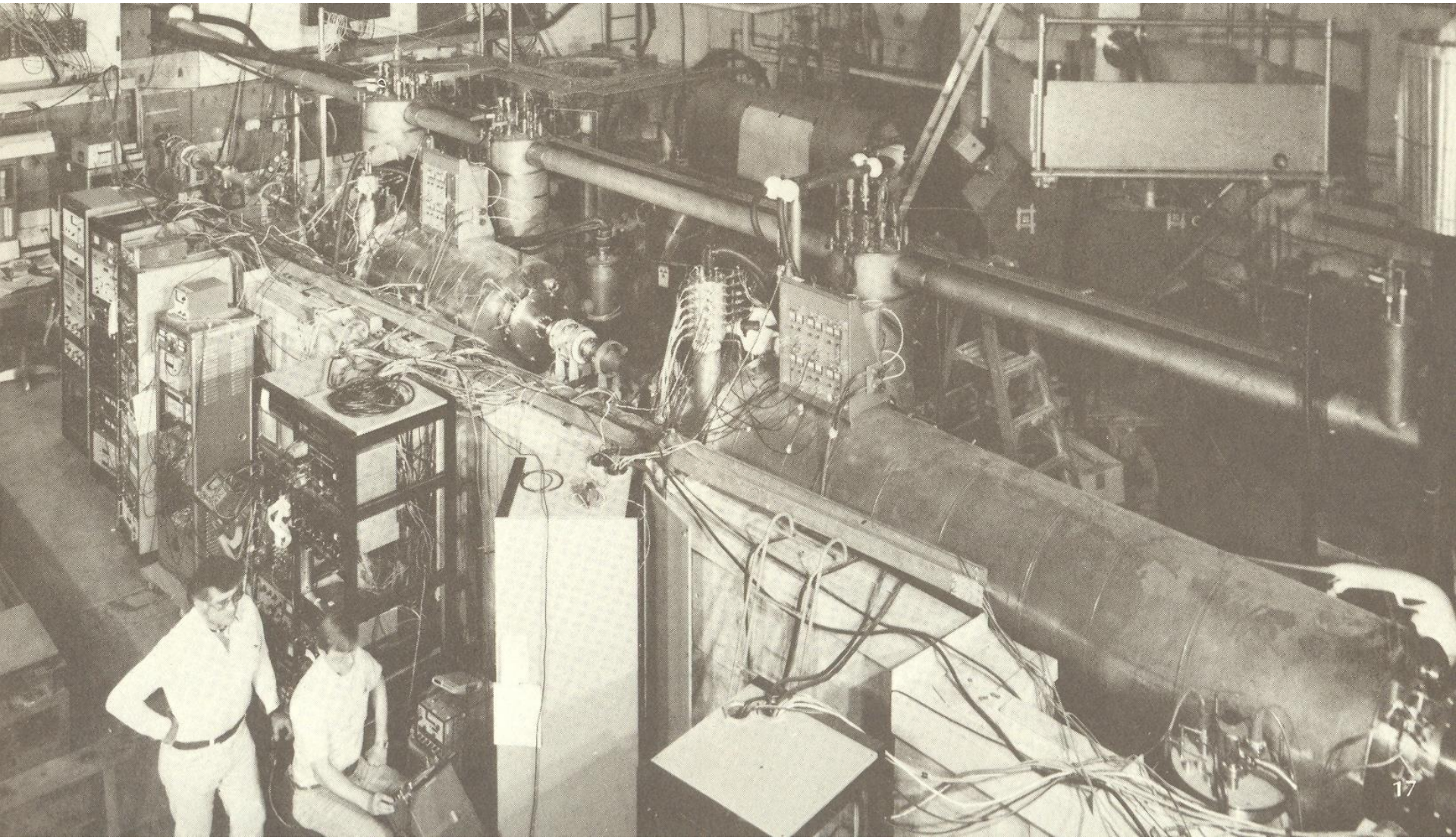
a) Laboratório de Pesquisa em Física e Química

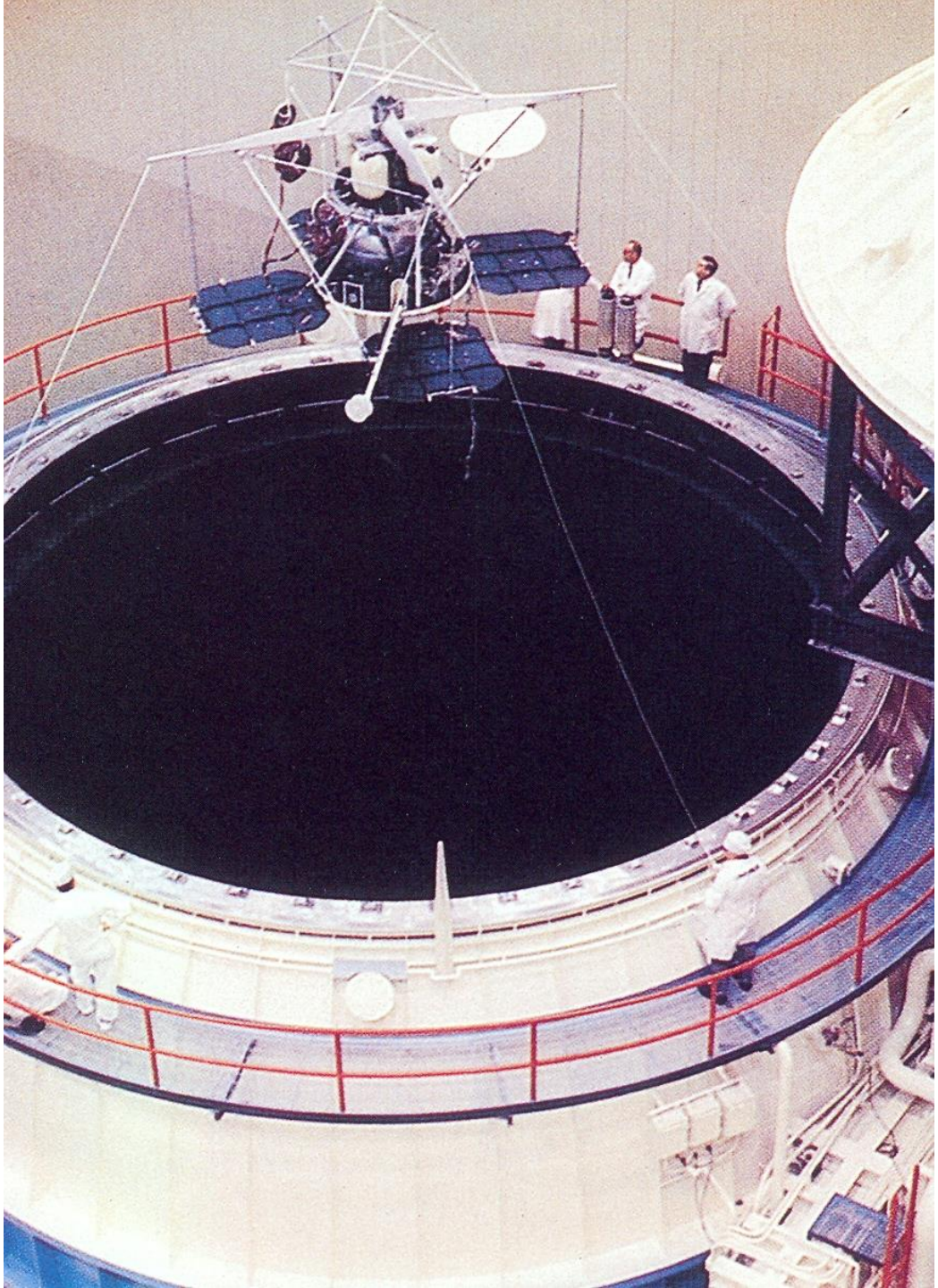


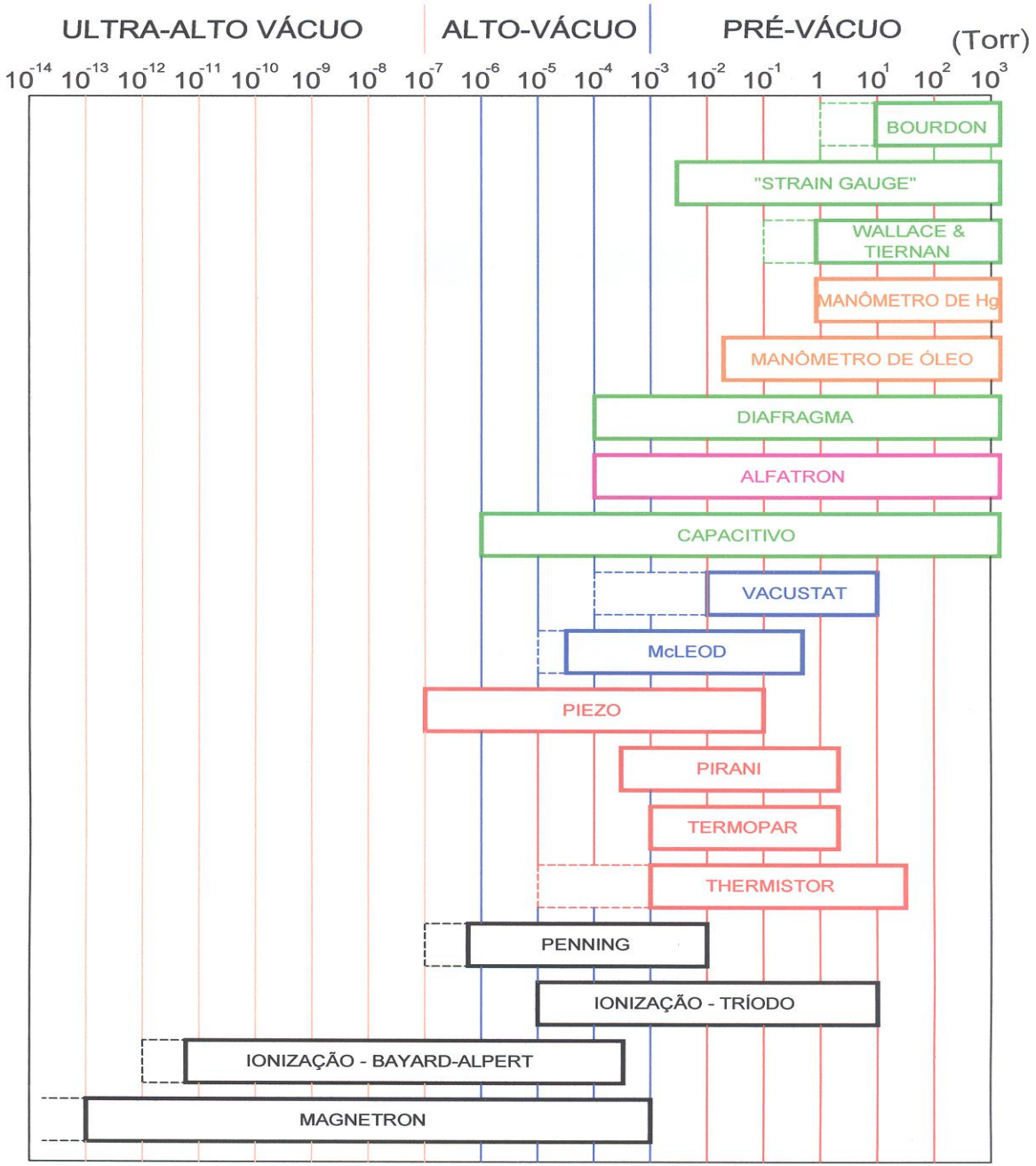
b) Processos Industriais



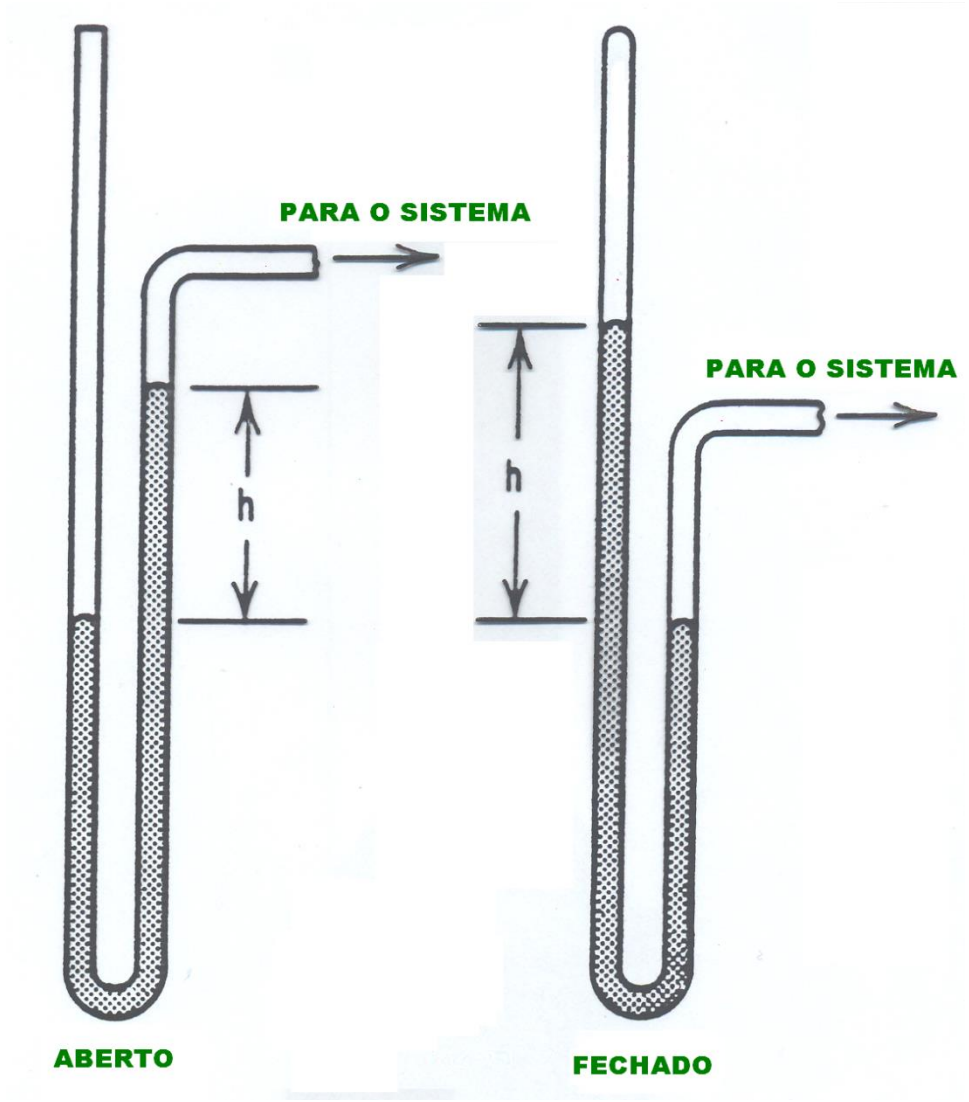

SAO PAULO
PELLETRON ACCELERATOR
FACILITY



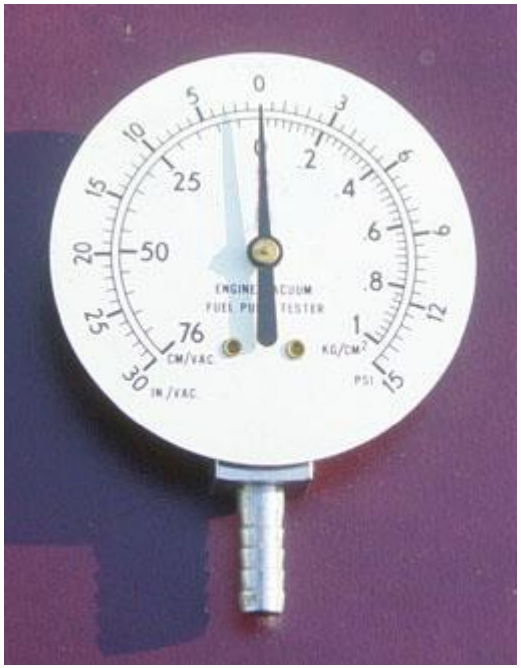


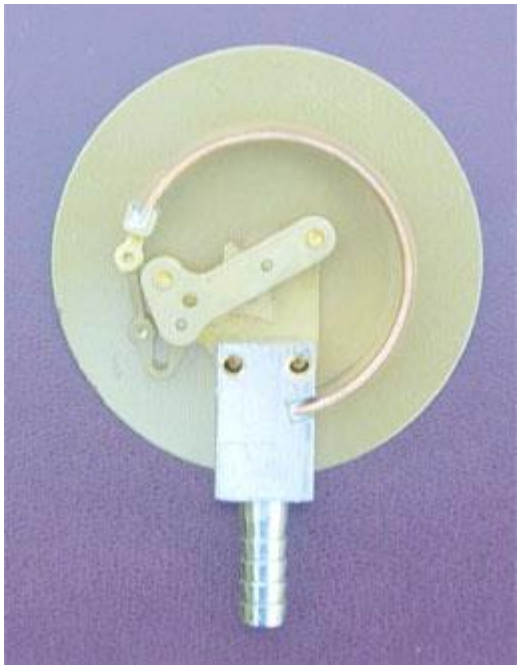

ULTRA-ALTO VÁCUO
ALTO-VÁCUO
PRÉ-VÁCUO
(Torr)
10^{-14} 10^{-13} 10^{-12} 10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3}
BOURDON
"STRAIN GAUGE"
WALLACE & TIERNAN
MANÔMETRO DE Hg
MANÔMETRO DE ÓLEO
DIAFRAGMA
ALFATRON
CAPACITIVO
VACUSTAT
McLEOD
PIEZO
PIRANI
TERMOPAR
THERMISTOR
PENNING
IONIZAÇÃO - TRÍODO
IONIZAÇÃO - BAYARD-ALPERT
MAGNETRON

TUBO EM “U”



BOURDON



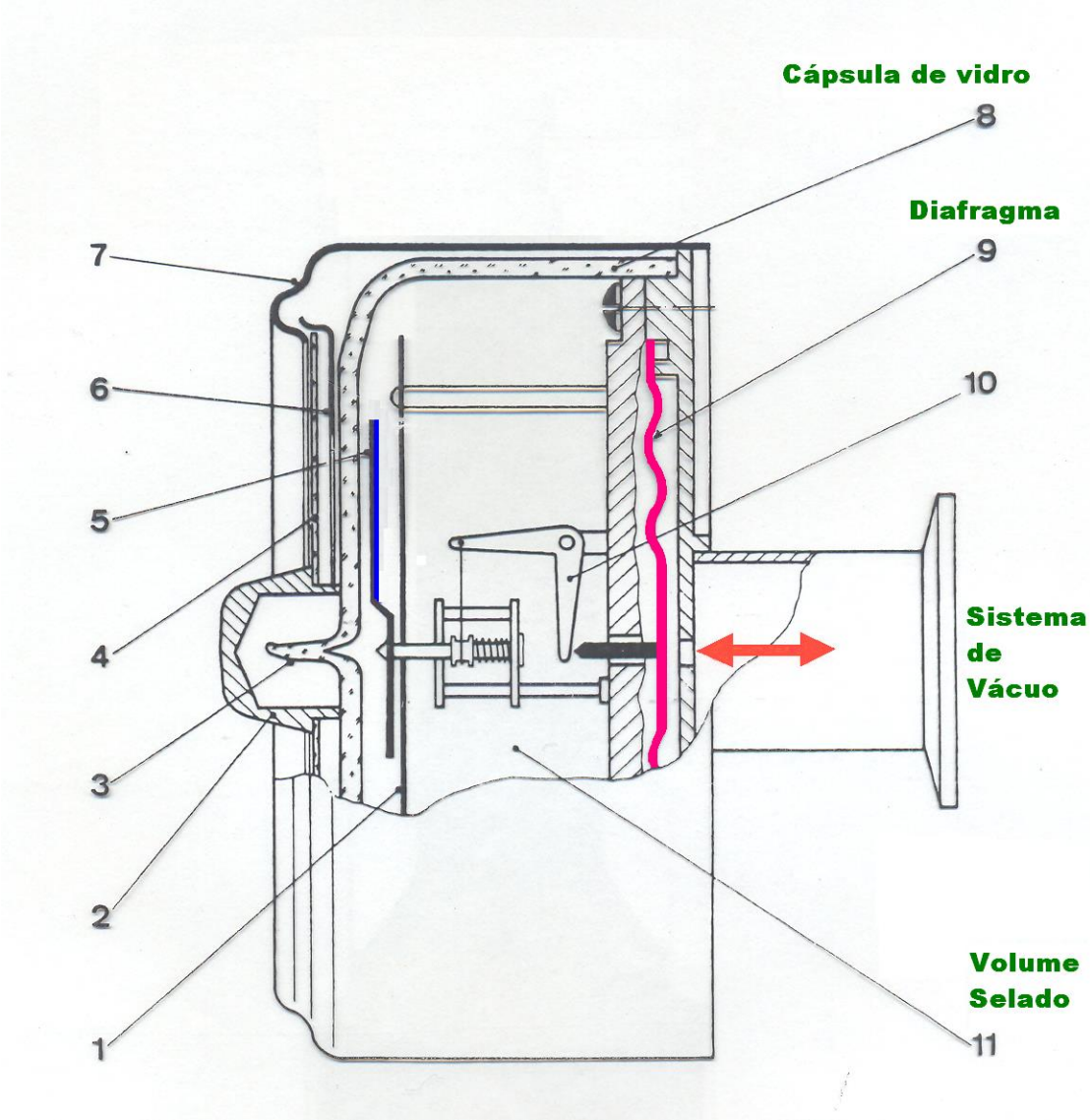


MANOVACUÔMETRO

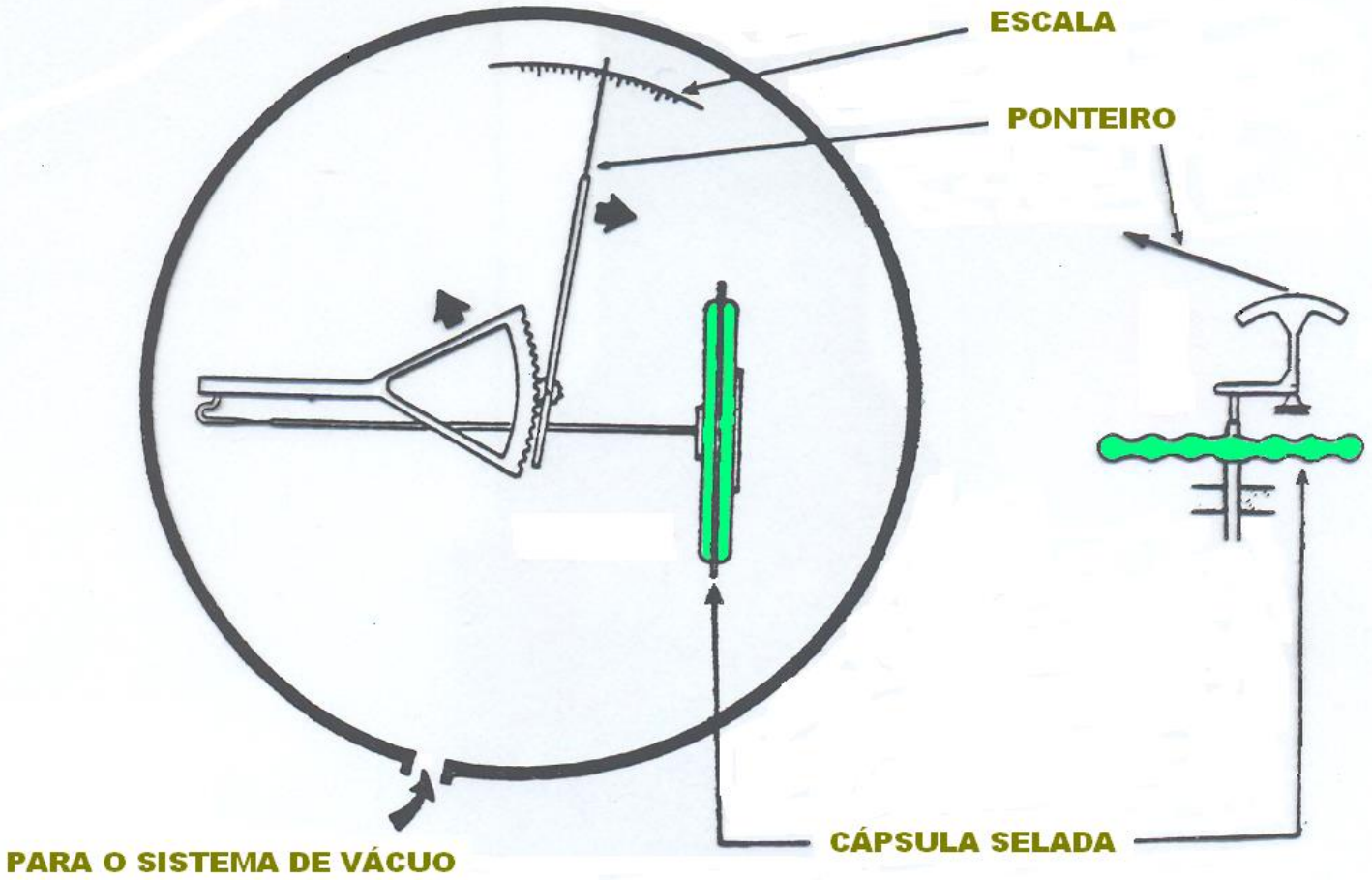
VÁCUO

PRESSÃO

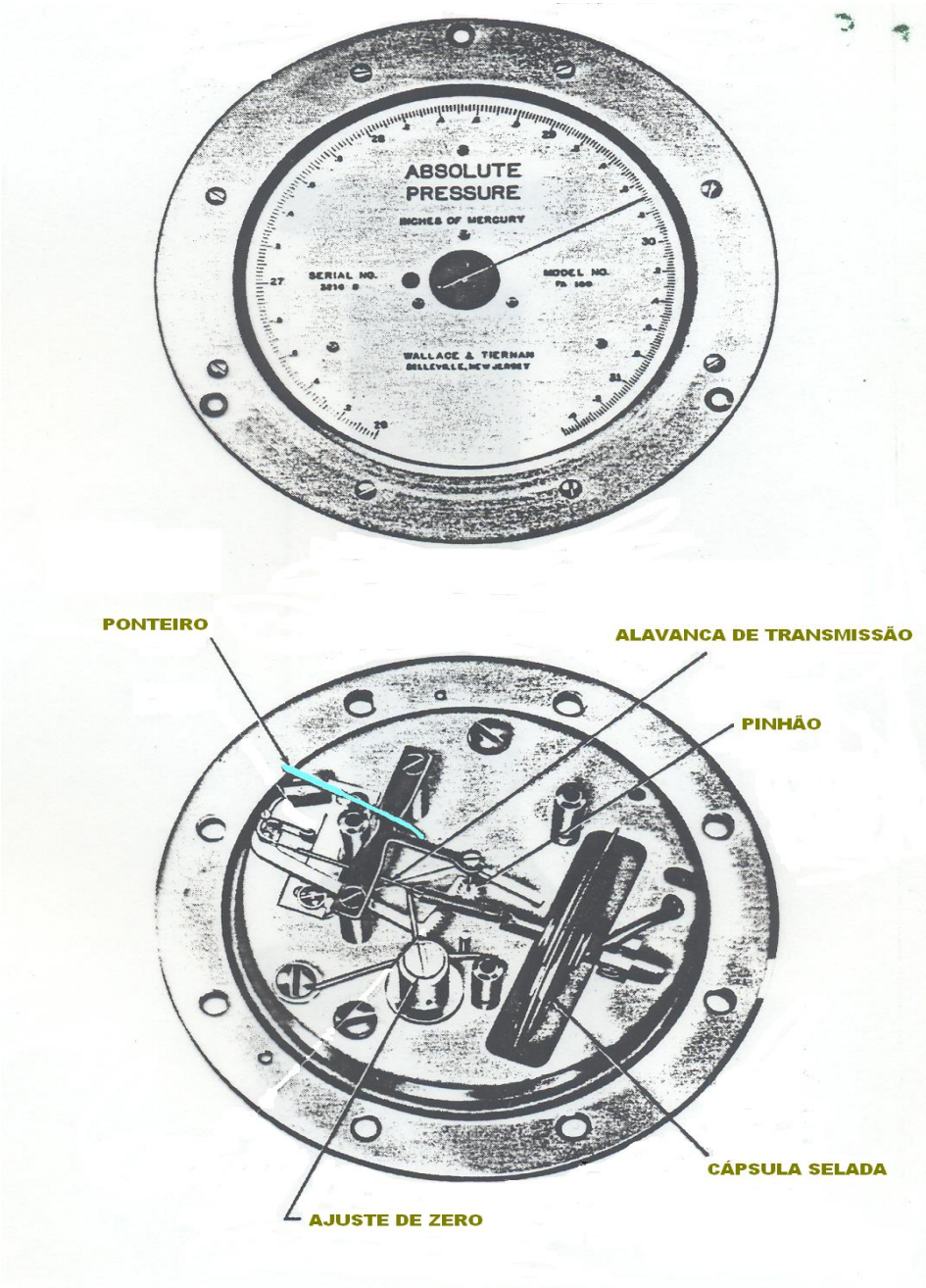
DIAFRAGMA


Cápsula de vidro
8
Diafragma
9
7
6
10
5
4
Sistema
de
Vácuo
3
2
Volume
Selado
1
11

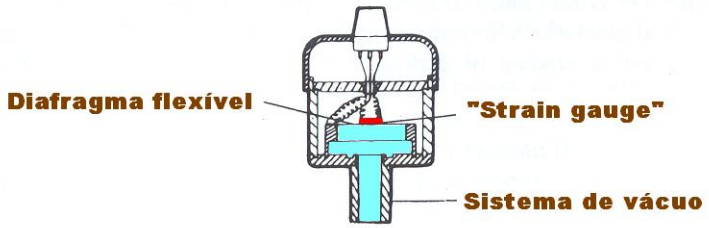
WALLACE & TIERNAN



WALLACE & TIERNAN



“STRAIN GAUGE”

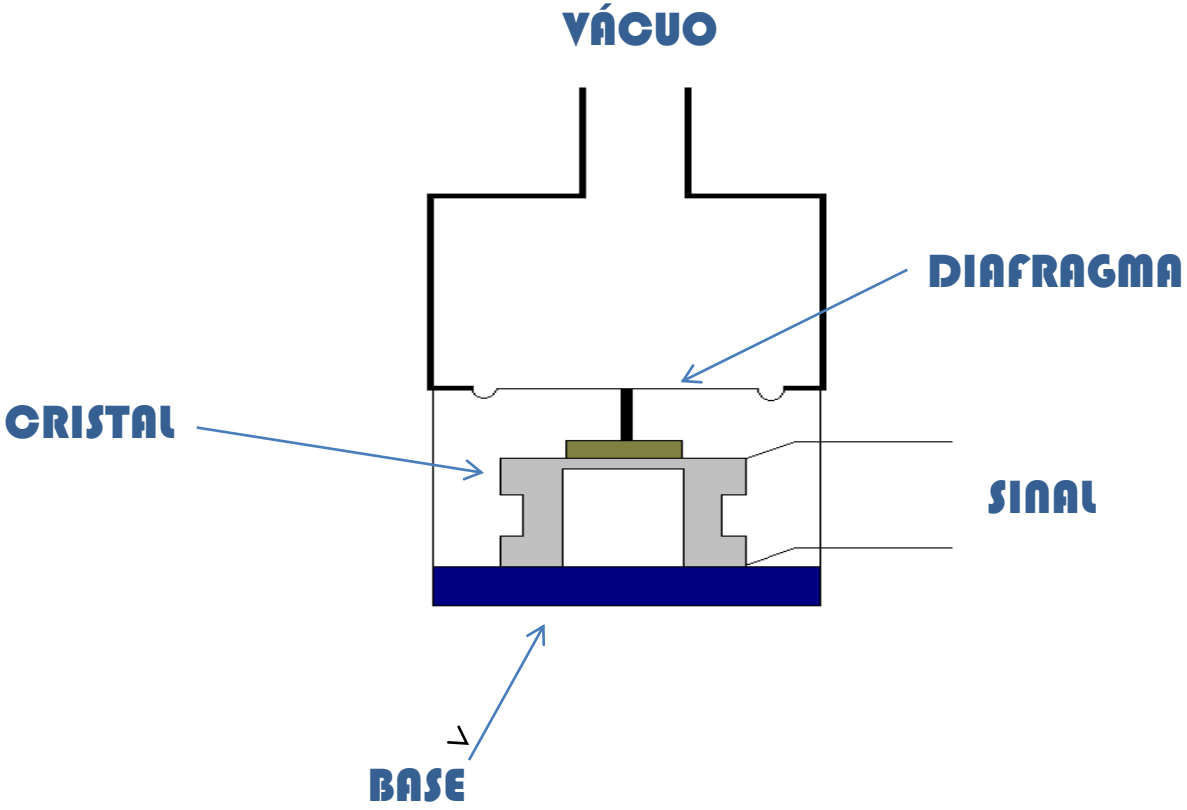


PIEZO (DIAFRAGMA)

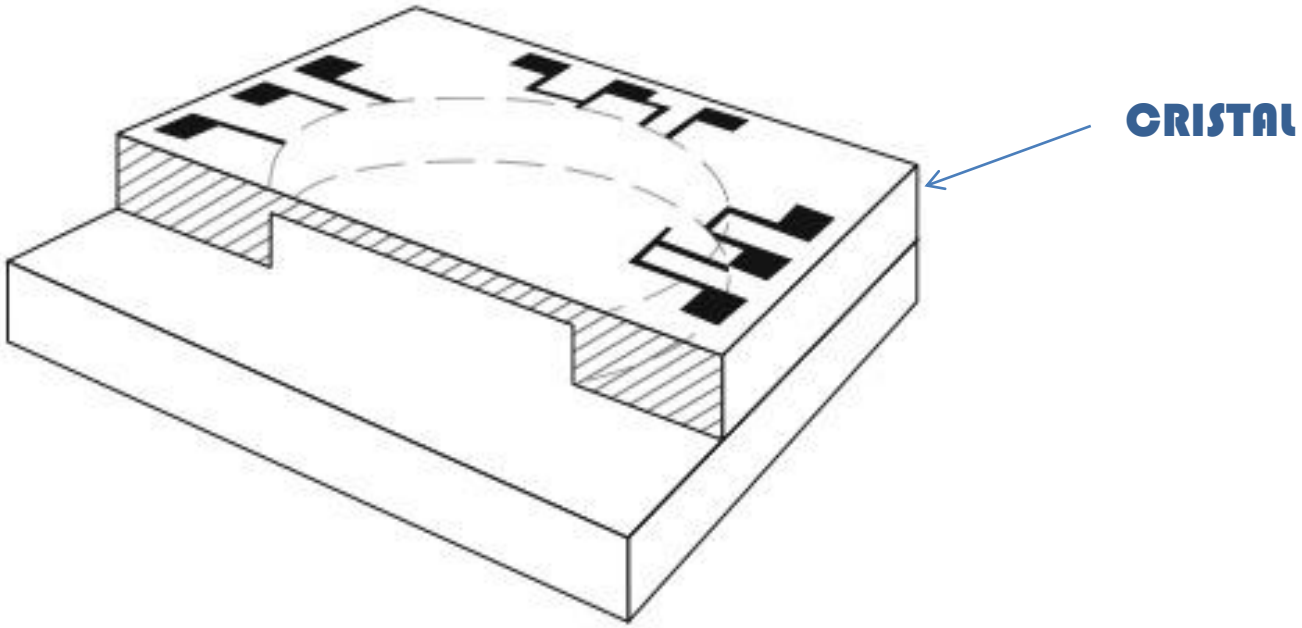
LEITURA + INTERFACE

SENSOR + ELETRÔNICA

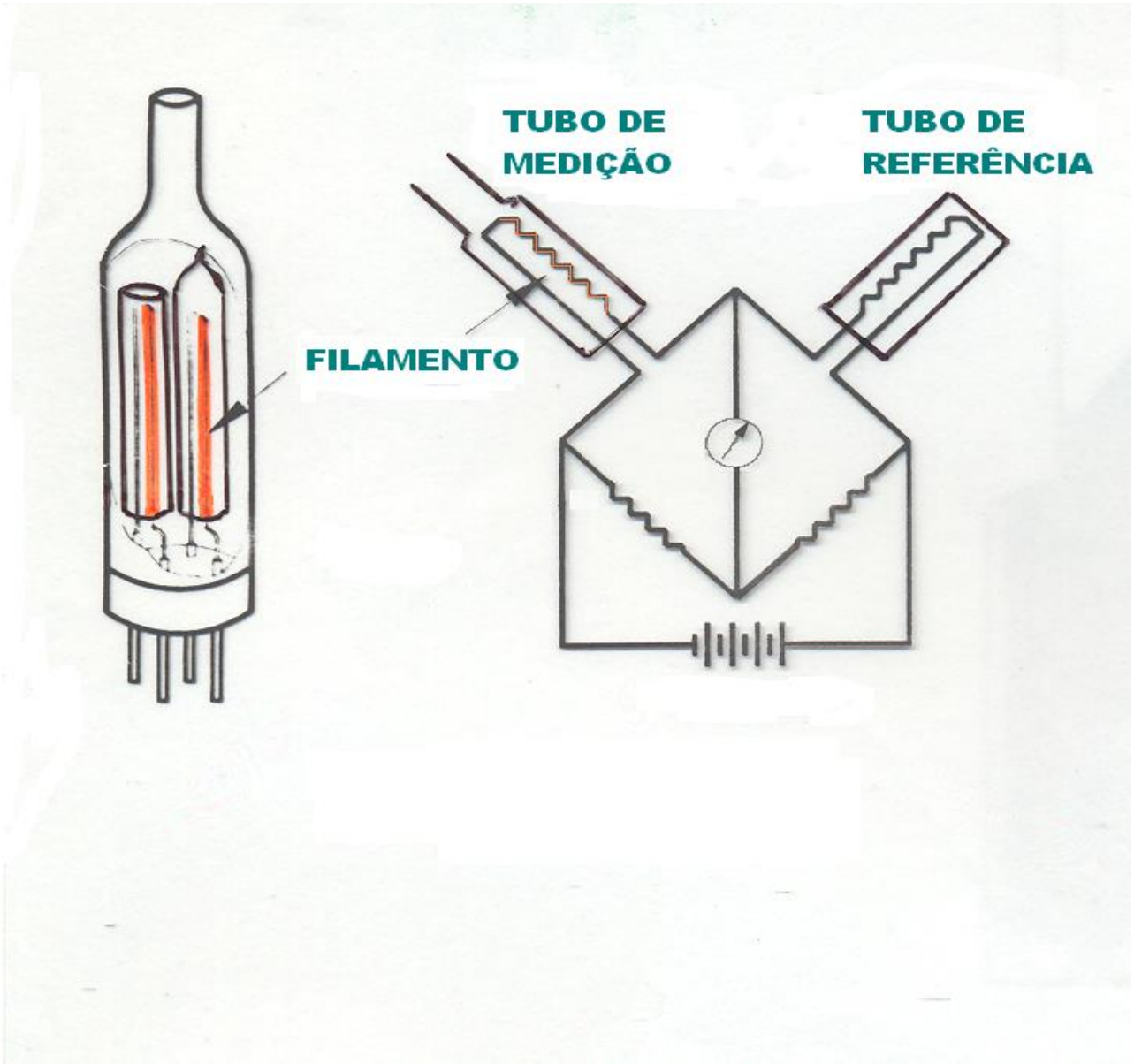
PIEZO (DIAFRAGMA)



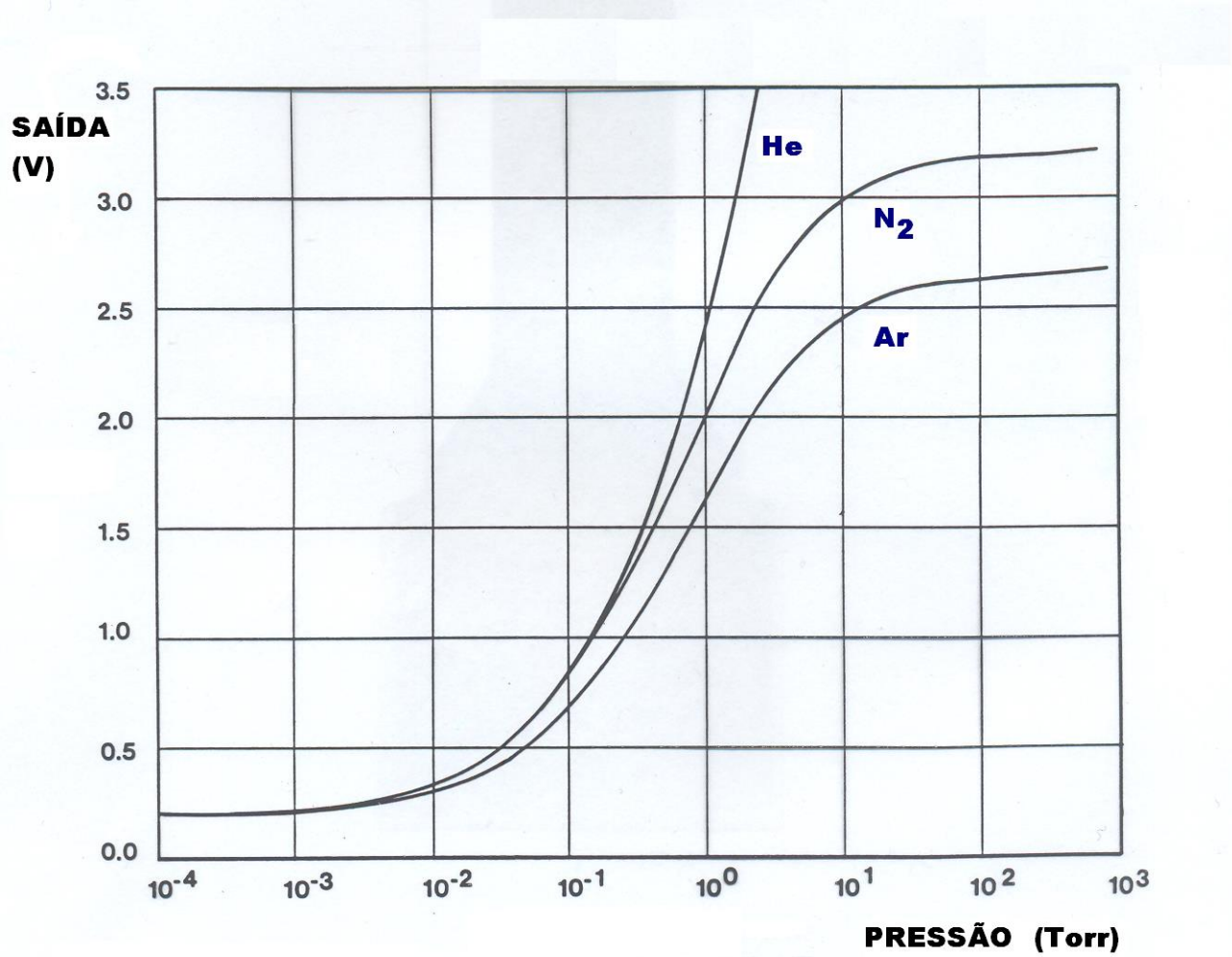
PIEZO – SENSOR DE CRISTAL DE QUARTZO



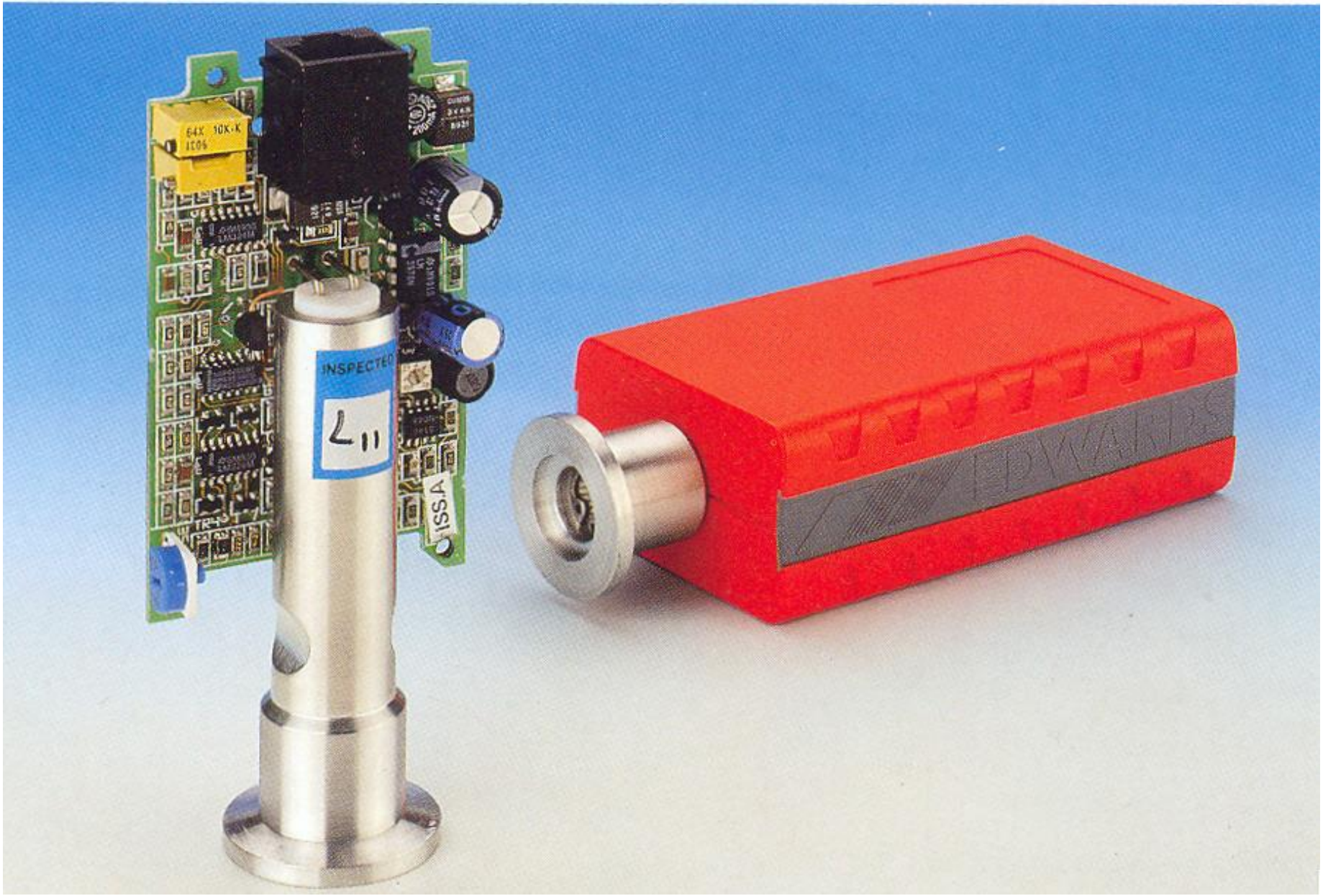
PIRANI



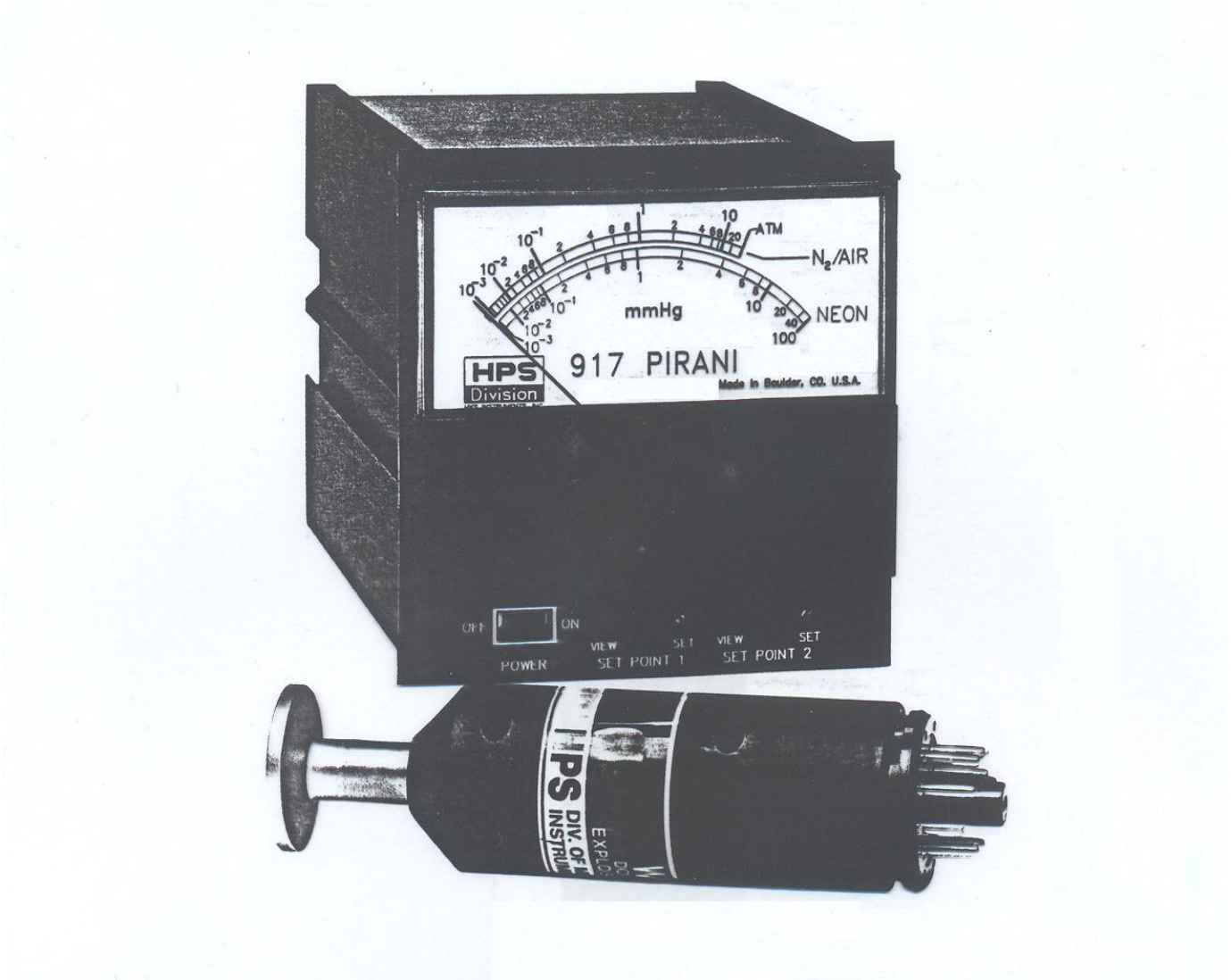
PIRANI – CURVA DE RESPOSTA



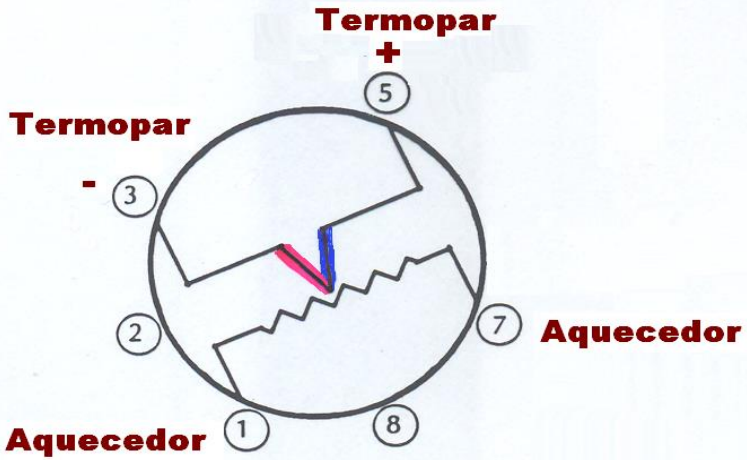
PIRANI (EDWARDS)

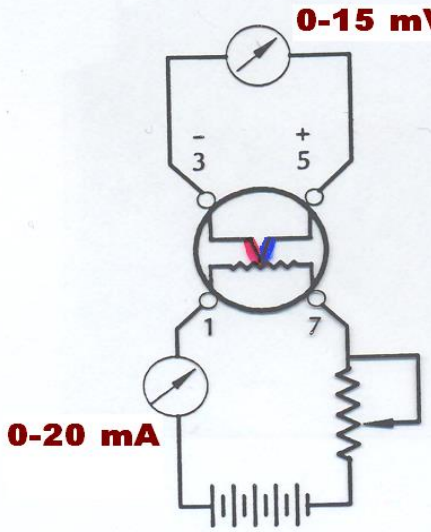


PIRANI (HPS)

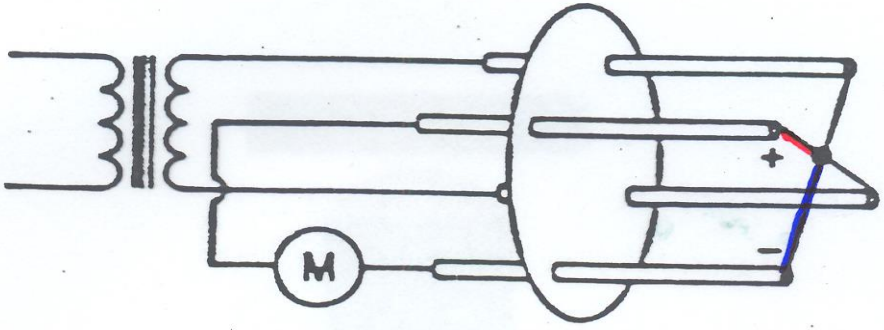

ATM
N_2/AIR
mmHg
NEON
917 PIRANI
HPS
Division
Made in Boulder, CO. U.S.A.
OFF
ON
POWER
VIEW
SET
SET POINT 1
VIEW
SET
SET POINT 2
HPS
DIV. OF

TERMOPAR

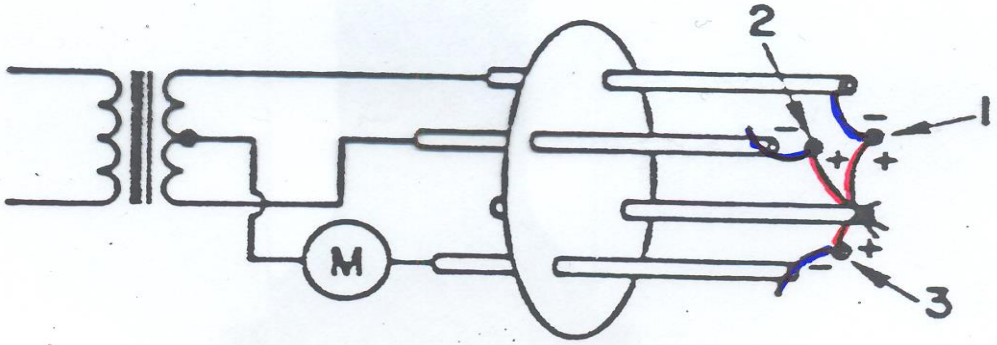

Termopar
+
5
Termopar
-
3
2
7
Aquecedor
Aquecedor
1
8


0-15 mV
-
3
+
5
1
7
0-20 mA

TERMOPAR

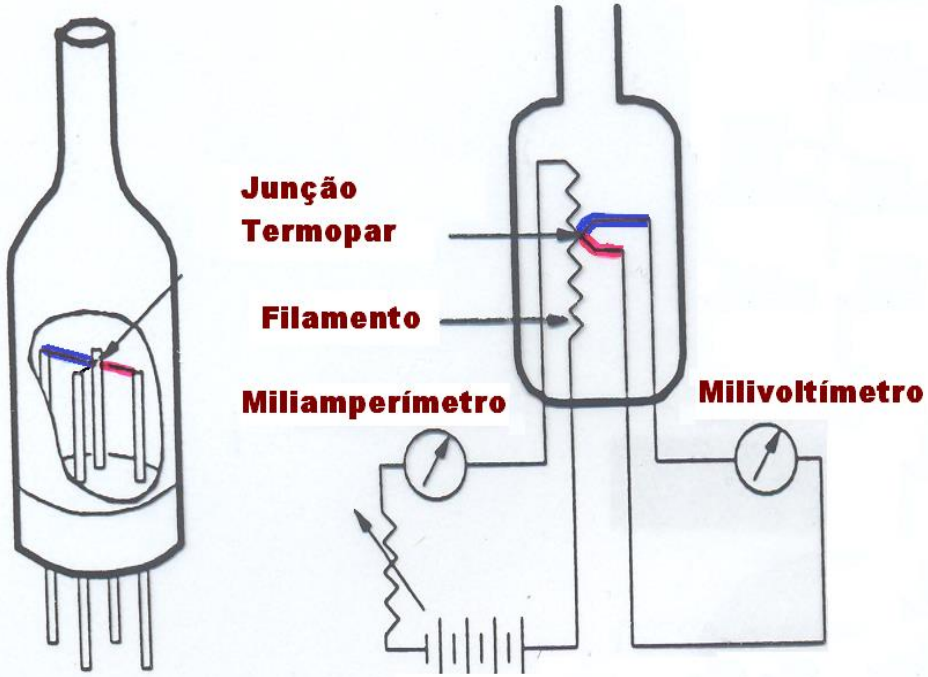


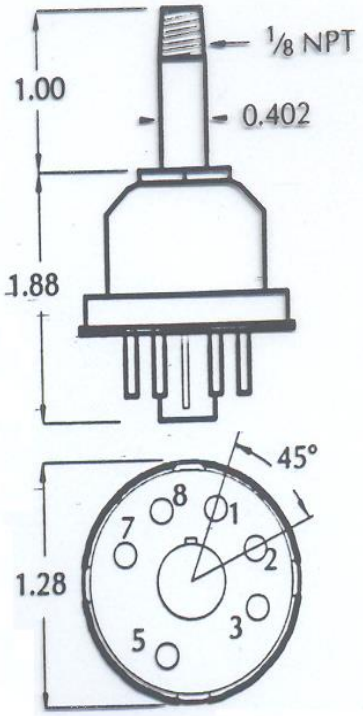
(A)



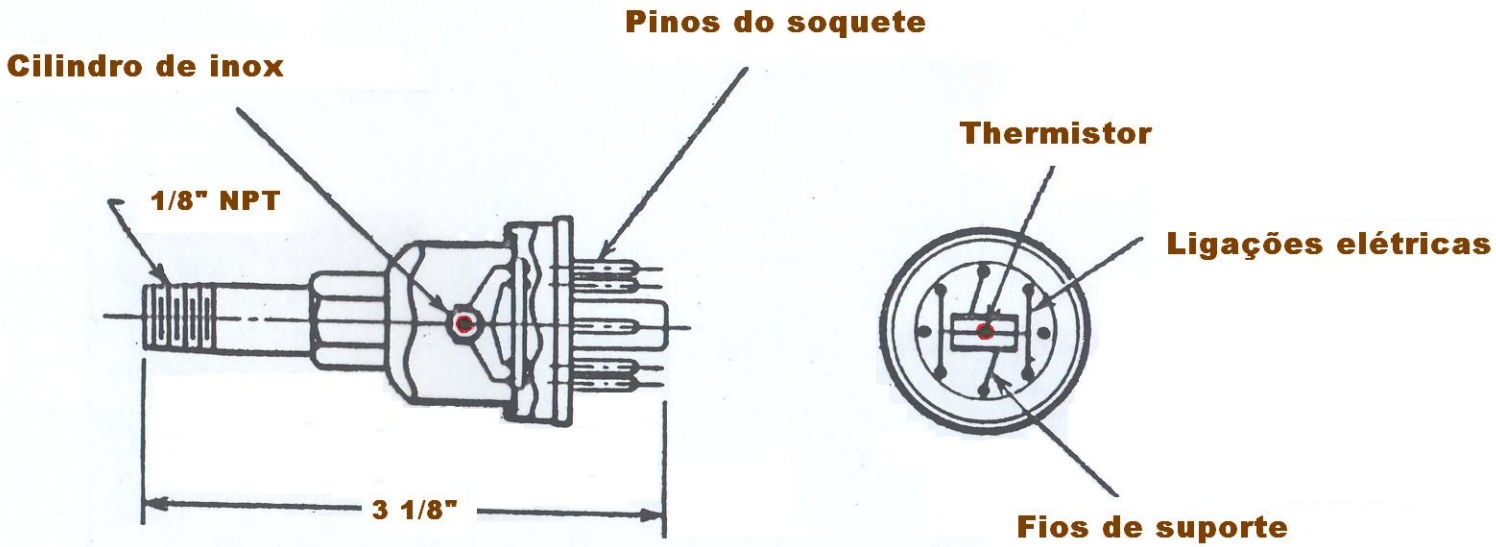
(B)

TERMOPAR

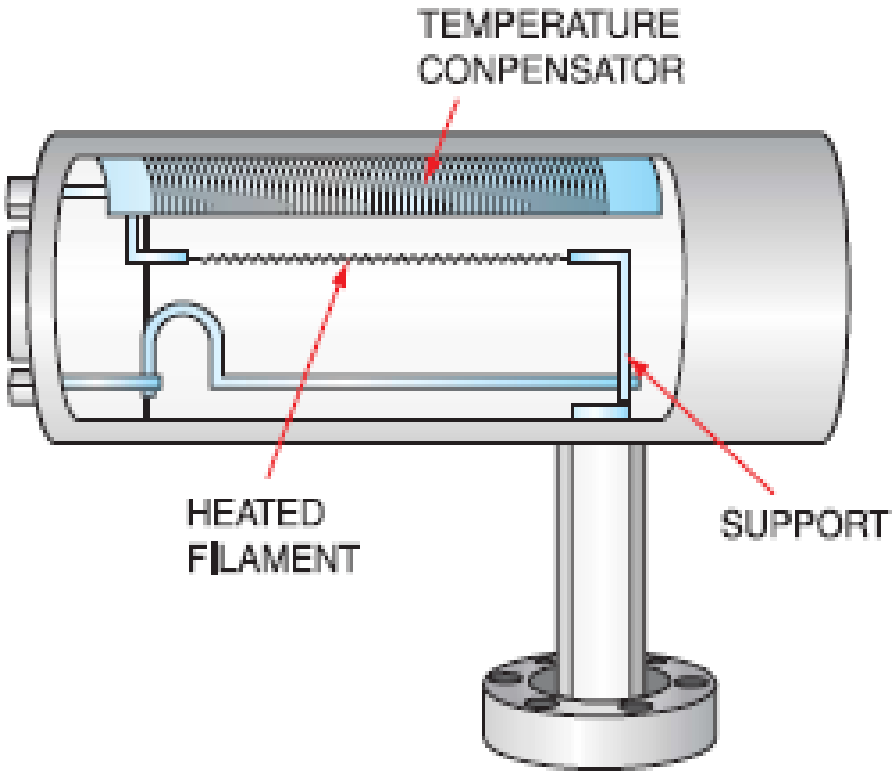

Junção
Termopar
Filamento
Miliamperímetro
Milivoltímetro


1/8 NPT
1.00
0.402
1.88
45°
1.28
8
1
7
2
3
5

THERMISTOR


Pinos do soquete
Cilindro de inox
1/8" NPT
3 1/8"
Thermistor
Ligações elétricas
Fios de suporte

CONVECTRON



CONVECTRON


760
LEYBOLD


PFEIFFER VACUUM
PFEIFFER

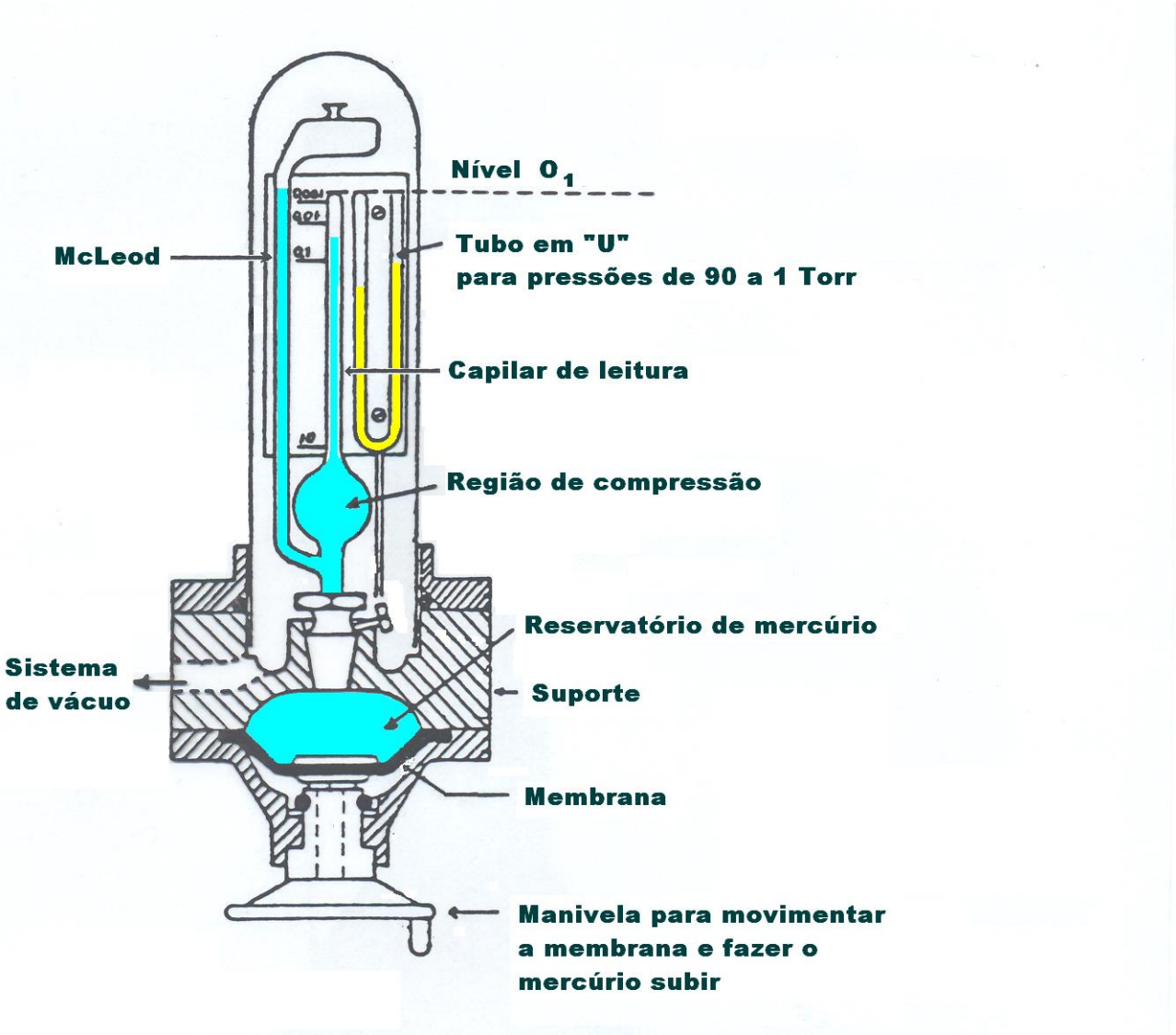

0.0
TORR
X 10
mks
MKS


GRANVILLE PHILLIPS


388
EDWARDS


VARIAN
AGILENT VARIAN

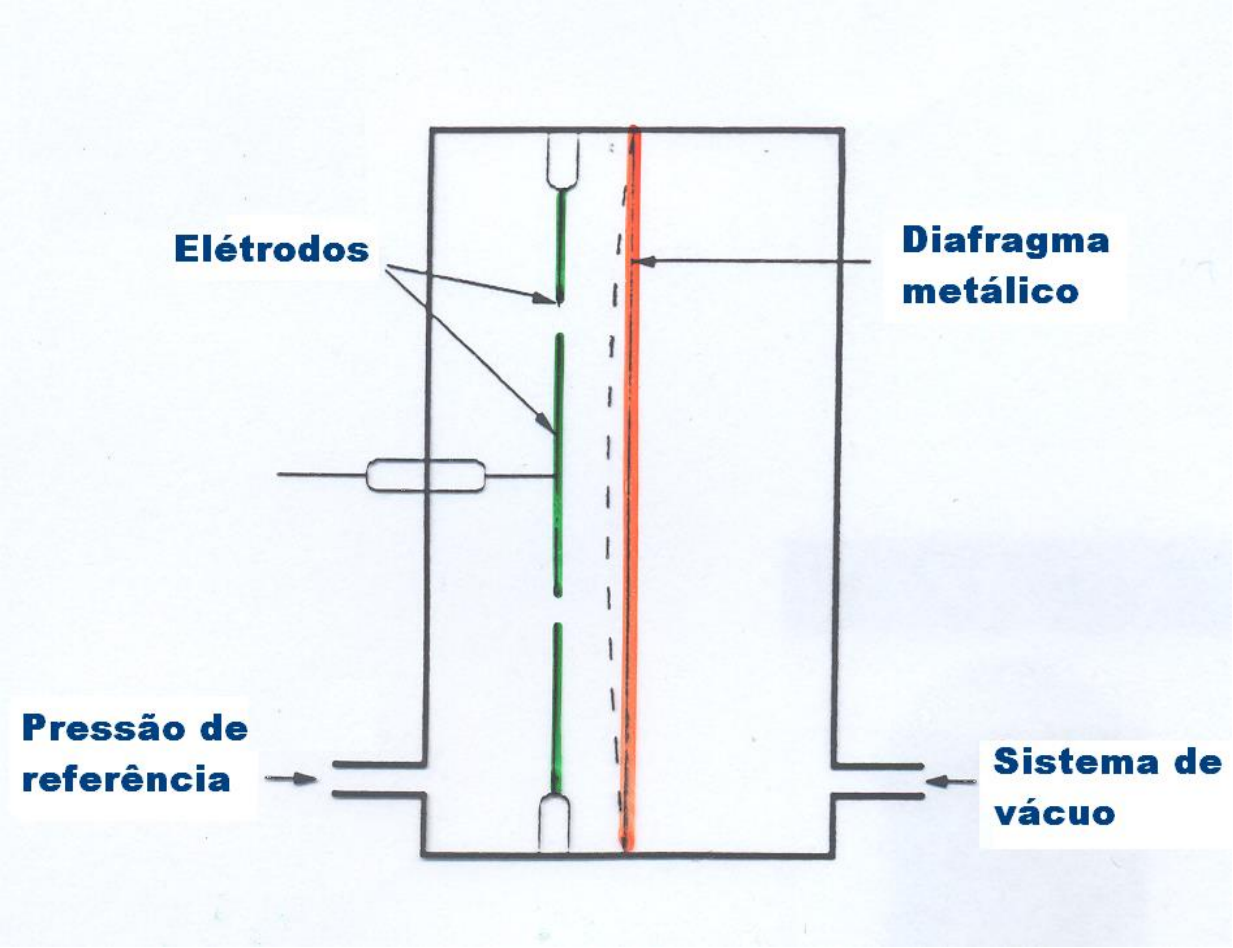
KAMMERER (McLEOD)



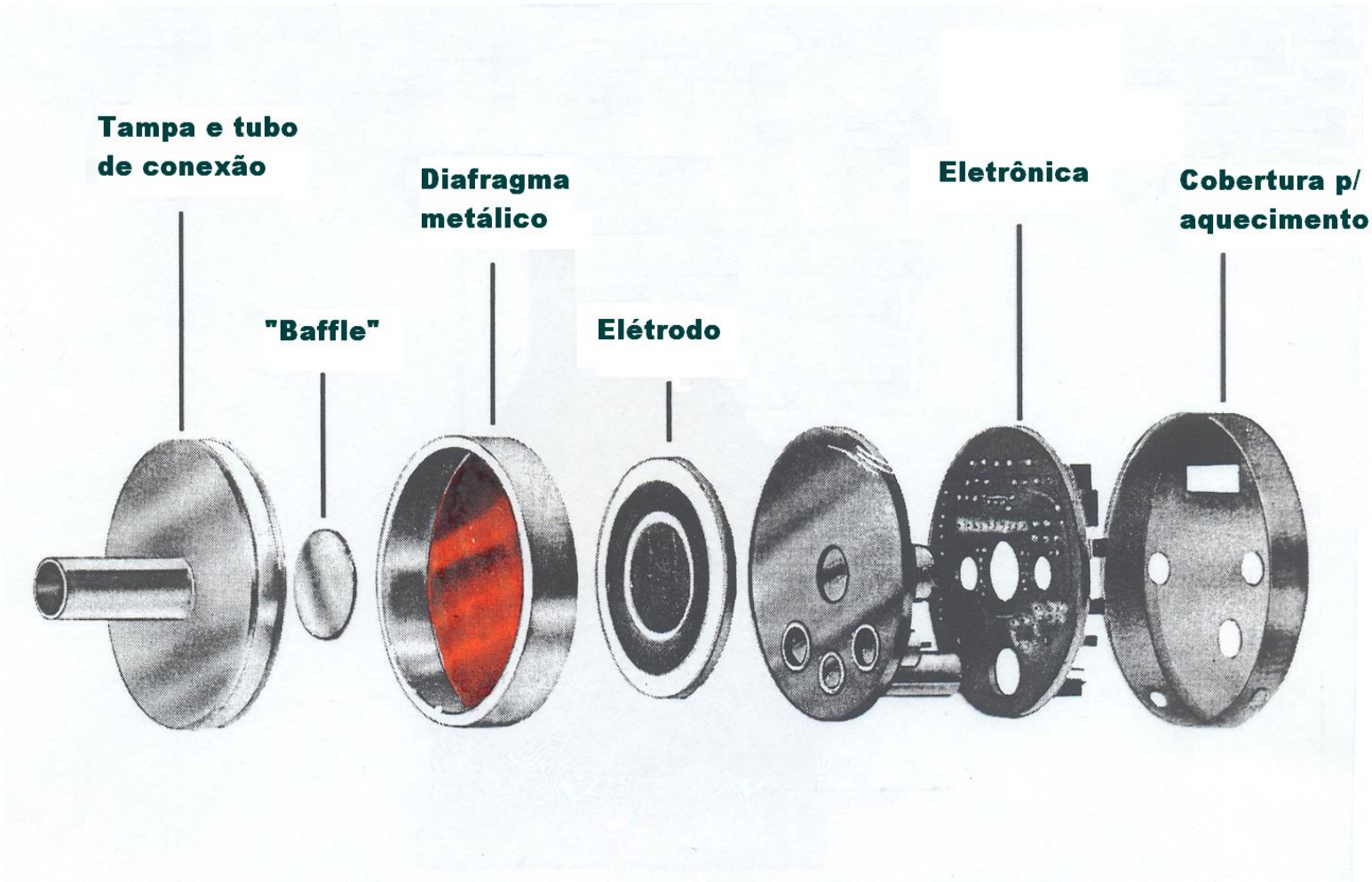
McLEOD


VACUSTAT 2
Made in England
Edwards

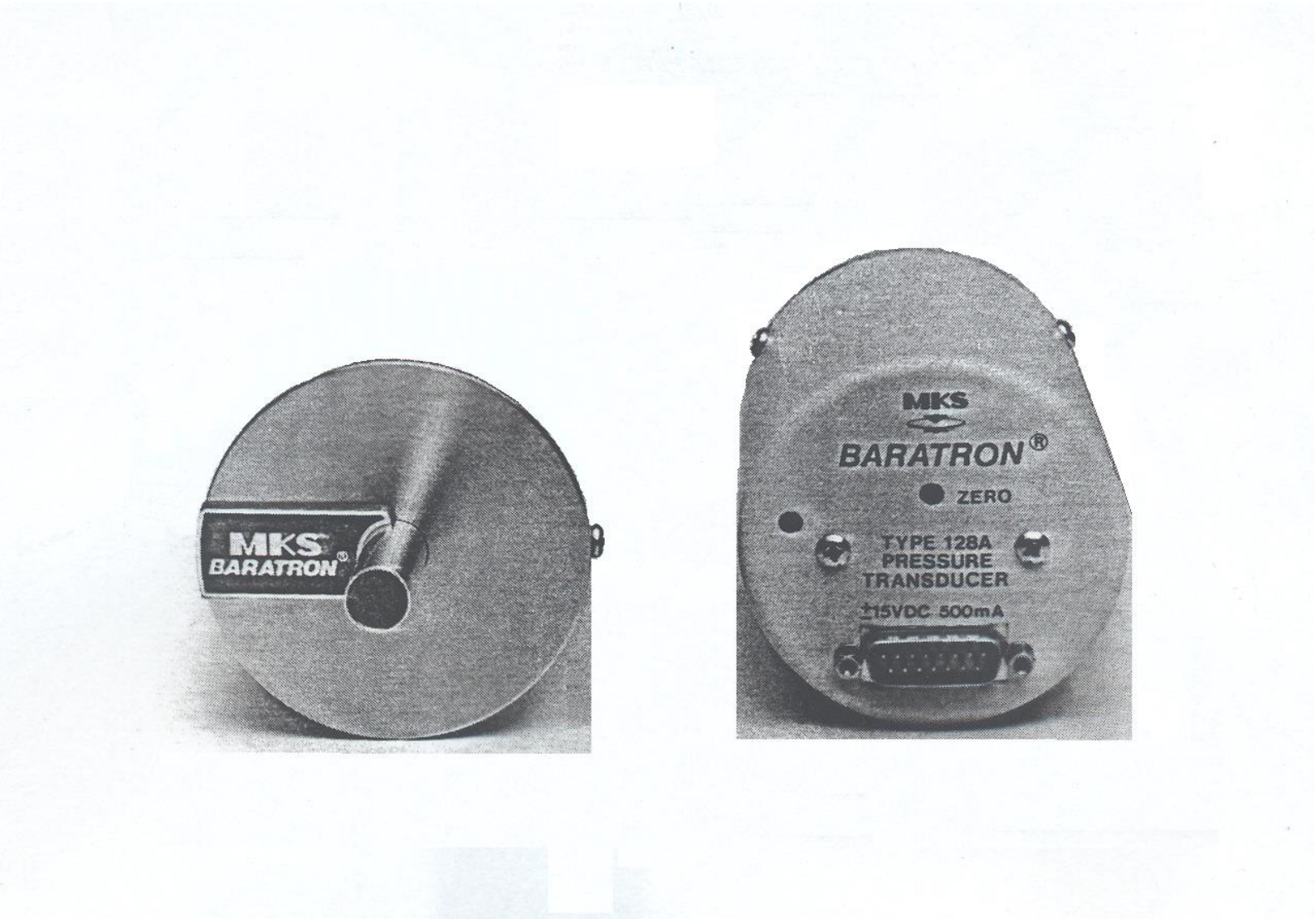
CAPACITIVO


Elétrodos
Diafragma metálico
Pressão de referência
Sistema de vácuo

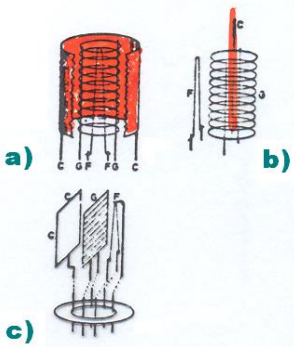
CAPACITIVO

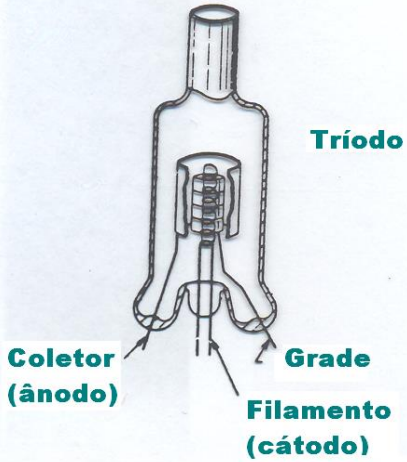

Tampa e tubo de conexão
"Baffle"
Diafragma metálico
Elétrodo
Eletrônica
Cobertura p/ aquecimento

CAPACITIVO (BARATRON)



IONIZAÇÃO – CÁTODO QUENTE

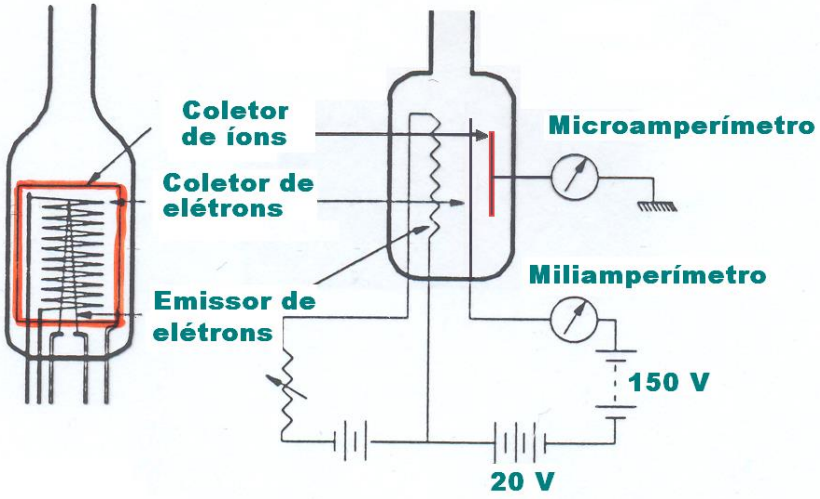




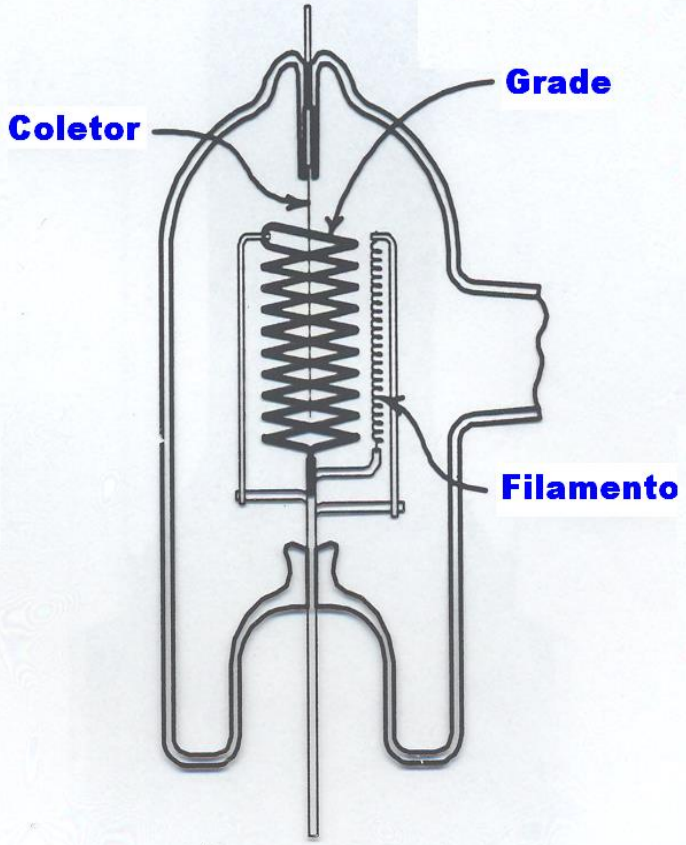
a) e c) Tríodo

b) Bayard-Alpert

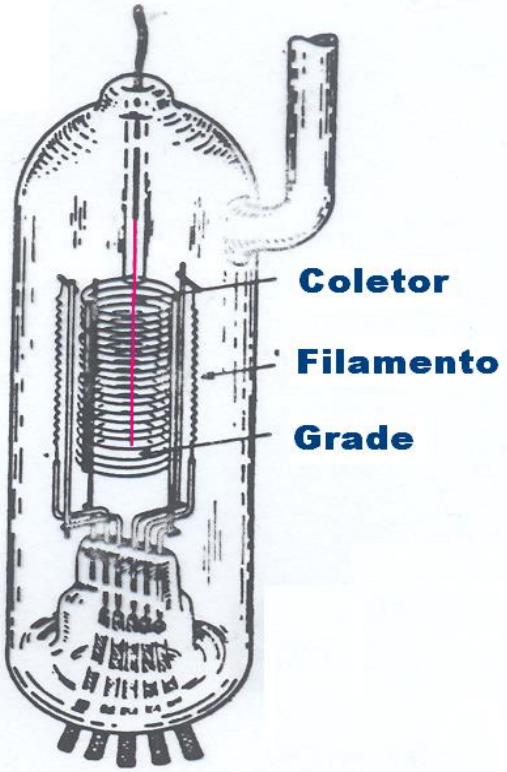
F - filamento
C - coletor
G - grade



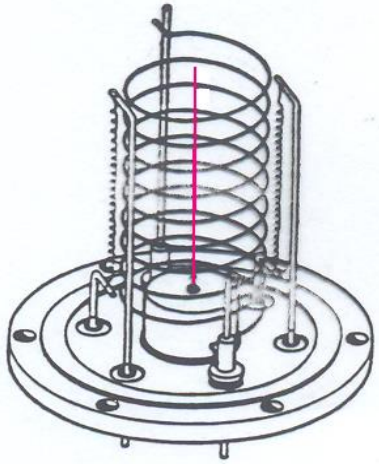
IONIZAÇÃO – BAYARD-ALPERT



IONIZAÇÃO – BAYARD-ALPERT

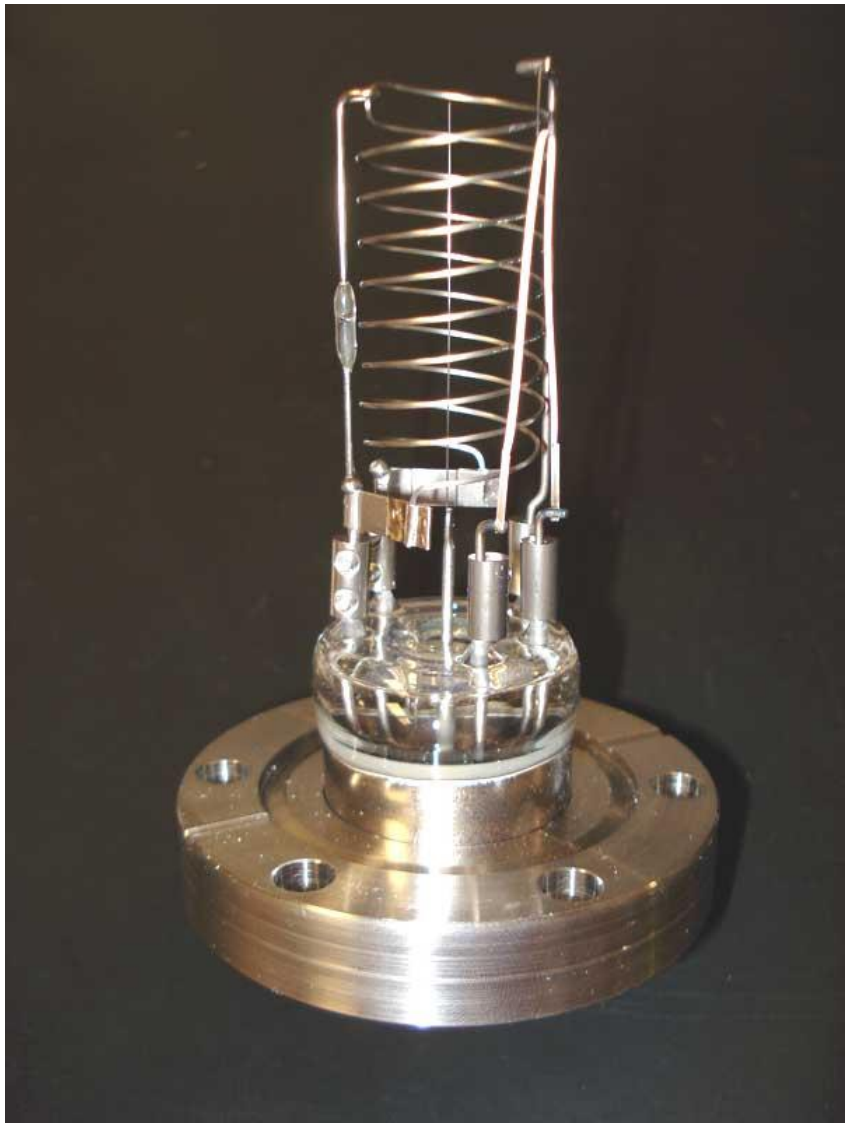


Ampola de vidro



Com flange de metal ("nude")

BAYARD-ALPERT (“NUDE”)

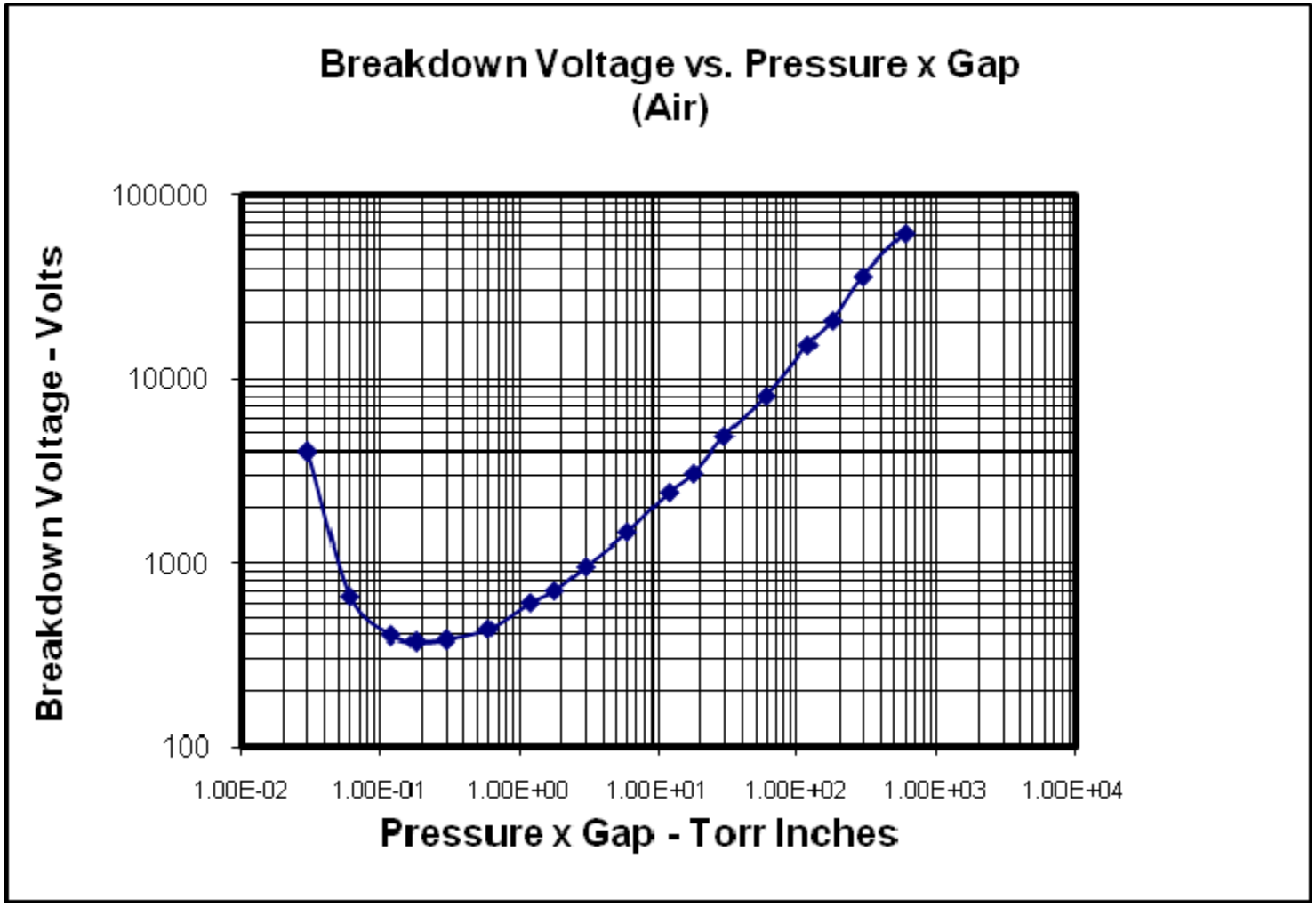


BAYARD-ALPERT

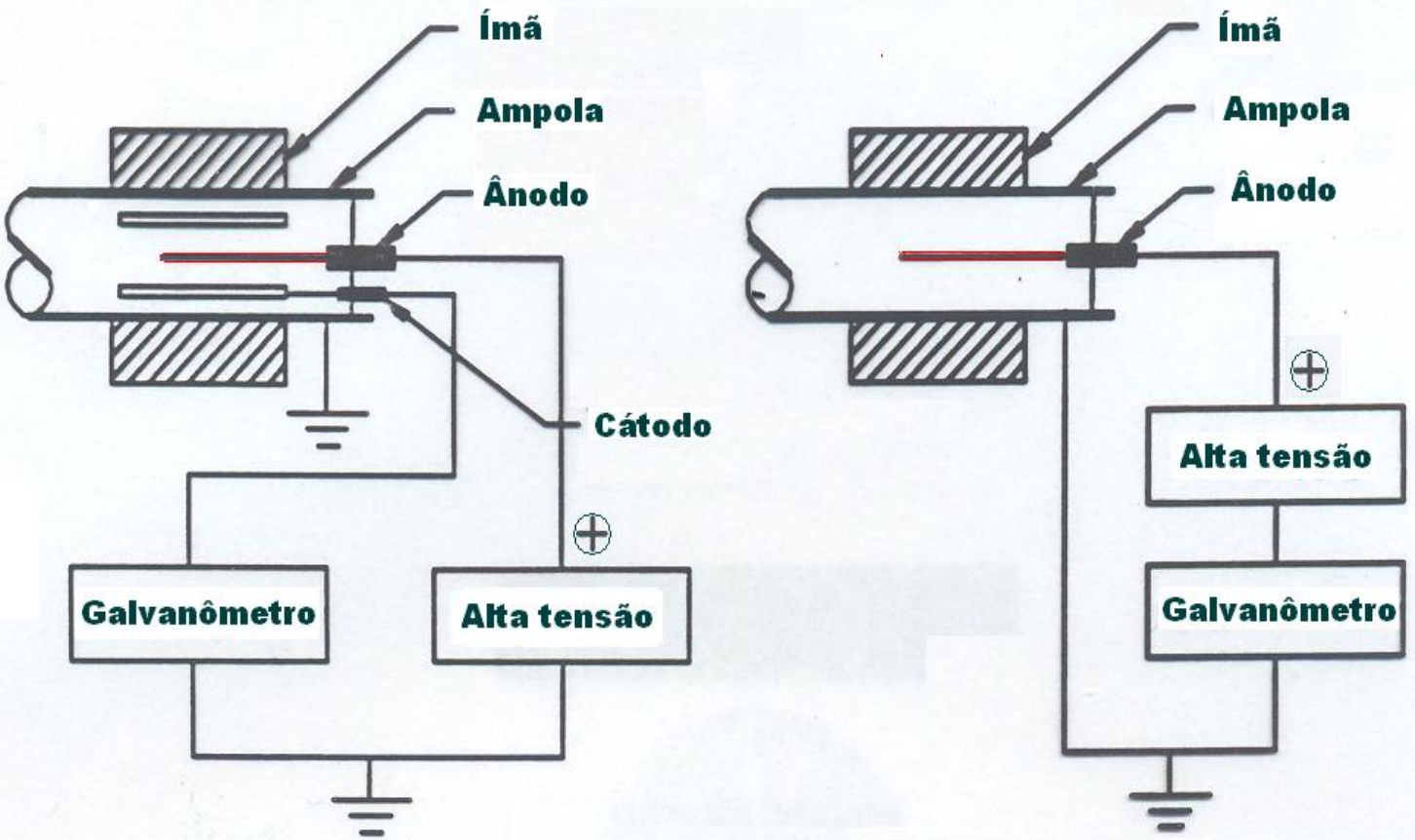
IONIZAÇÃO – SENSIBILIDADE P/ VÁRIOS GASES

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

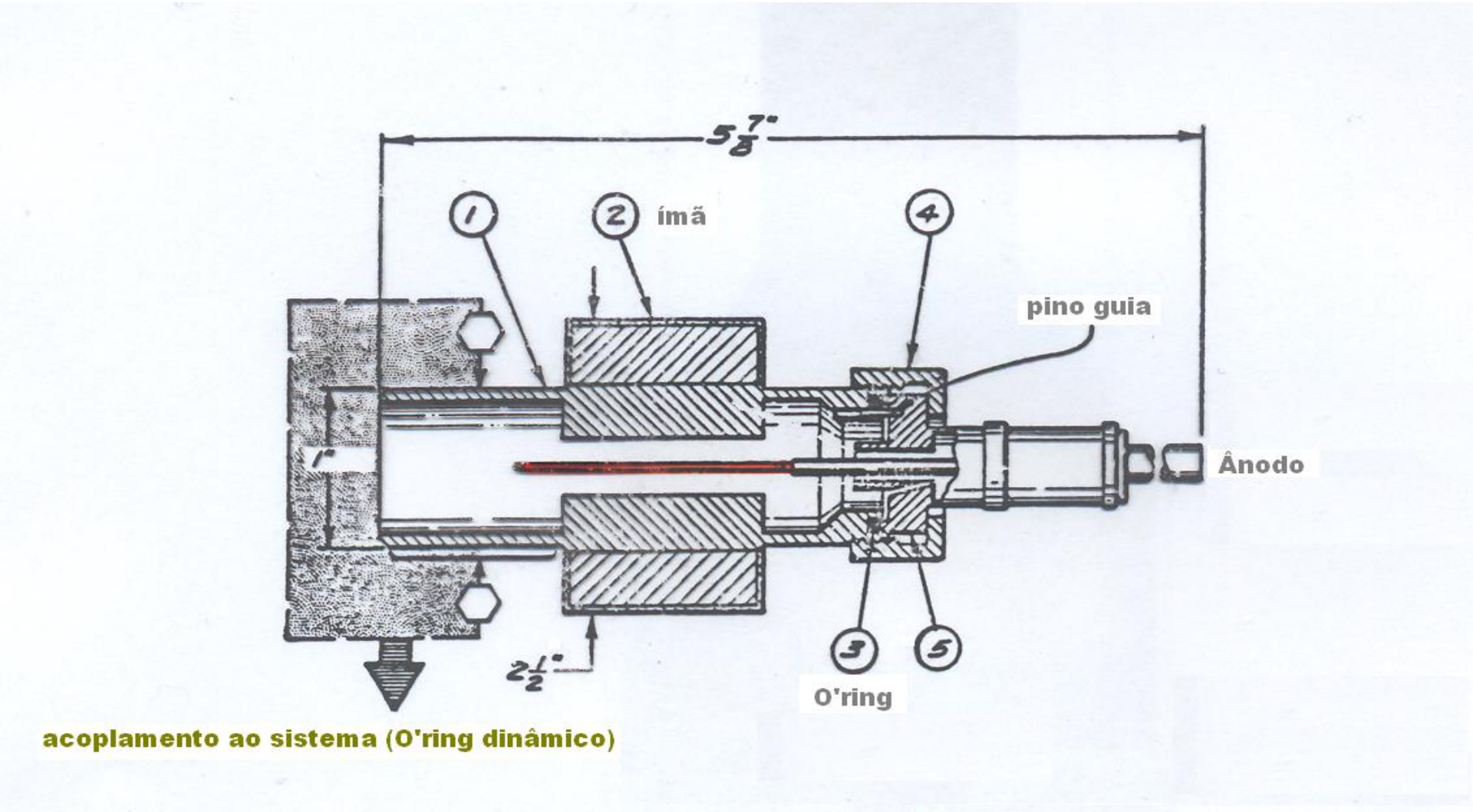
Gás	Reynolds	Dushman and Young	Wagener and Johnson	Riddiford	Schulz
He	0.10–0.13	0.13	...	0.24	0.14
Ne	0.12–0.24	0.20	...	...	0.22
Ar	1.00	1.00	...	1.00	1.00
Kr	...	1.56	...	...	...
Xe	...	2.29	...	...	...
H_2	...	0.39	0.44	0.36	0.28
N_2	0.73–0.81	0.84	0.84	0.94	0.67
O_2	...	...	0.71	1.07	...
Hg	1.73–2.50	2.89	...	...	...
Dry air	...	...	...	0.76	...
CO	...	...	0.90	...	...
CO_2	...	...	1.15	...	...
H_2O	...	...	0.75	...	...
SF_6	...	...	...	...	1.7


Breakdown Voltage vs. Pressure x Gap
(Air)
Breakdown Voltage - Volts
100000
10000
1000
100
1.00E-02
1.00E-01
1.00E+00
1.00E+01
1.00E+02
1.00E+03
1.00E+04
Pressure x Gap - Torr Inches

IONIZAÇÃO – CÁTODO FRIO



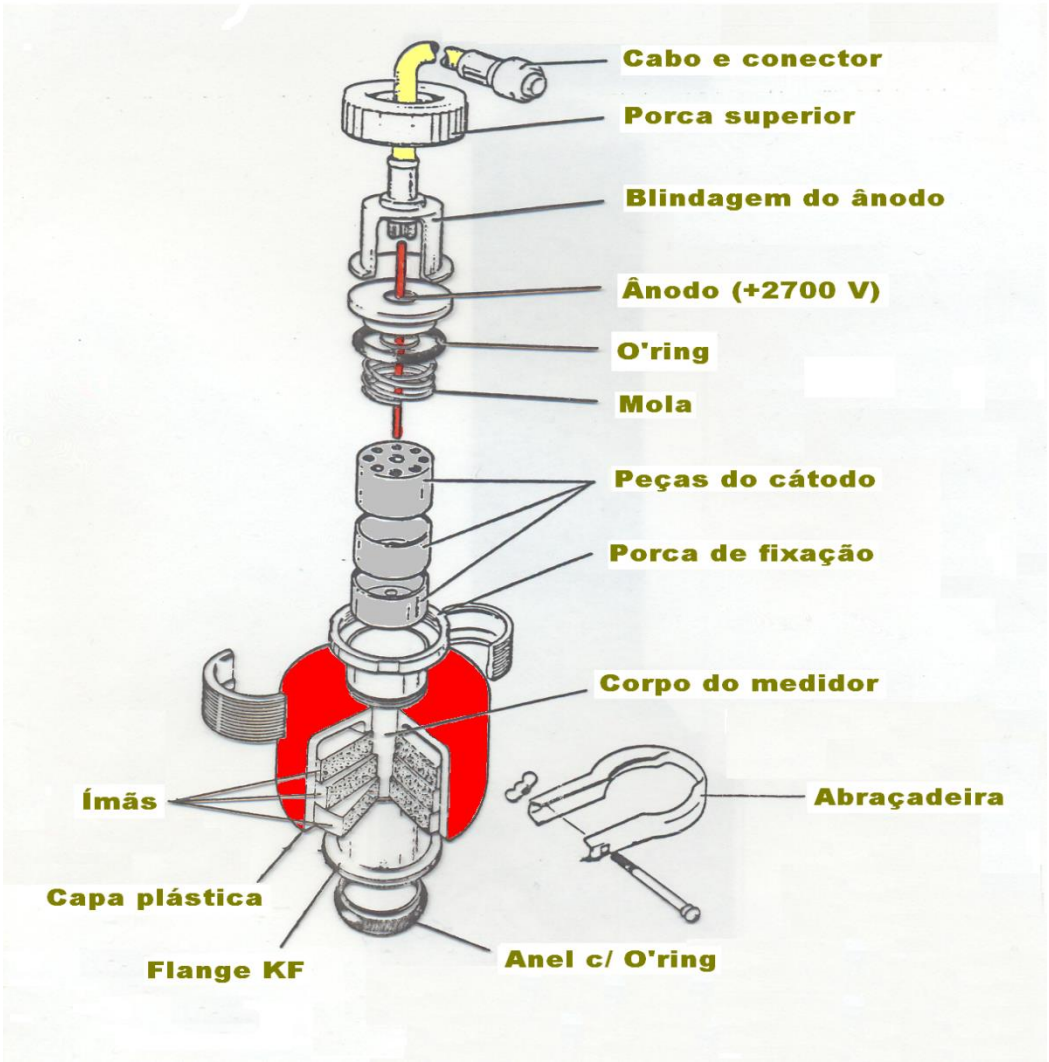
PENNING (CVC)



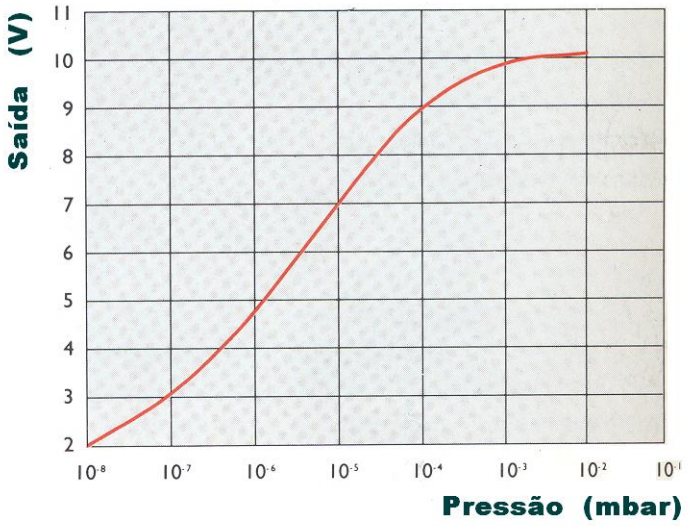
acoplamento ao sistema (O'ring dinâmico)

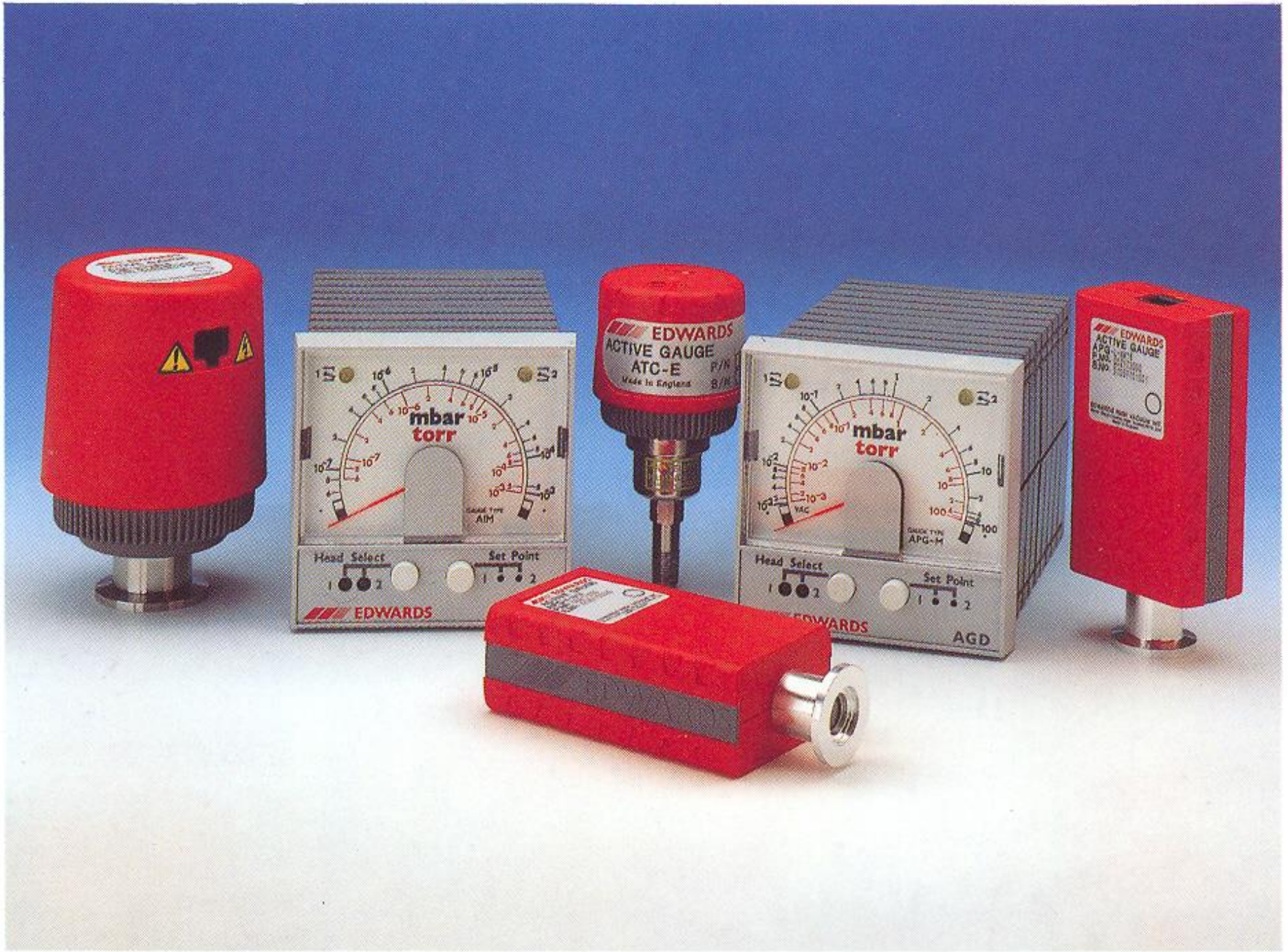
MAGNETRON INVERTIDO (PENNING) EDWARDS ACTIVE

PENNING (EDWARDS CP25)

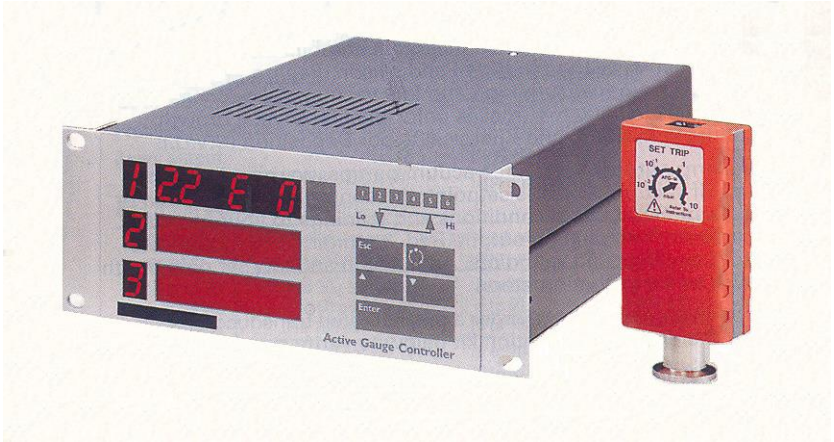


PENNING (MAGNETRON INVERTIDO) EDWARDS

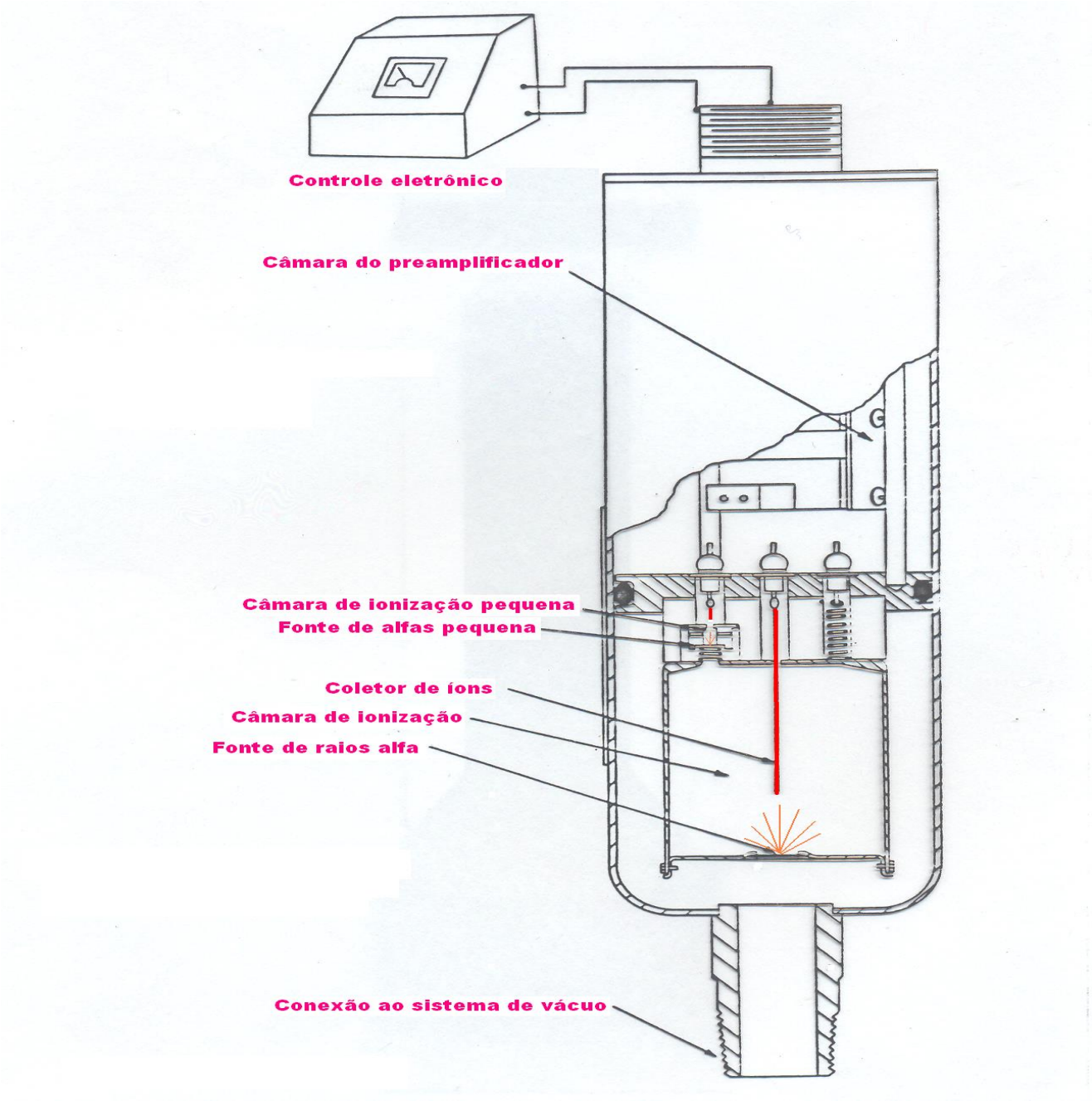



EDWARDS
ACTIVE GAUGE
ATC-E
Made in England
mbar
torr
AIM
Head Select
Set Point
EDWARDS
mbar
torr
APG-M
Head Select
Set Point
AGD
EDWARDS
ACTIVE GAUGE

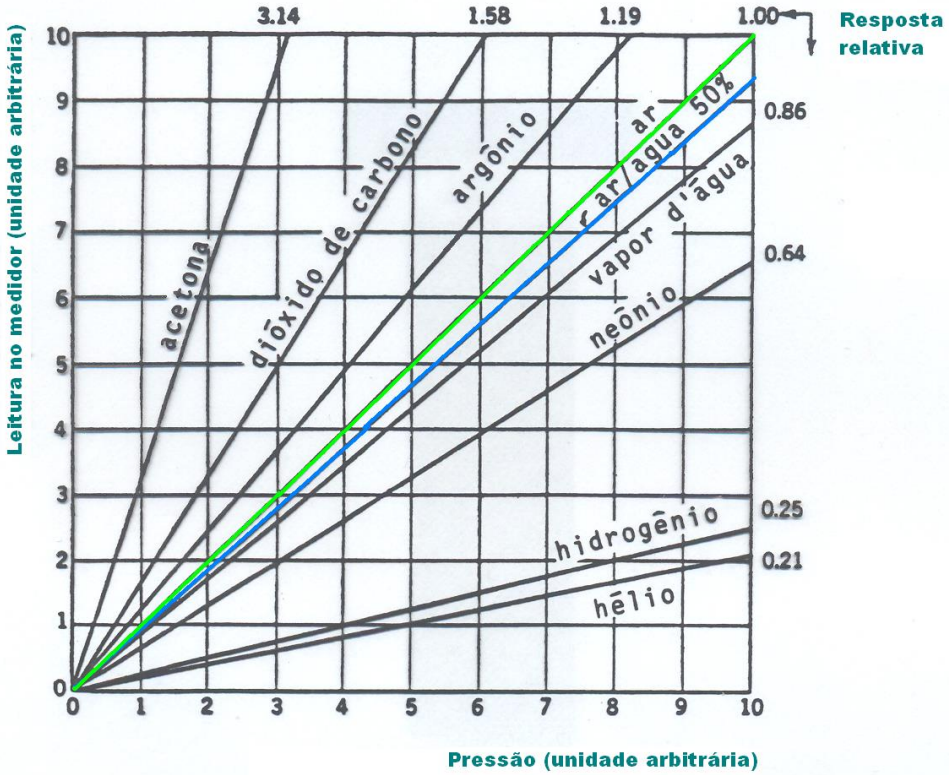
PIRANI EDWARDS ACTIVE



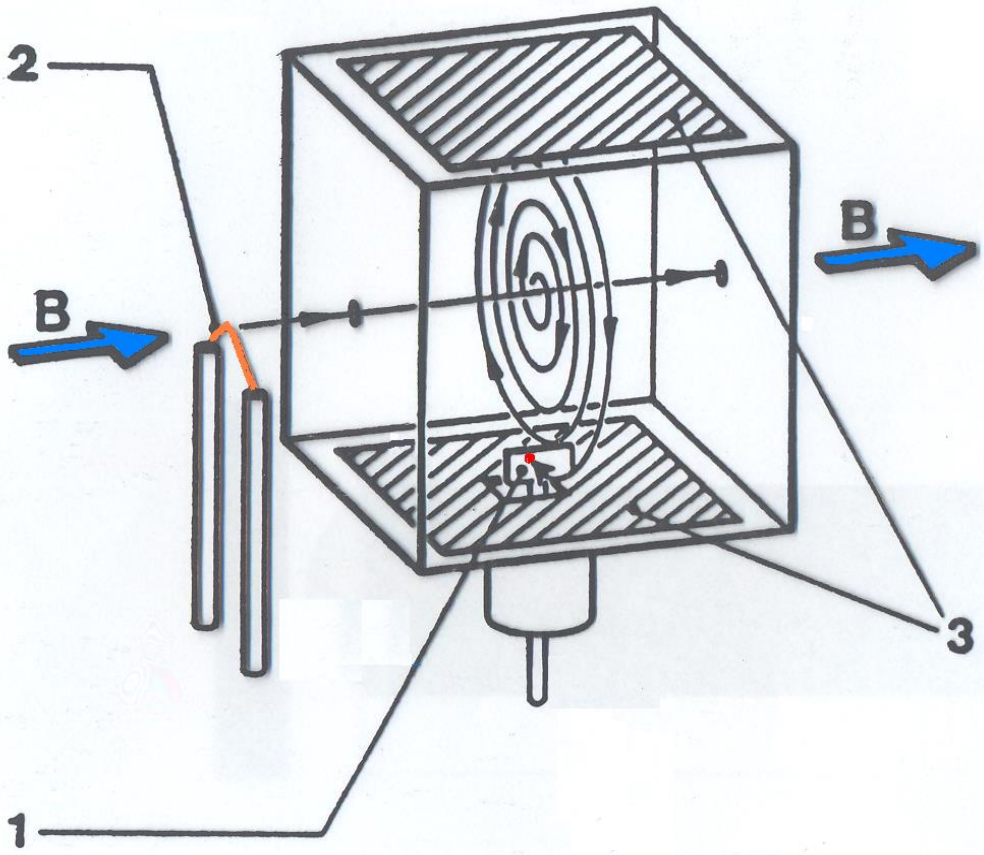
ALPHATRON


Controle eletrônico
Câmara do preamplificador
G
G
Câmara de ionização pequena
Fonte de alfas pequena
Coletor de íons
Câmara de ionização
Fonte de raios alfa
Conexão ao sistema de vácuo

ALPHATRON


3.14
1.58
1.19
1.00
Resposta relativa
0.86
0.64
0.25
0.21
Leitura no medidor (unidade arbitrária)
Pressão (unidade arbitrária)
acetona
dióxido de carbono
argônio
ar
ar/água 50%
vapor d'água
neônio
hidrogênio
hélio
0
1
2
3
4
5
6
7
8
9
10

MAGNETRON

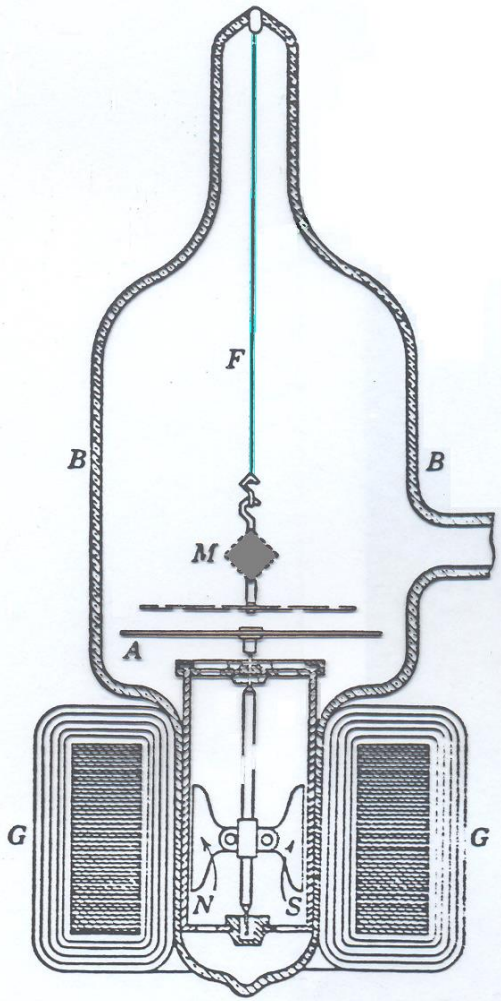


1 - Coletor

2 - Cátodo (filamento)

3 - Elétrodo de RF

FIBRA DE QUARTZO



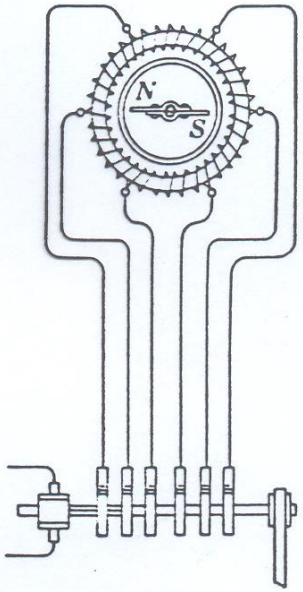
F - Fibra de quartzo

B - Ampola de vidro

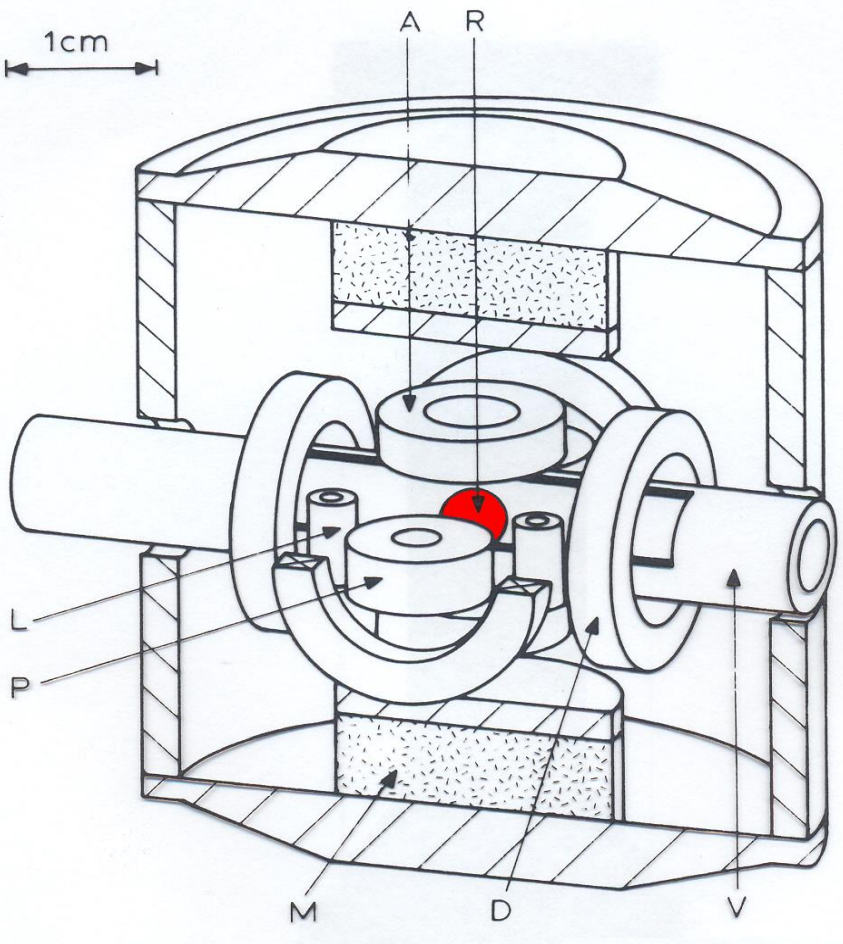
M - Espelho

A - Disco giratório

G - Eletroímã

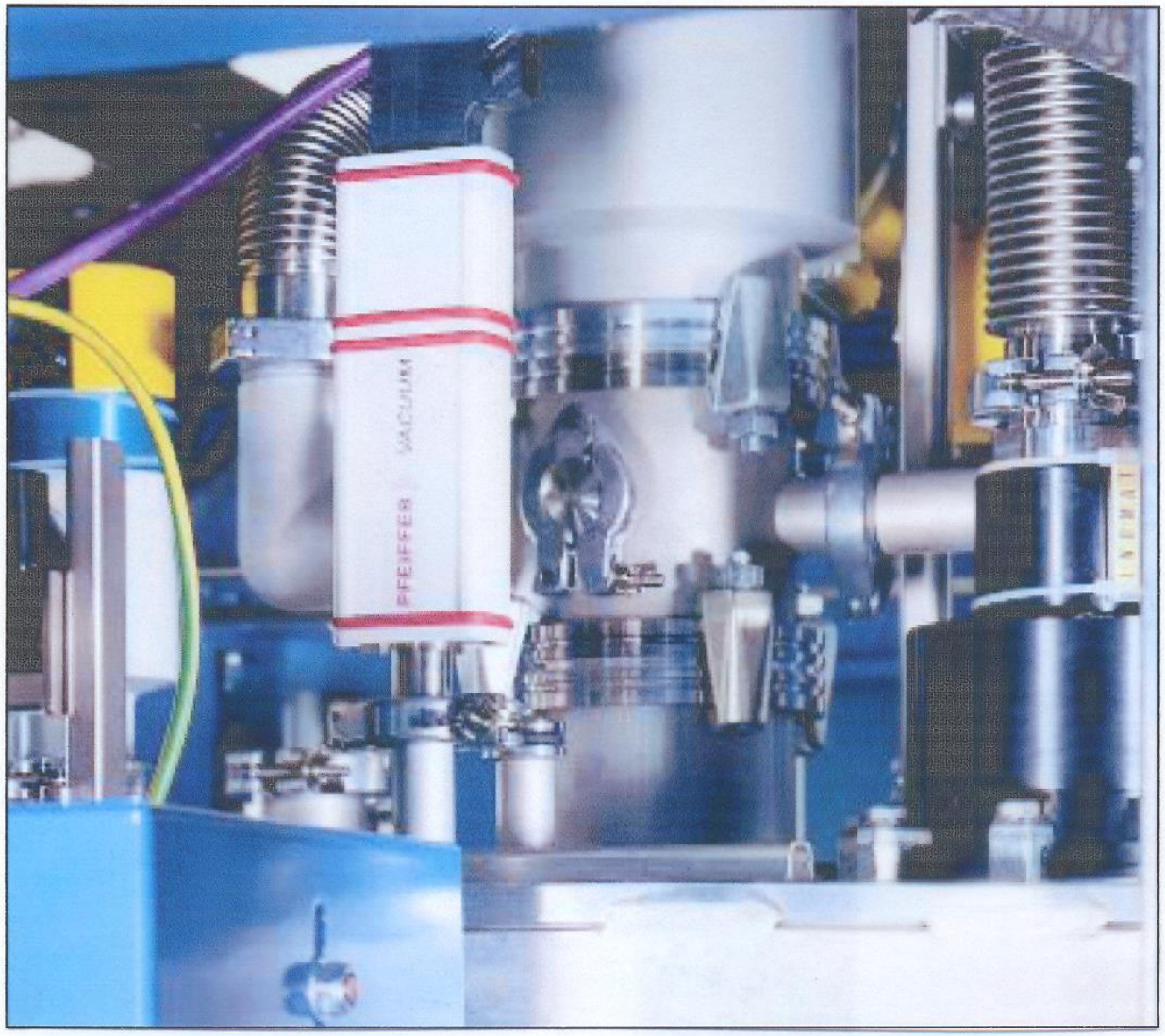


VISCOSÍMETRO

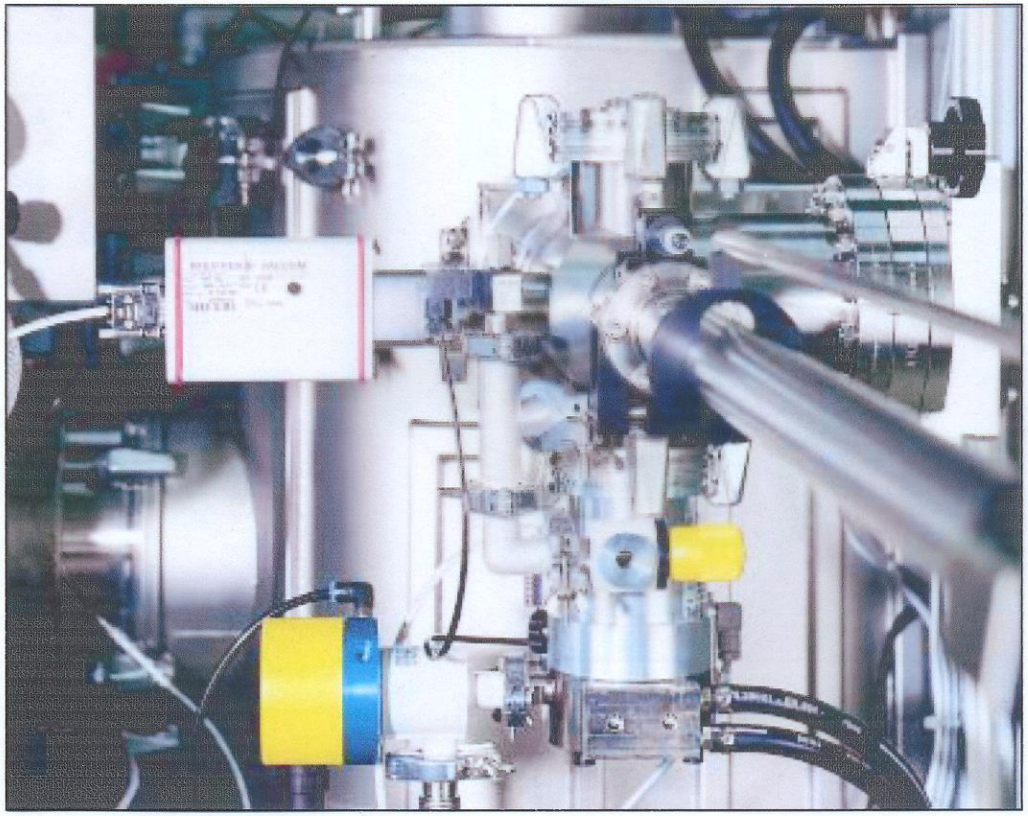


SISTEMA PADRÃO LEYBOLD

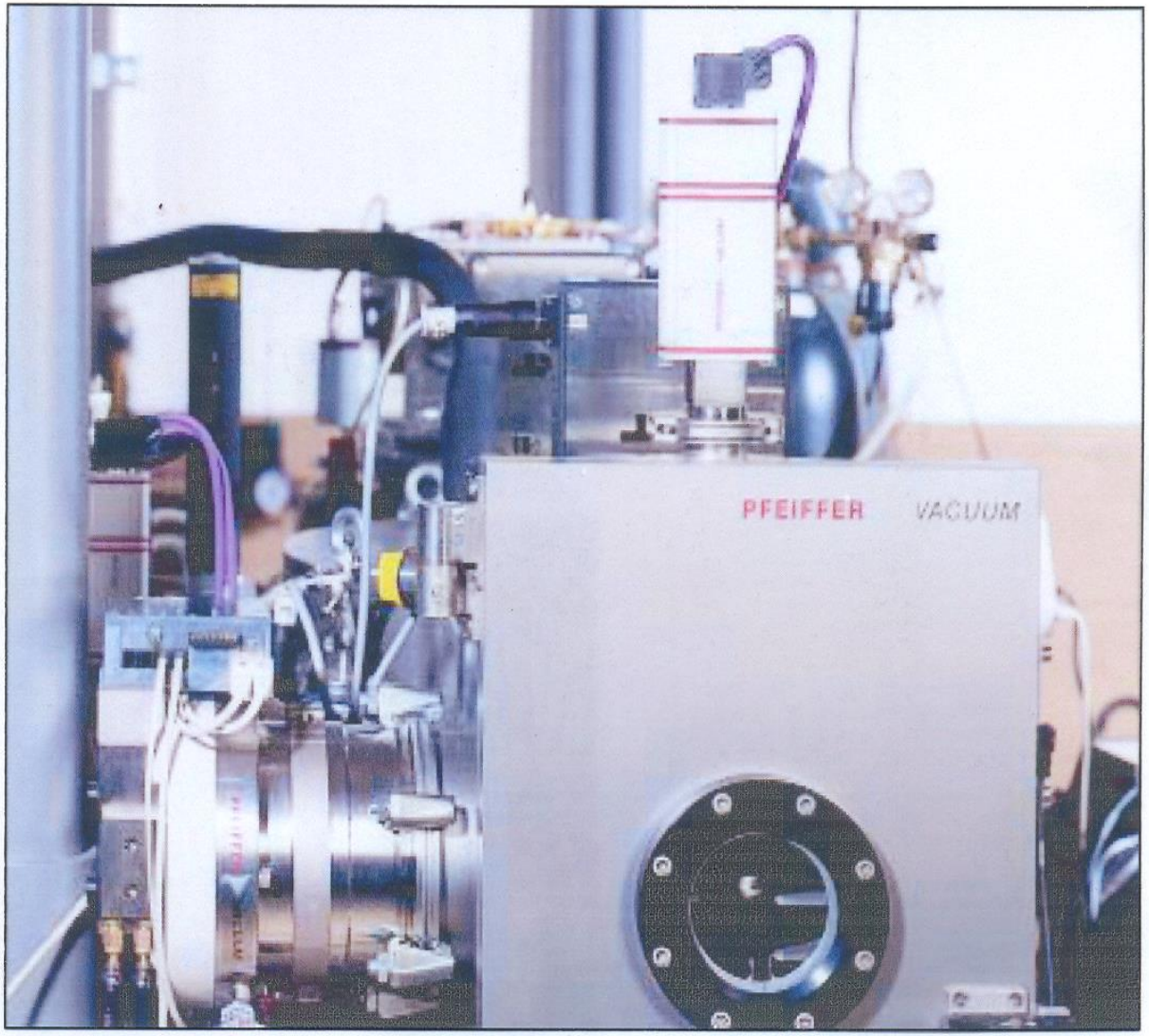
PIEZO/PIRANI RPT-100 PFEIFFER



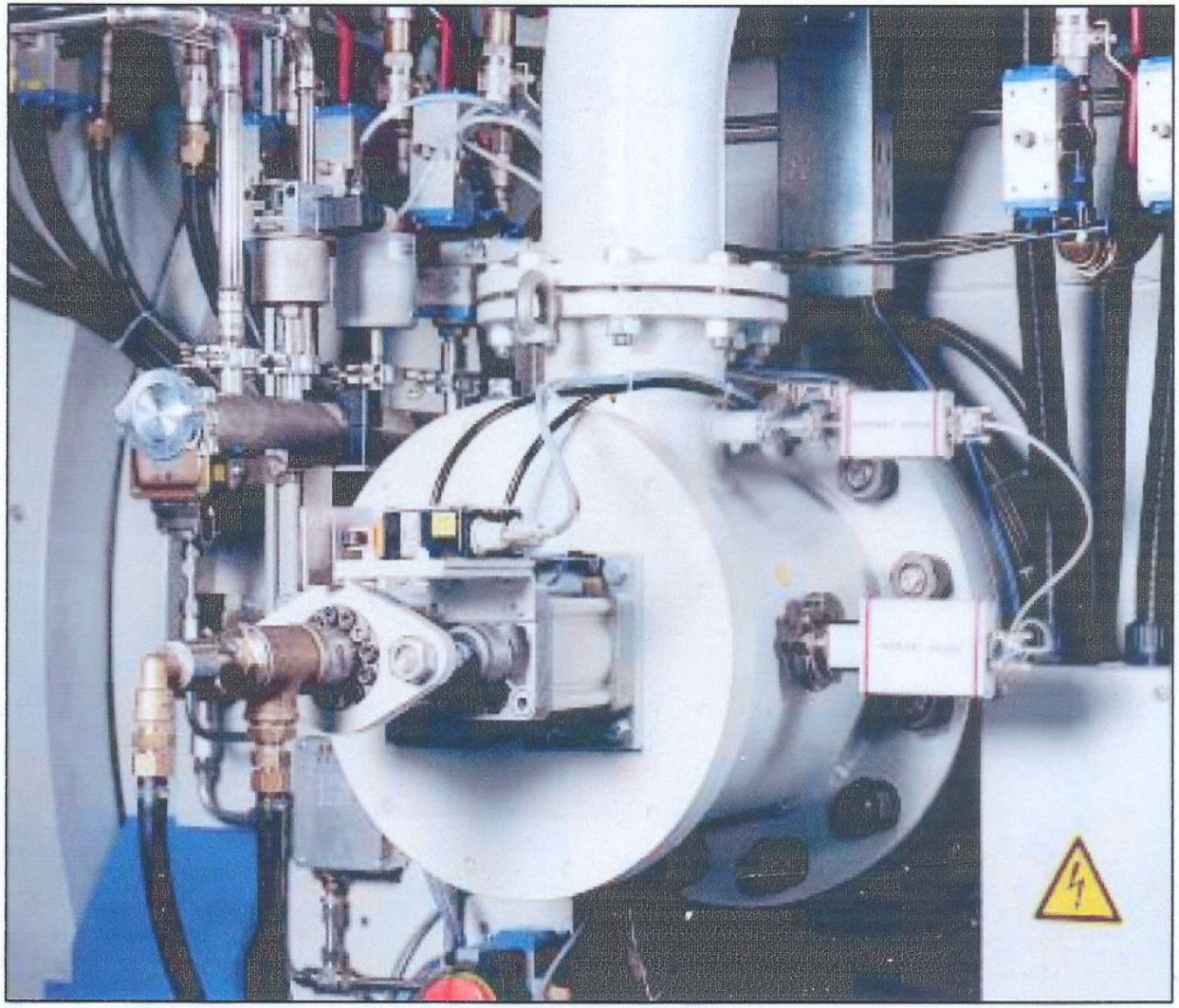
PIRANI/BAYARD-ALPERT HPT-100 PFEIFFER



PIRANI/BAYARD-ALPERT E PIEZO/PIRANI PFEIFFER



PIRANI/BAYARD-ALPERT E PIEZO PFEIFFER



MEDIDORES PFEIFFER