MEDIDAS EN FLUIDOS

INEL 5205 Instrumentación

SENSORES DE PRESIÓN

Unidades de Presión

1 psi ≡ 1 lbf/in^2

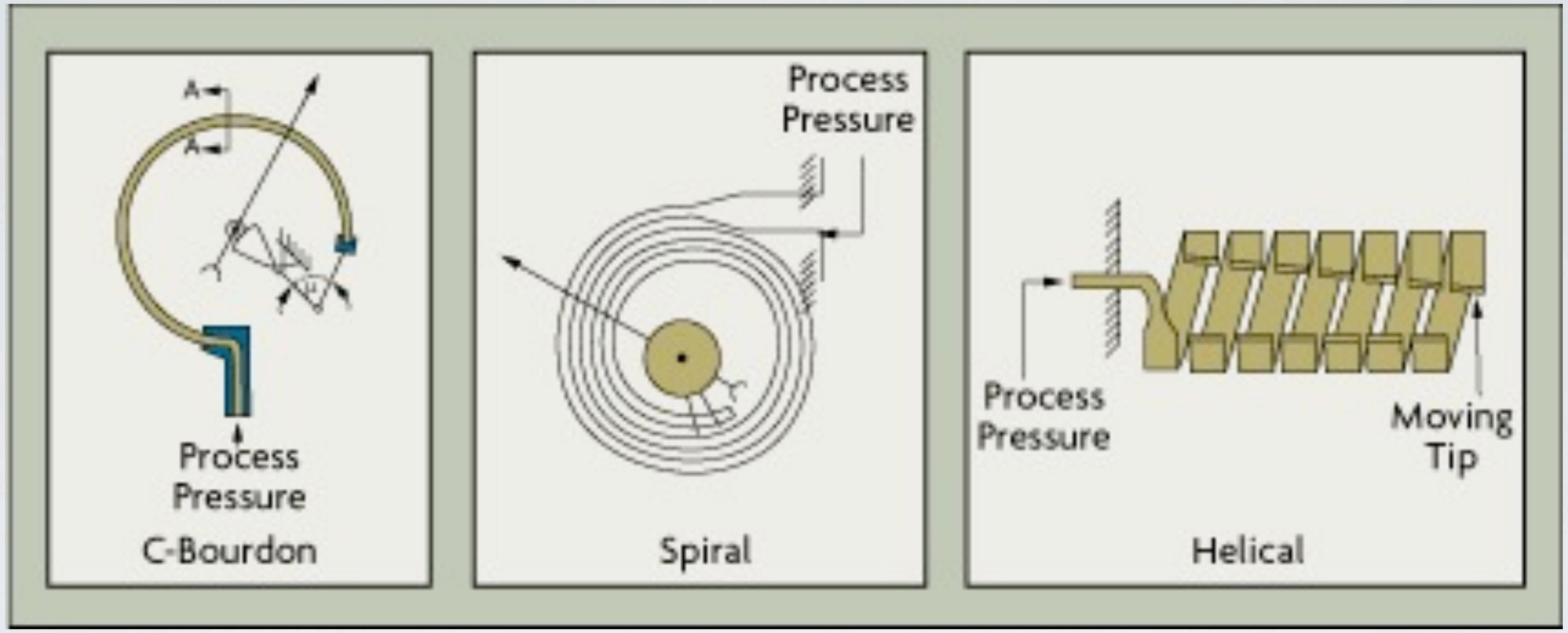
= 6,894.76 Pa = 6,894.76 newton/m^2

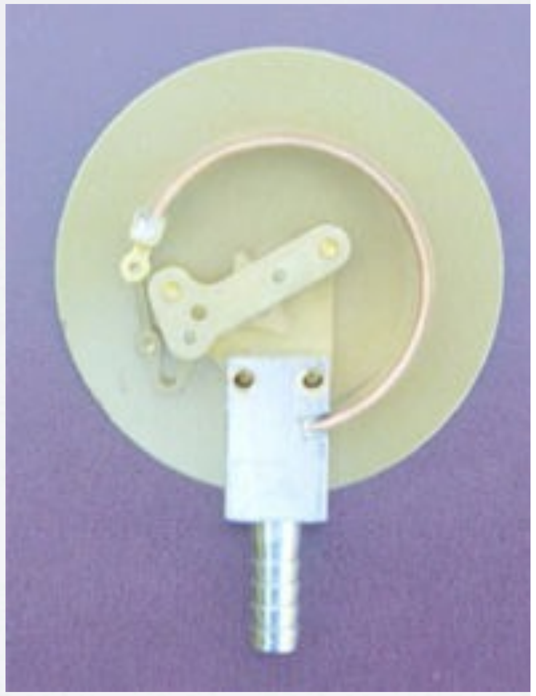
= 68.948×10^{-3} bar (1 bar = 10^5 Pa)

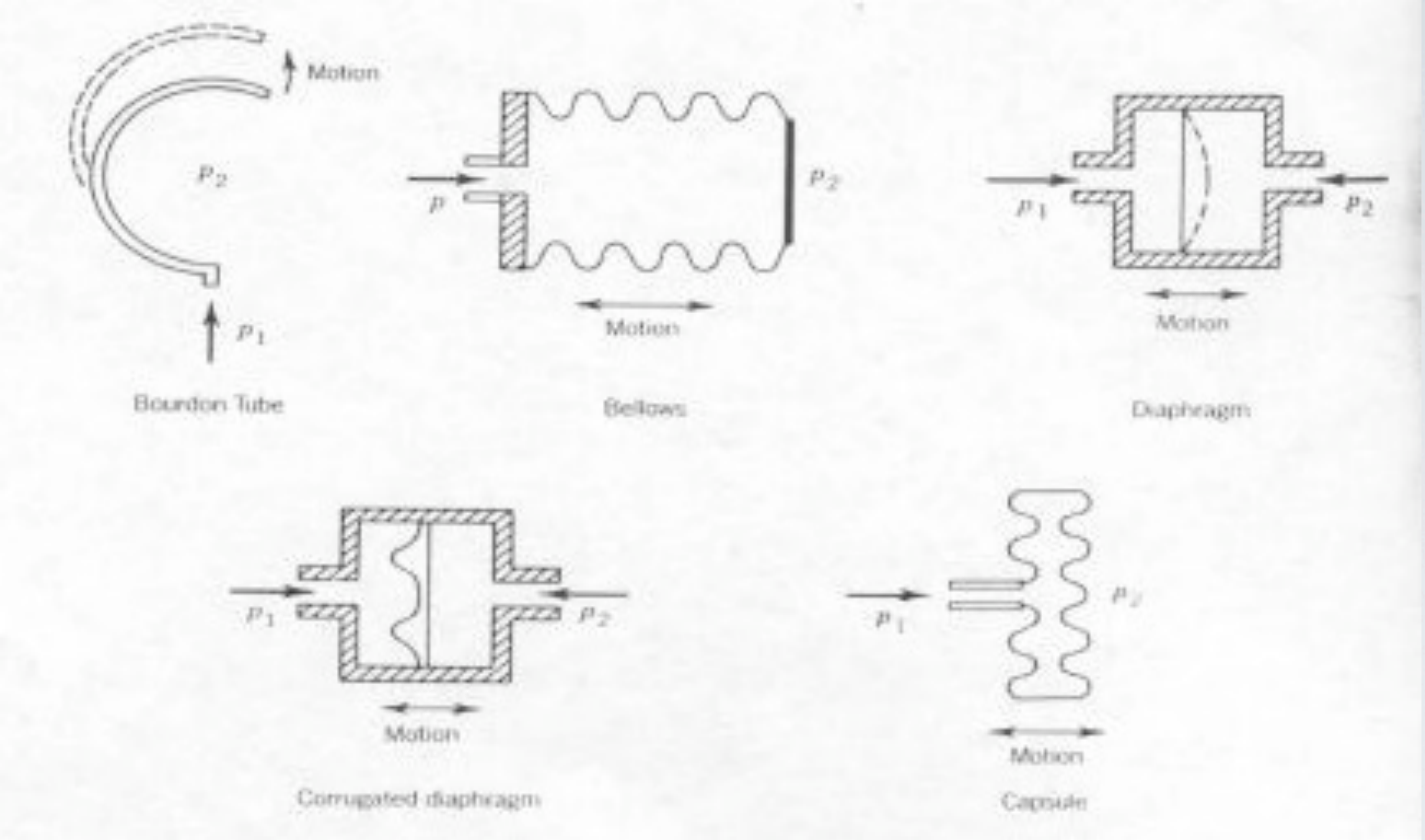
= 68.046×10^{-3} atm

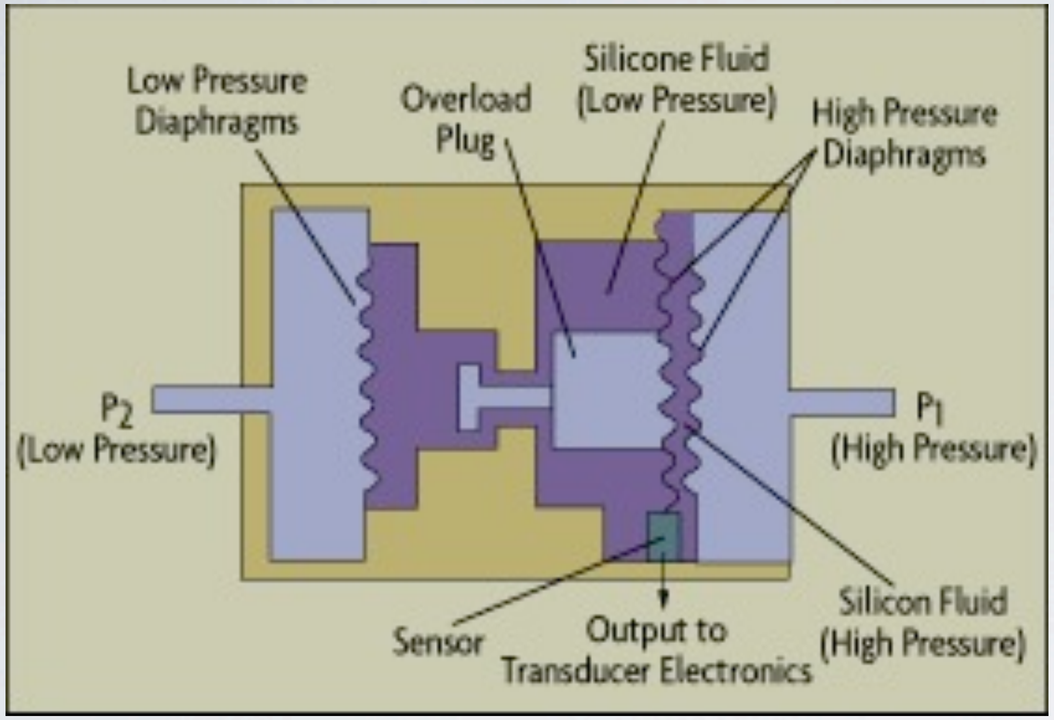
= 51.715 torr = 51.715 mm-Hg

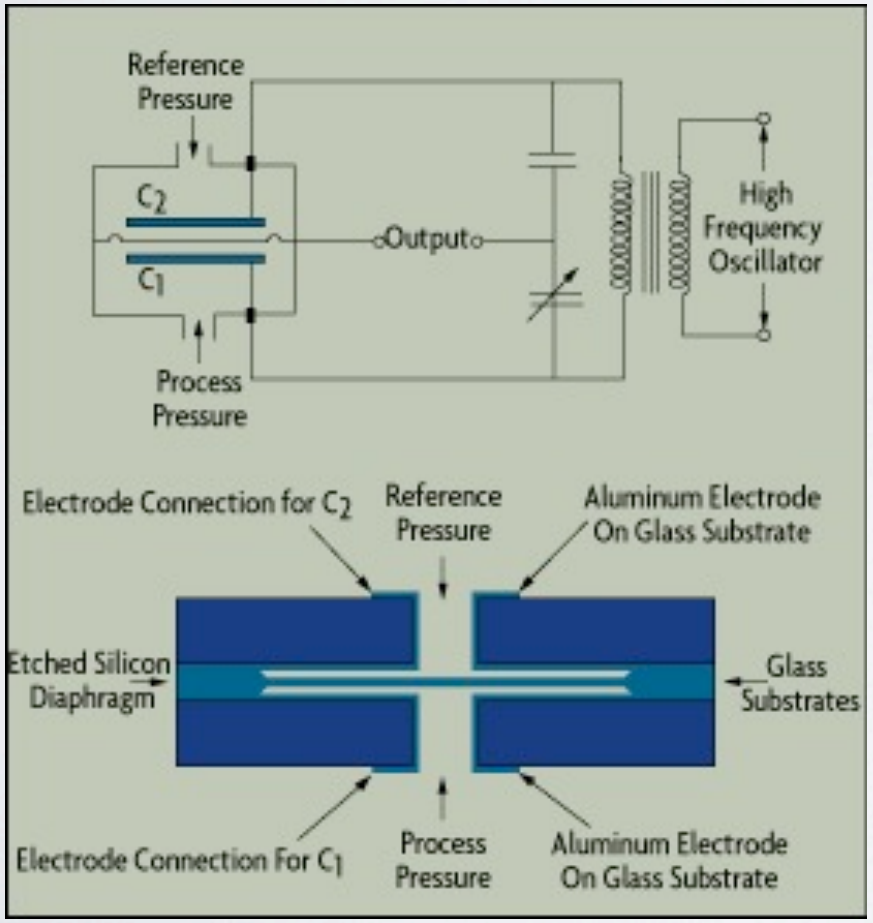
TUBO DE BOURDON

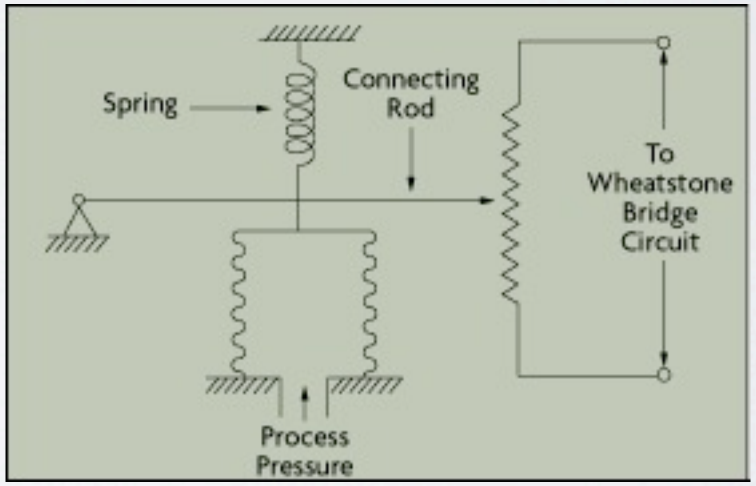





Motion
P_2
P_1
Bourdon Tube
P
P_2
Motion
Bellows
P_1
P_2
Motion
Diaphragm
P_1
P_2
Motion
Corrugated diaphragm
P_1
P_2
Motion
Capsule


Low Pressure Diaphragms
Overload Plug
Silicone Fluid (Low Pressure)
High Pressure Diaphragms
P_2 (Low Pressure)
P_1 (High Pressure)
Sensor
Output to Transducer Electronics
Silicon Fluid (High Pressure)


Reference Pressure
C_2
C_1
Output
High Frequency Oscillator
Process Pressure
Electrode Connection for C_2
Reference Pressure
Aluminum Electrode On Glass Substrate
Etched Silicon Diaphragm
Glass Substrates
Electrode Connection For C_1
Process Pressure
Aluminum Electrode On Glass Substrate


Spring
Connecting Rod
To Wheatstone Bridge Circuit
Process Pressure

$$(p_1 - p_2) = h\rho g$$

g = 980.665 cm/s^2; **ρ** = liquid density

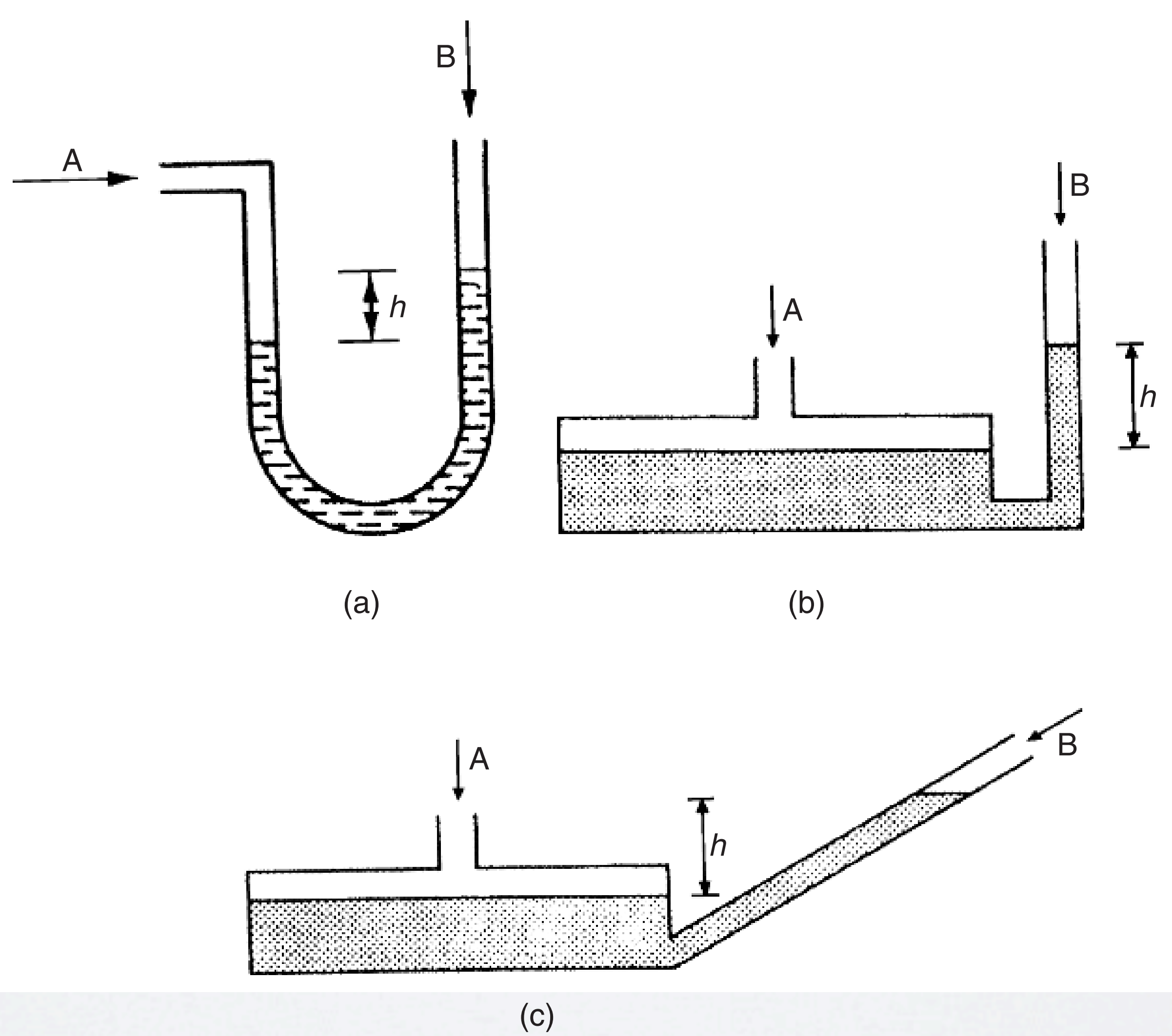
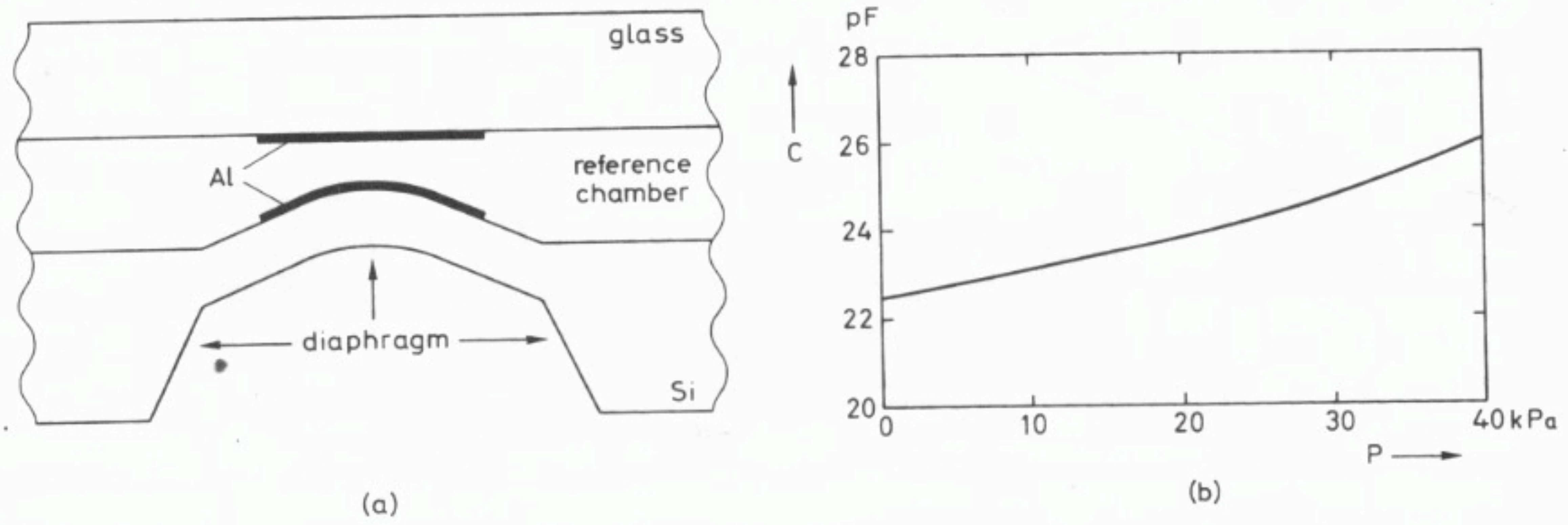


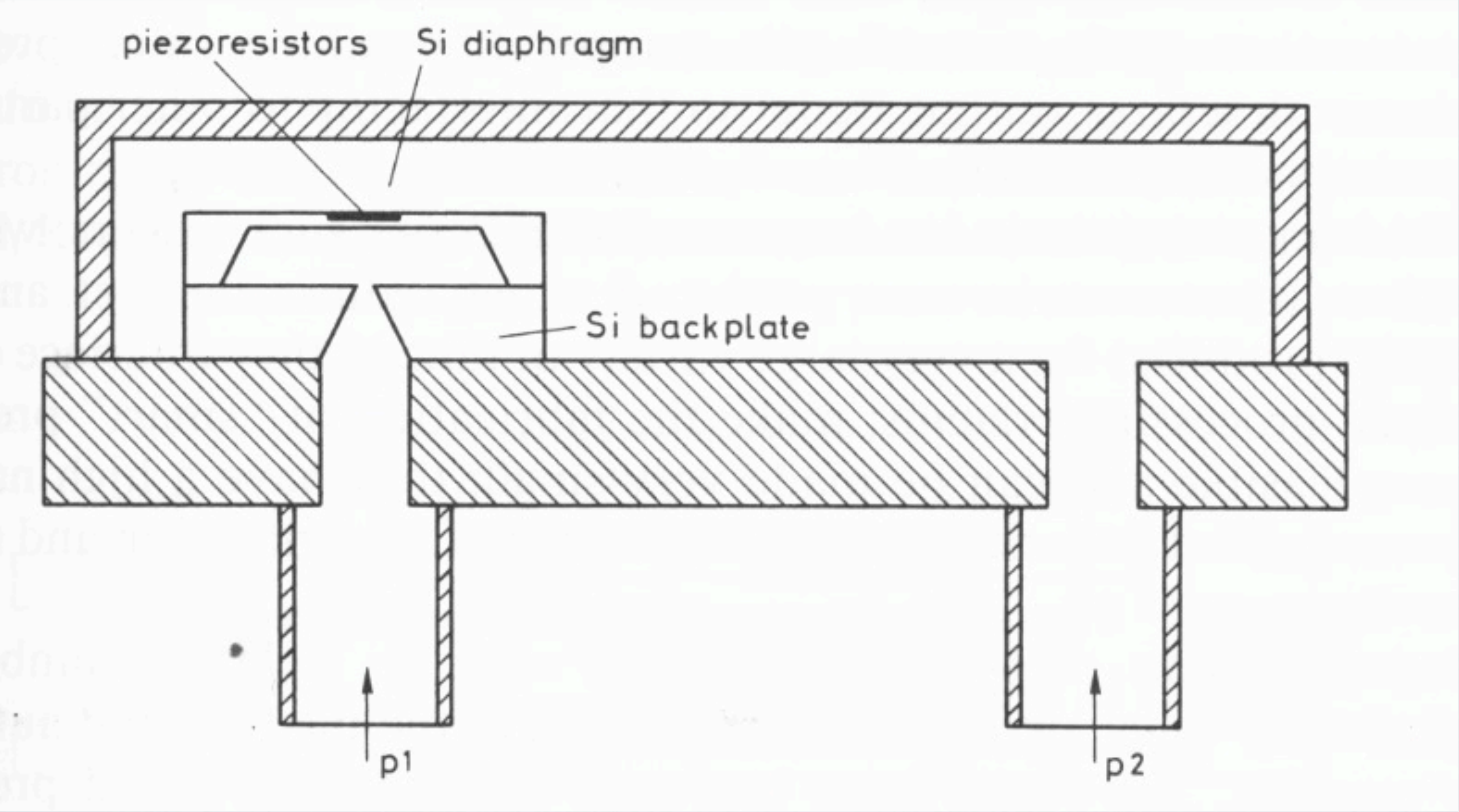
Fig. 15.6 Manometers: (a) U-tube; (b) well type; (c) inclined type.

Capacitivo - basado en membrana de Si



(a) (b)

MEDICIÓN DE FLUJO



MEDICIÓN DE FLUJO

Q = flujo volumetrico

Q_m = flujo de masa = ρQ = dm/dt

Q_v = velocidad del flujo = Q/A

Flujo turbulento: N > 4000

Flujo laminar: N < 2000

Re = numero de Reynolds

$$Re = \frac{Q_v d\rho}{\mu}$$

μ = viscosidad del fluido

Ecuación de Bernoulli

$$Q = k\sqrt{P_2 - P_1}$$

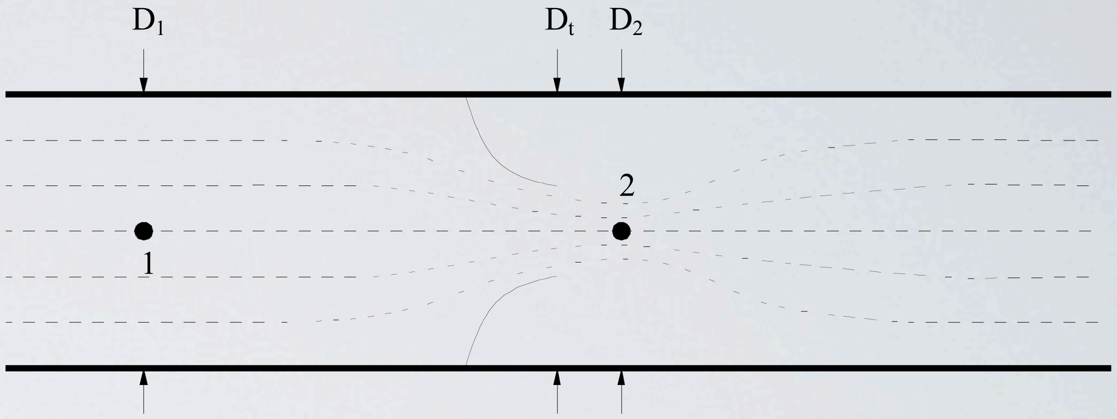


Figure 2.1: A generalised restriction / differential pressure flow meter.

Ideally,

$$\begin{aligned}
\dot{m} &= \rho u_1 A_1 = \rho u_2 A_2 \Rightarrow u_1 = \frac{A_2}{A_1} u_2 \\
\frac{u_1^2}{2} + \frac{p_1}{\rho} &= \frac{u_2^2}{2} + \frac{p_2}{\rho} \qquad \text{(Bernoulli's equation)} \\
u_2 &= \frac{\sqrt{\frac{2}{\rho}\left(p_2 - p_1\right)}}{1 - \frac{A_2}{A_1}} \\
\dot{m} &= \frac{A_2 \sqrt{2\rho\left(p_2 - p_1\right)}}{1 - \frac{A_2}{A_1}}
\end{aligned}$$

Due to non-idealities:

$$\dot{m}_{actual} = \frac{C A_t}{\sqrt{1 - \beta^4}} \sqrt{2\rho\left(p_2 - p_1\right)}$$

where: $\beta = \frac{D_t}{D_1}$, D_t and A_t are the diameter and area of the *throat* of the restriction.

$$C = \text{discharge coefficient}$$

$$K \equiv \frac{C}{1-\beta^4} = \text{ flow coefficient}$$

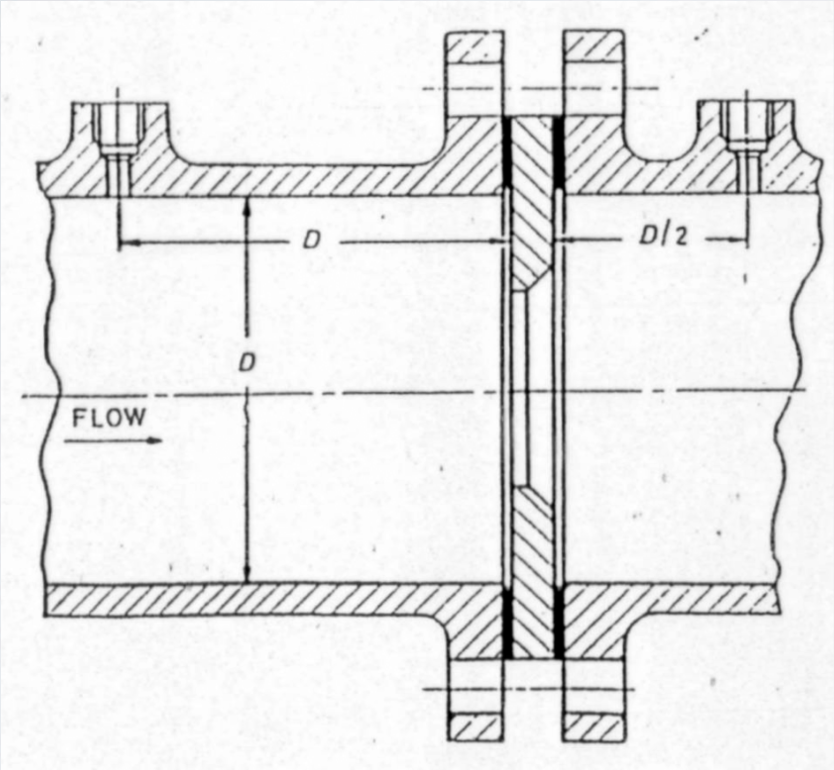


Figure 2.3. Orifice profile
(Furness, 1989)

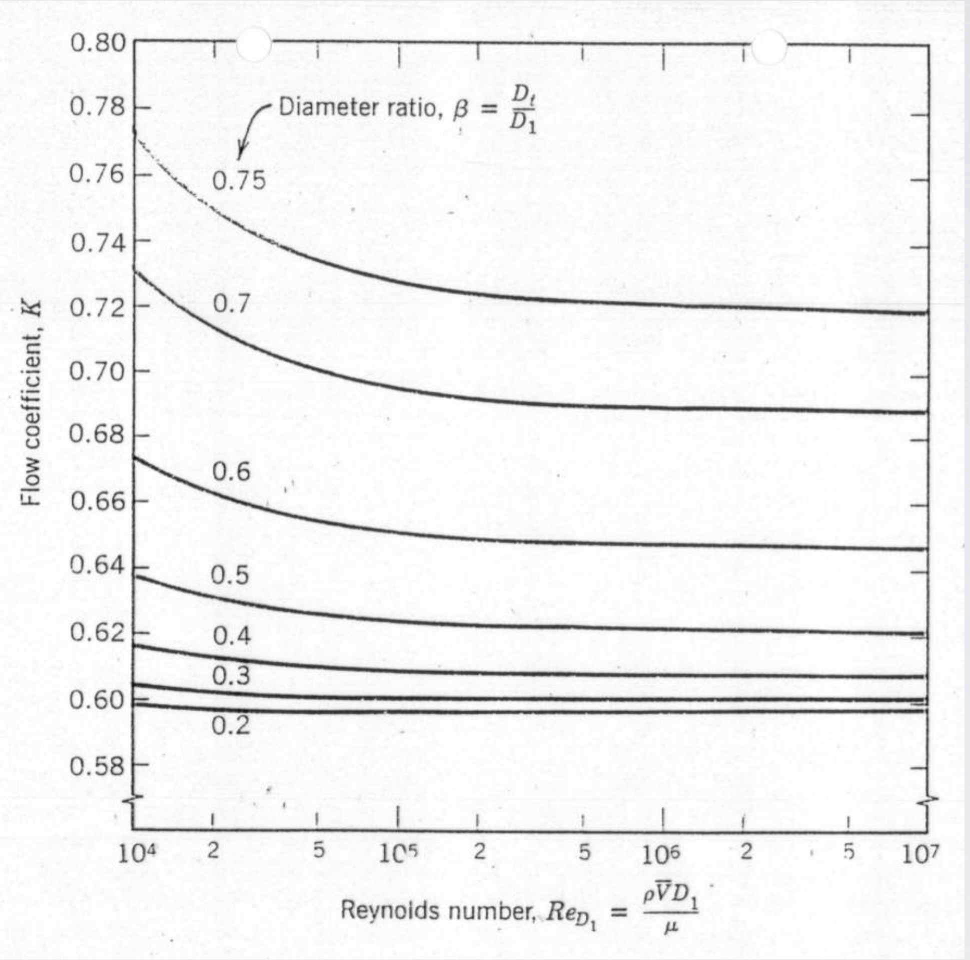


Figure 2.4: Flow coefficients for orifice with corner taps.

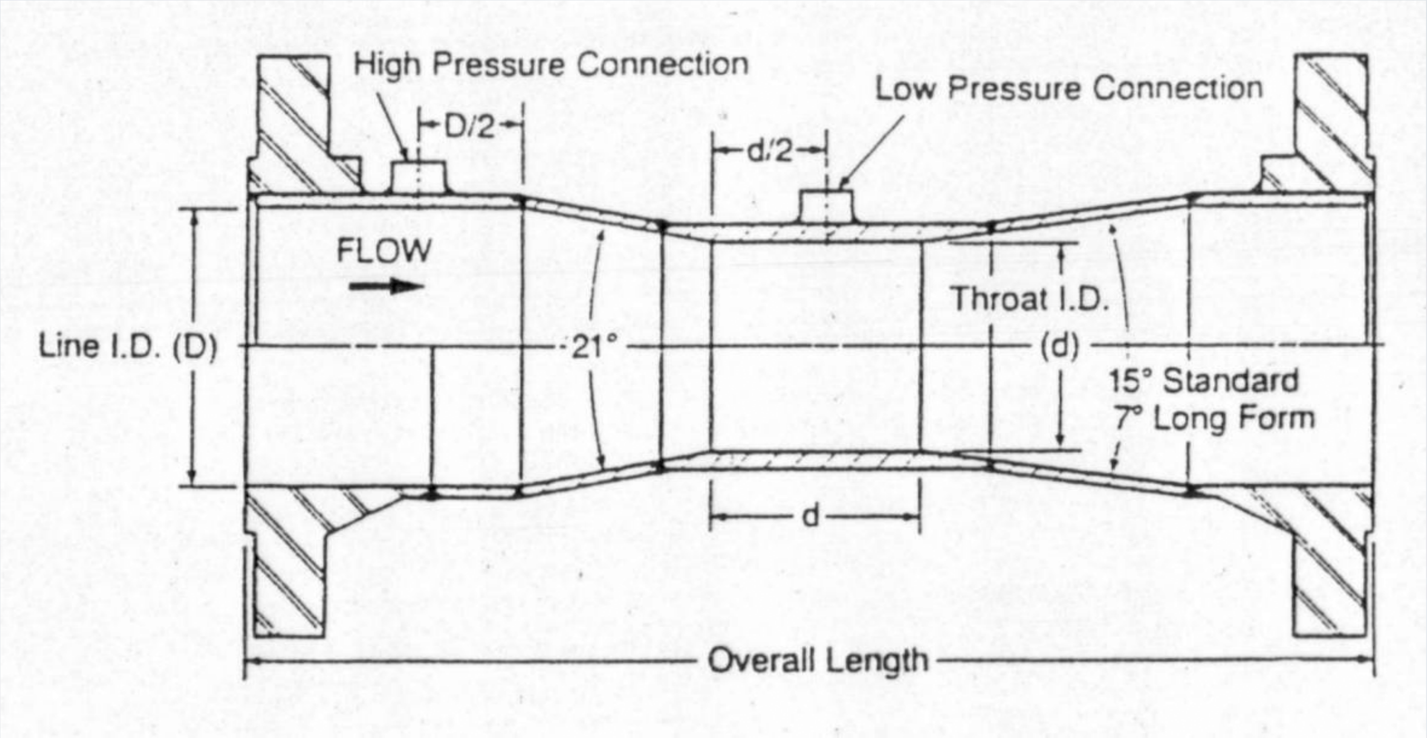
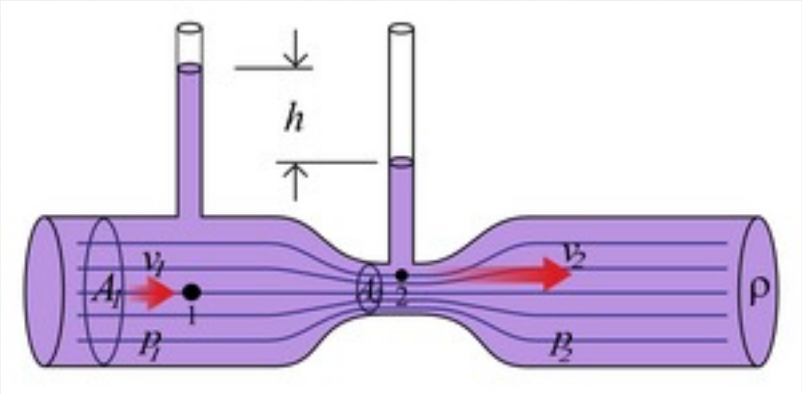
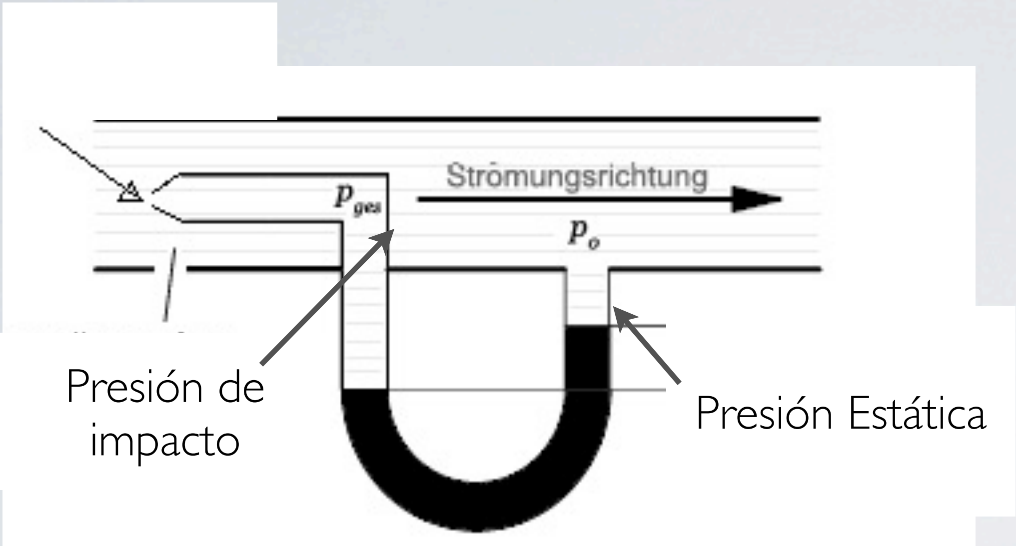


Figure 2.5: The Venturi meter (Furness, 1989)

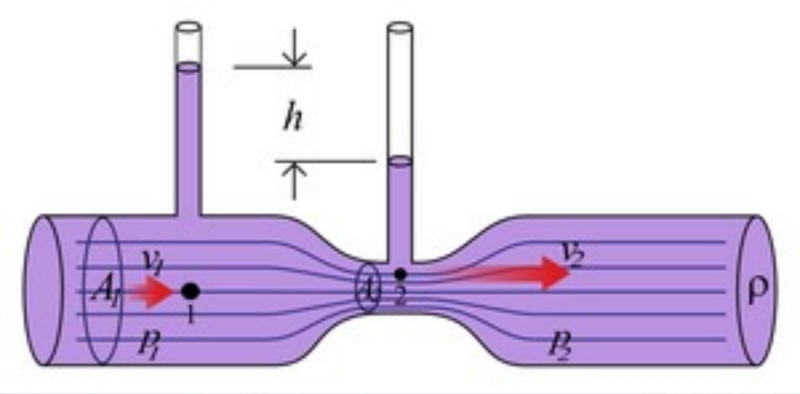
$$C = 0.99 \text{ for } 10^5 < Re < 10^7$$



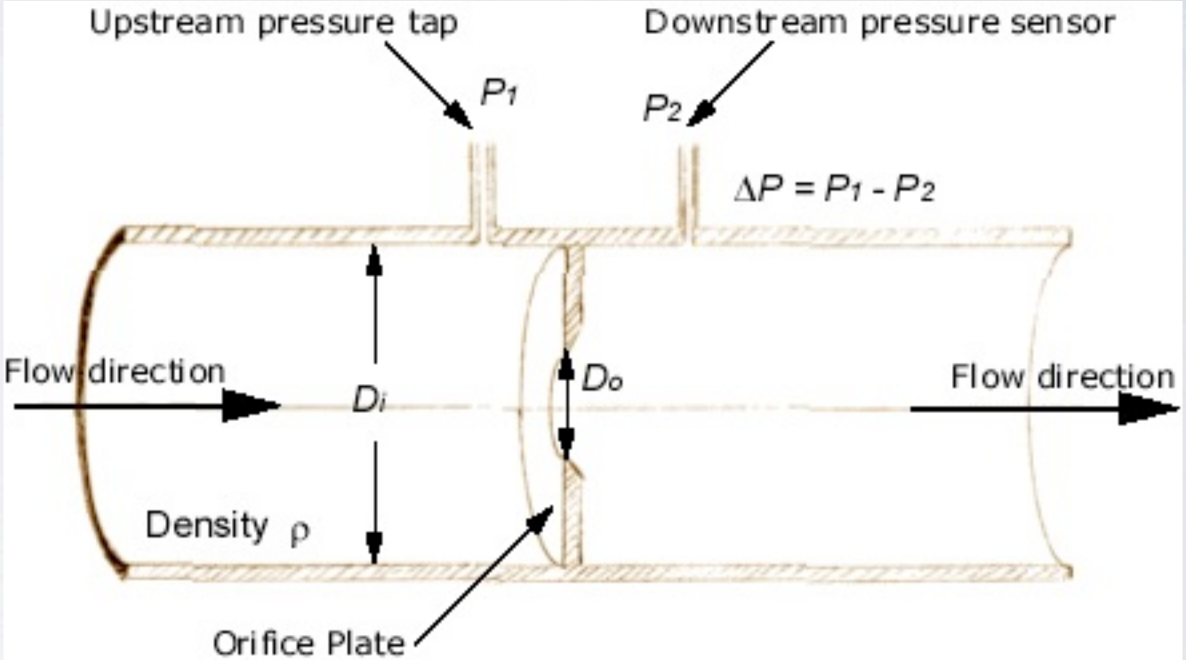
Obstruction-type



tubo de Pitot



Venturi meter



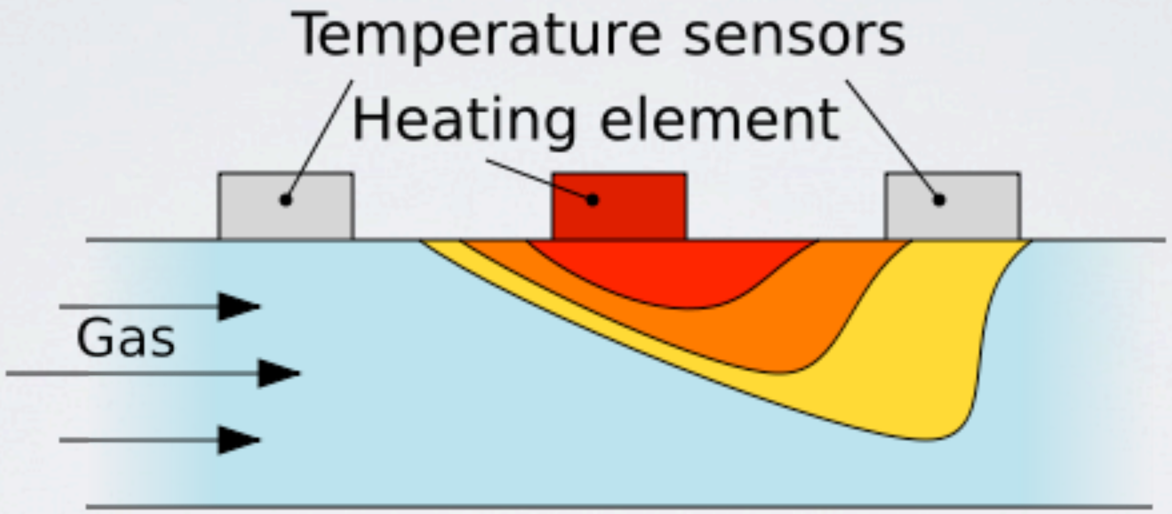
Orifice plate

http://www.youtube.com/watch?feature=player_detailpage&v=oUd4WxjoHKY

CORIOLIS FLOWMETER

http://www.youtube.com/watch?
feature=player_detailpage&v=XIIViaNITIw

THERMAL FLOW



http://www.youtube.com/watch?feature=player_detailpage&v=XIlViaNITIw

VORTEX FLOWMETER

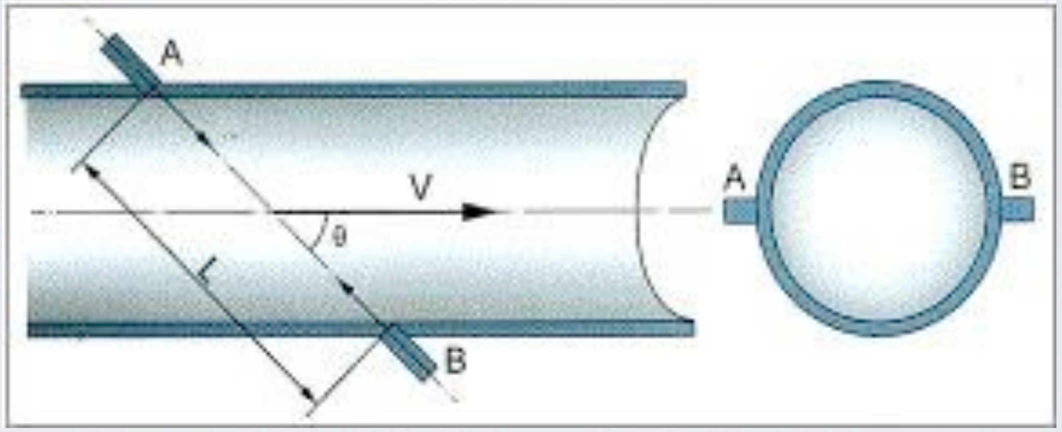
http://www.youtube.com/watch?feature=player_detailpage&v=GmTmDM7jHzA

Example: Design an instrument to measure a flow from 20 to 150 gal/min using an orifice plate system. The orifice plate is described by Bernoulli's equation, with K=119.5(gal/min)/psi½.

The instrument should produce a 4-20mA signal proportional to the flow. The relationship between current and flow should be linear, with 4mA and 20mA corresponding to 20 gal/min and 150 gal/min, respectively.

Piezoresistive strain gages with GF=50 are attached to a diaphragm and are used to measure the pressure difference.

Metro de flujo ultrasónico



$$Q_v = \frac{L}{\sin\theta}\frac{t_{UP} - t_{DOWN}}{t_{UP} \times t_{DOWN}}$$

http://www.youtube.com/watch?feature=player_detailpage&v=Bx2RnrfLkQg

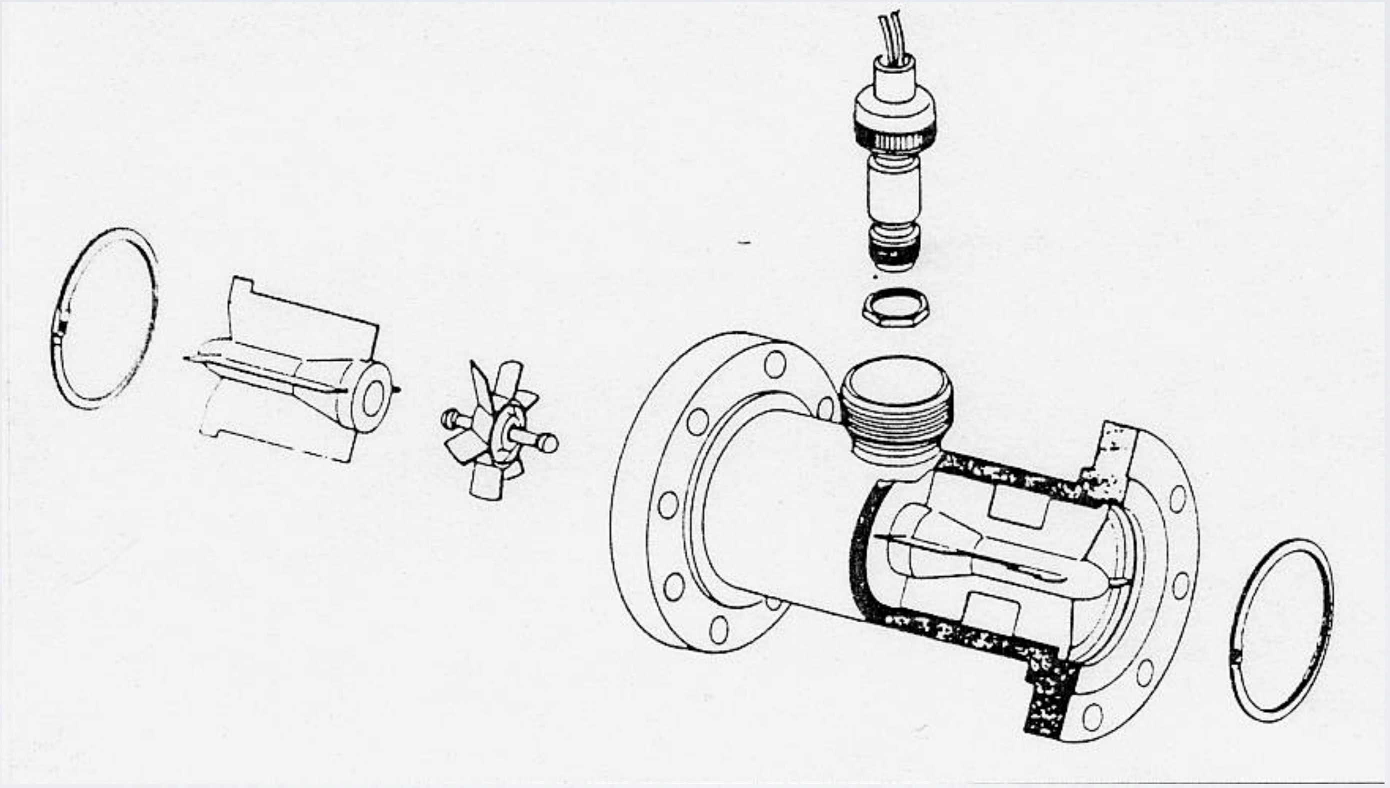


Figure 2.17: Construction of an *Axial Turbine* flow meter.

$$Q = K\omega$$

Electromagnetic flowmeter

http://www.youtube.com/watch?feature=player_detailpage&v=yYQrLVMDZy0