PRESSURE

WMO TRAINING WORKSHOP ON METROLOGY FOR SOUTHWEST PACIFIC RA V ENGLISH SPEAKING COUNTRIES

Melbourne, Australia, 21-25 November 2011

Plan of the discussion

I – CONCEPTS TERMS DEFINITION

II – PHYSICAL PRINCIPLE

III – DERIVED SYSTEM

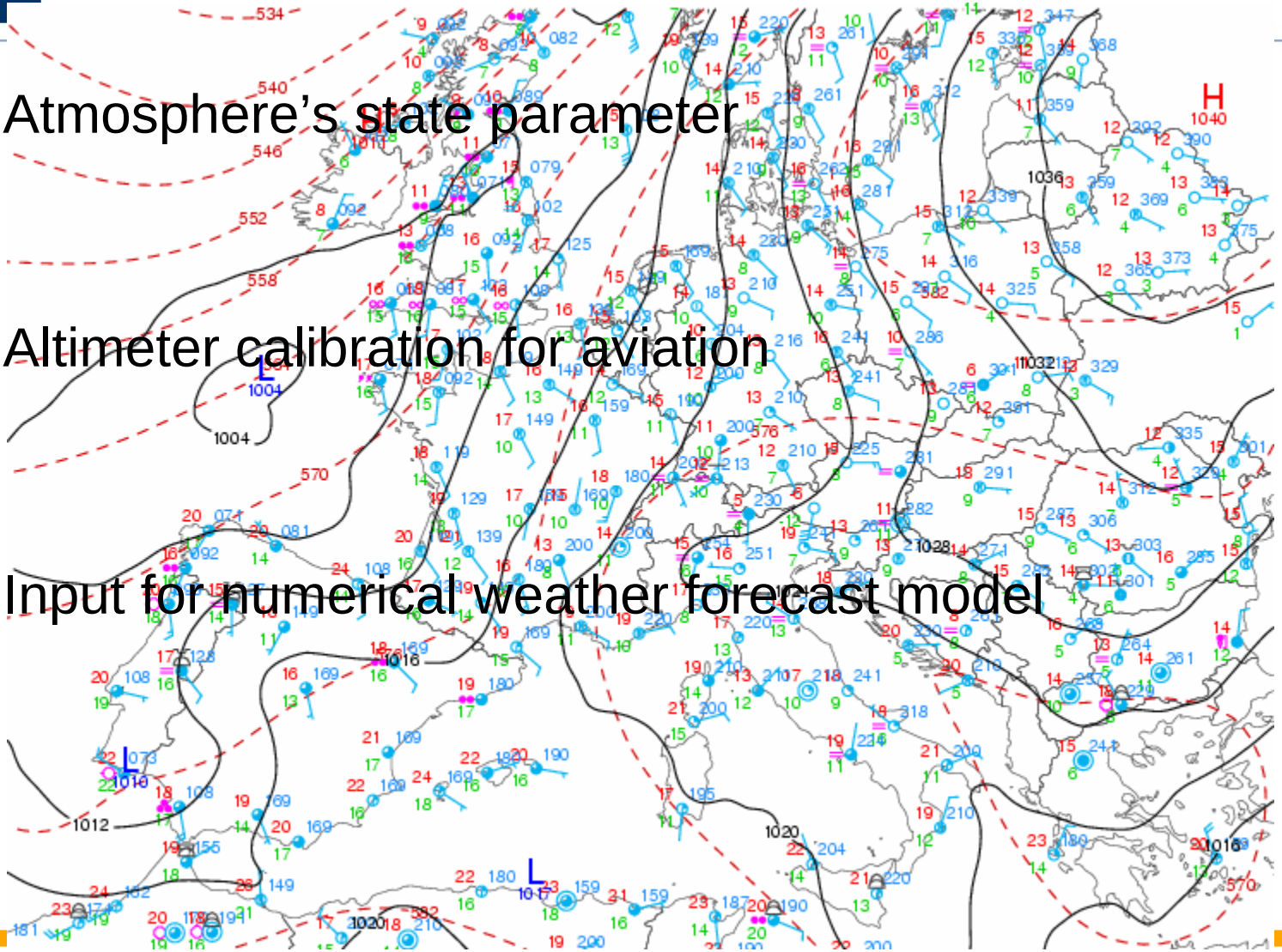
IV – NMHSs and Pressure Measurement

V – BIBLIOGRAPHY

VI – CONCLUSION

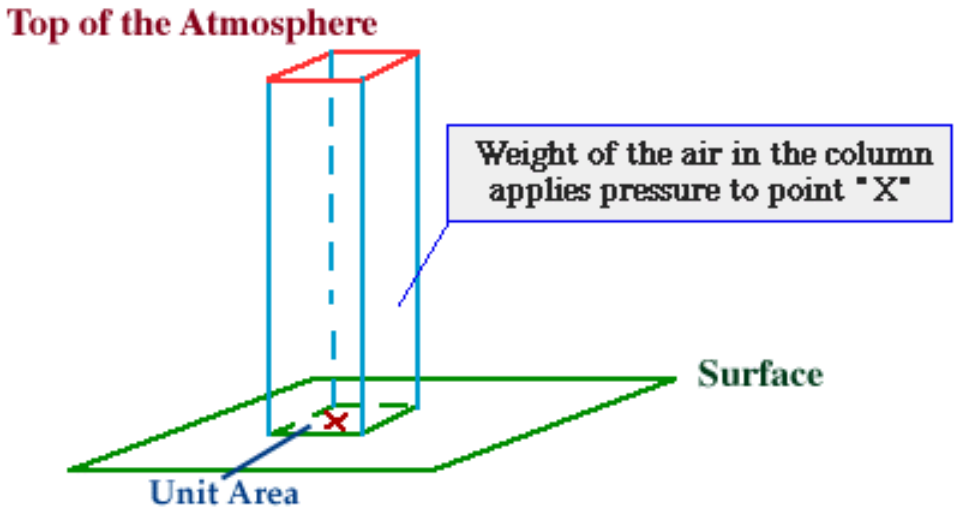
Definitions

- Atmosphere's state parameter
- Altimeter calibration for aviation
- Input for numerical weather forecast model



Definitions

- Pressure is generally the result of molecules impacting on their surroundings



$$P = \frac{F}{A}$$

HISTORY

- 1644 : The Italian physician Evangelista Torricelli (1608-1647) built the first siphoon barometer

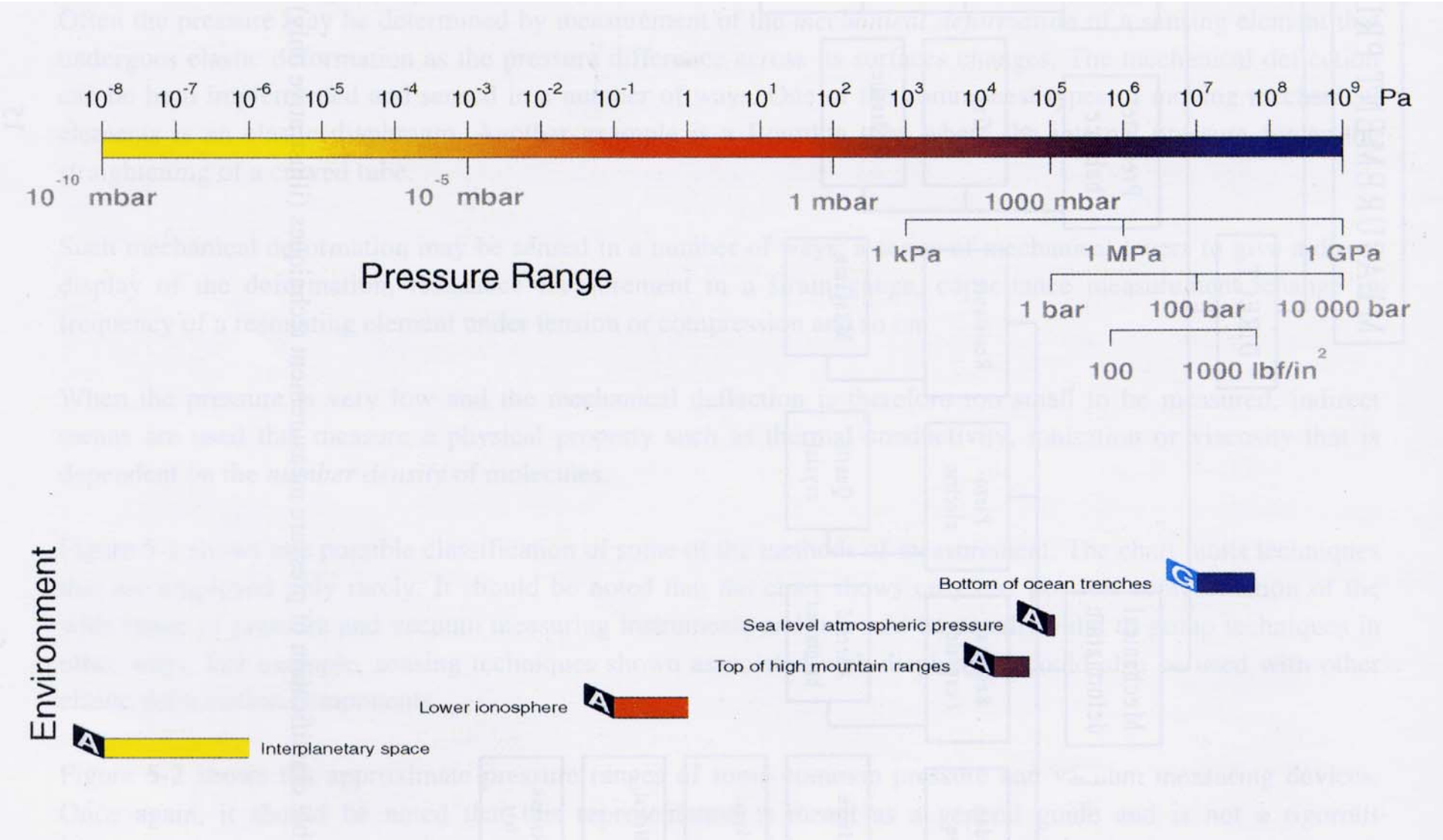
- 1648 : The french prodige Blaise Pascal (1623-1662) made a lot of experiments with some similar barometers at divers locations (Paris; Clermont-Ferrand).

Pascal (1623-1662)

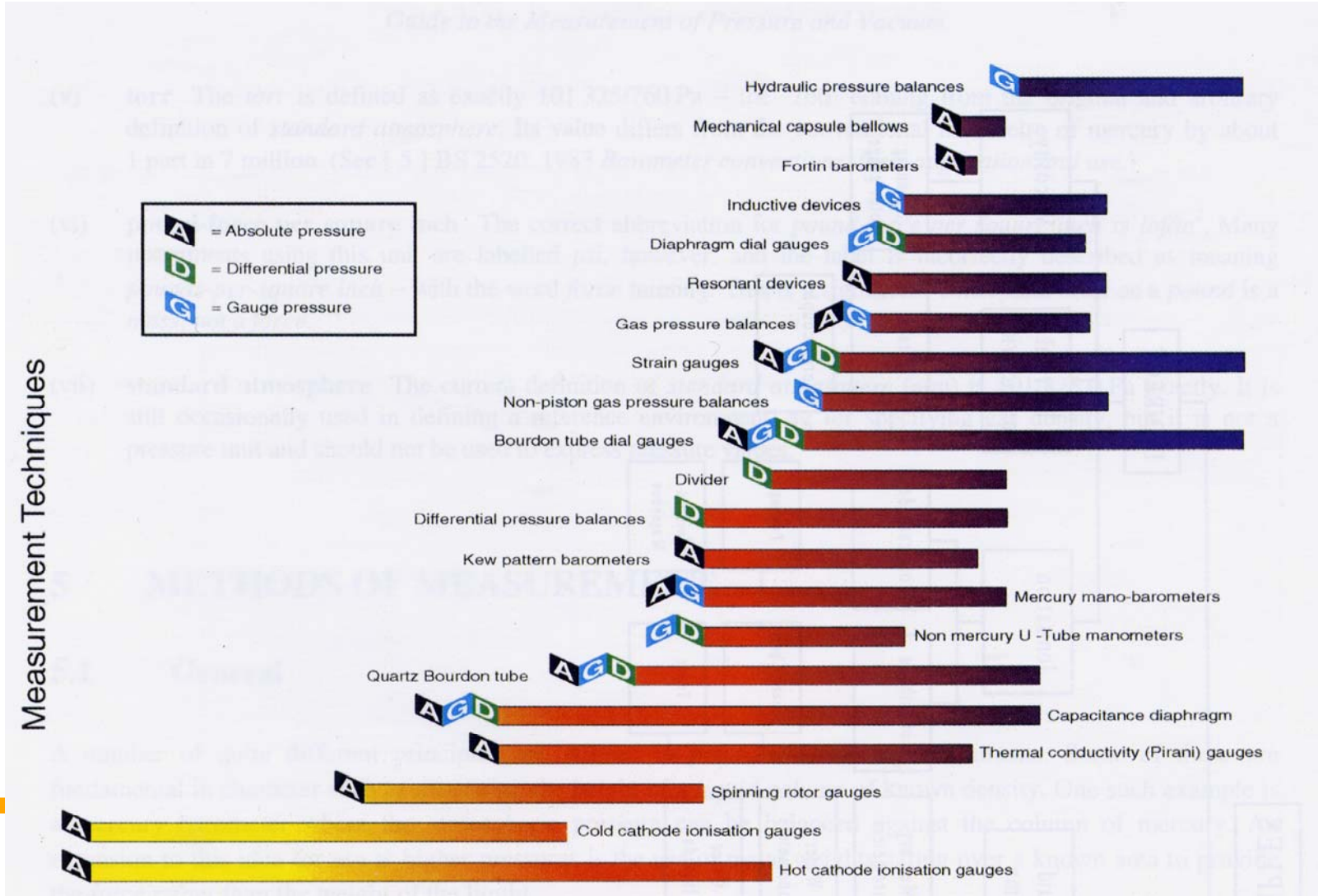
UNITS

UNIT	Symbol	Number of pascals
Pascal	Pa	1
Bar	bar	1. 10^5 (exactly)
Millibar	mbar	100 (exactly)
Hectopascal	hPa	100 (exactly)
Millimetre of mercury	mmHg	133.322…
Inch of mercury	inHg	3 386.39…
Inch of water	inH_2O	248.6… to 249.1…
Torr	torr	101 325/760 (exactly)
Kilogram-force per square centimeter	kgf/cm^2	98 066.5 (exactly)
Pound-force per square inch	Lbf/in^2	6 894.76…

Range


10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7} 10^{8} 10^{9} Pa
10^{-10} mbar
10^{-5} mbar
1 mbar
1000 mbar
1 kPa
1 MPa
1 GPa
1 bar
100 bar
10 000 bar
100
1000 lbf/in^2
Pressure Range
Environment
Bottom of ocean trenches
Sea level atmospheric pressure
Top of high mountain ranges
Lower ionosphere
Interplanetary space

Measurement techniques

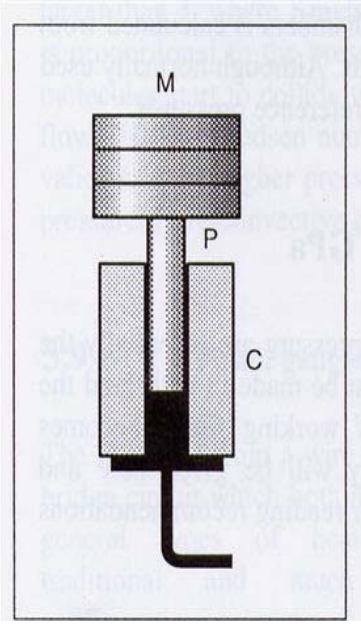


Physical Principle

$$p = \rho \times g \times h$$

Liquid column instruments

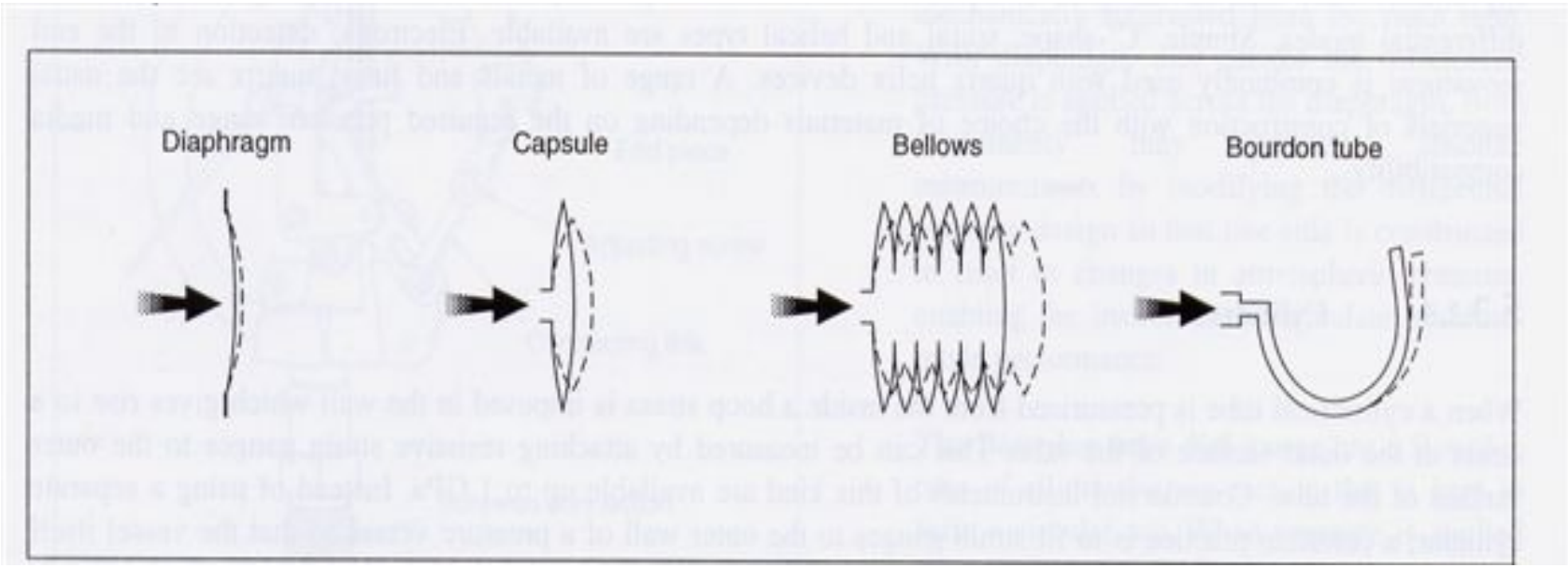
Physical Principle



$$p = \frac{m \times g}{A_e} \times (1 - \frac{\rho_a}{\rho_m})$$

Pressure balance and deight weight testers

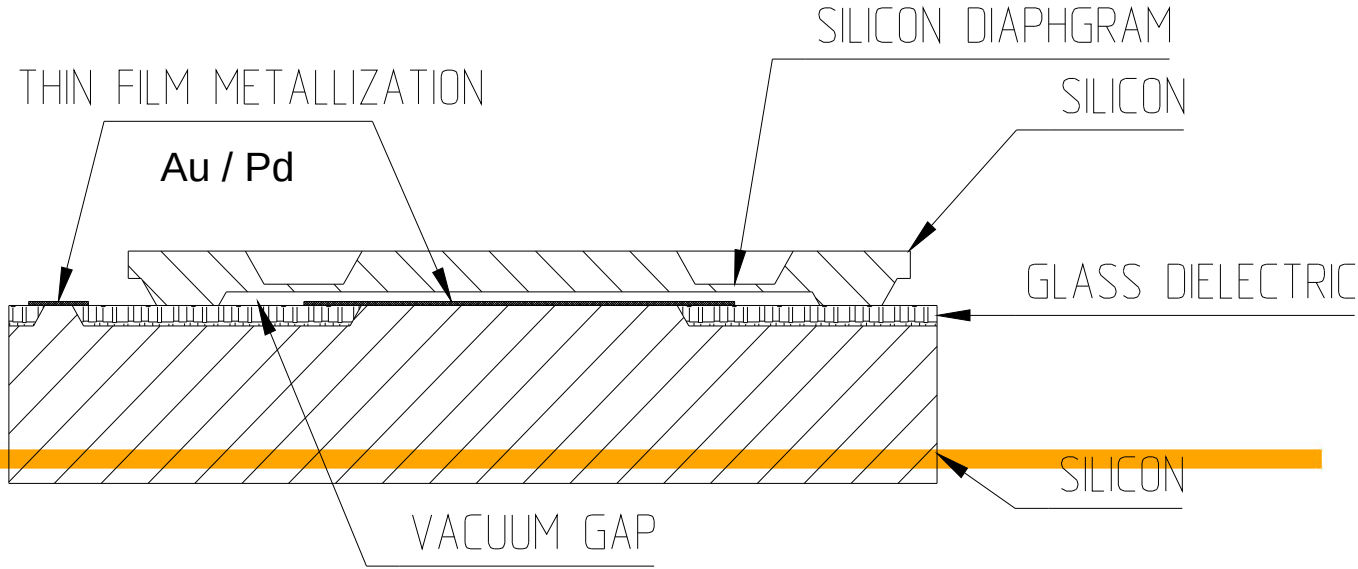
Derived System



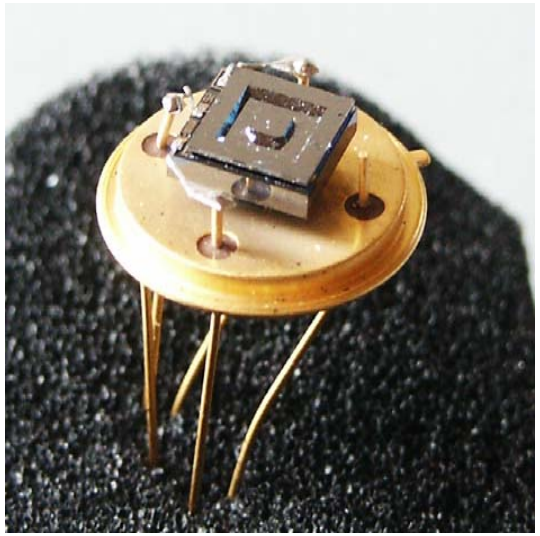
Mechanical deformation instruments

Diaphragm


Diaphragm


SILICON DIAPHGRAM
THIN FILM METALLIZATION
SILICON
Au / Pd
GLASS DIELECTRIC
SILICON
VACUUM GAP

Diaphragm

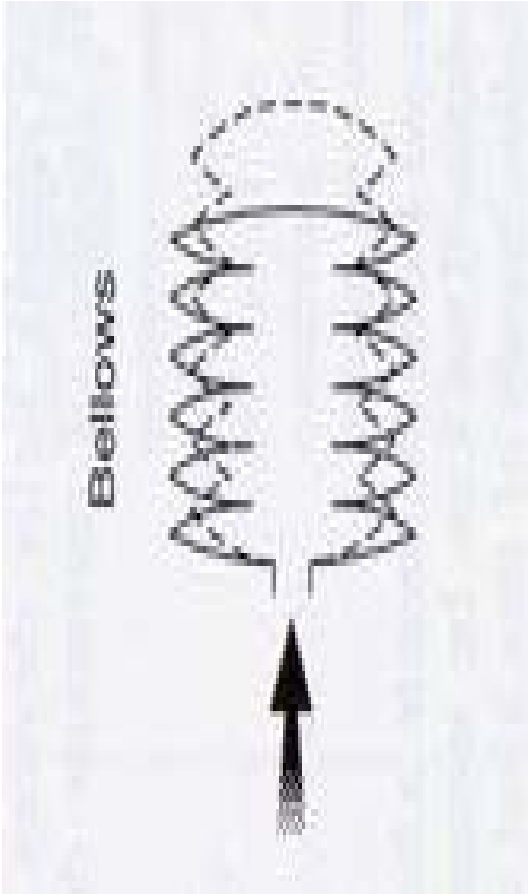


Silicium diaphragm

Capsule

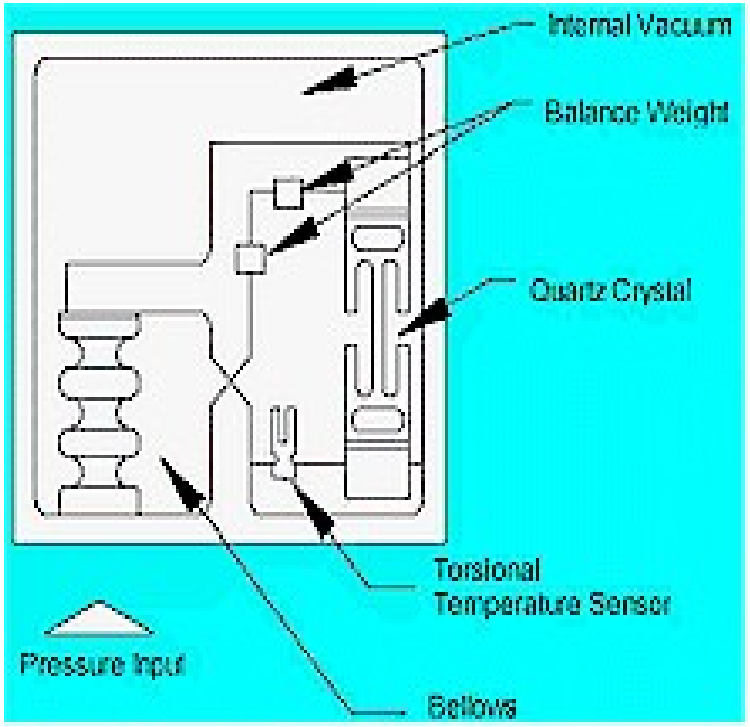
Capsule

Bellows



Bellows


29.55215 inHg
-.00037 inHg/s


Internal Vacuum
Balance Weight
Quartz Crystal
Torsional
Temperature Sensor
Pressure Input
Bellows

Bourdon Tube

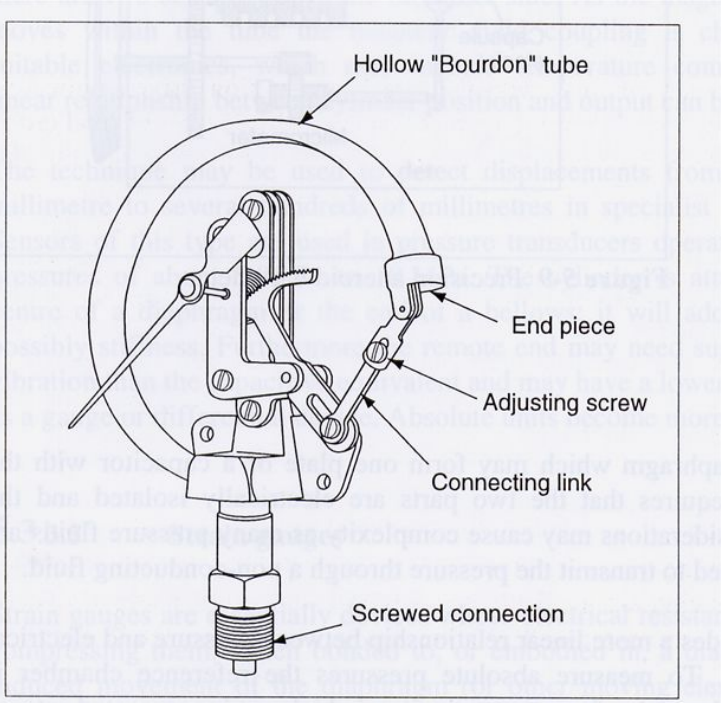
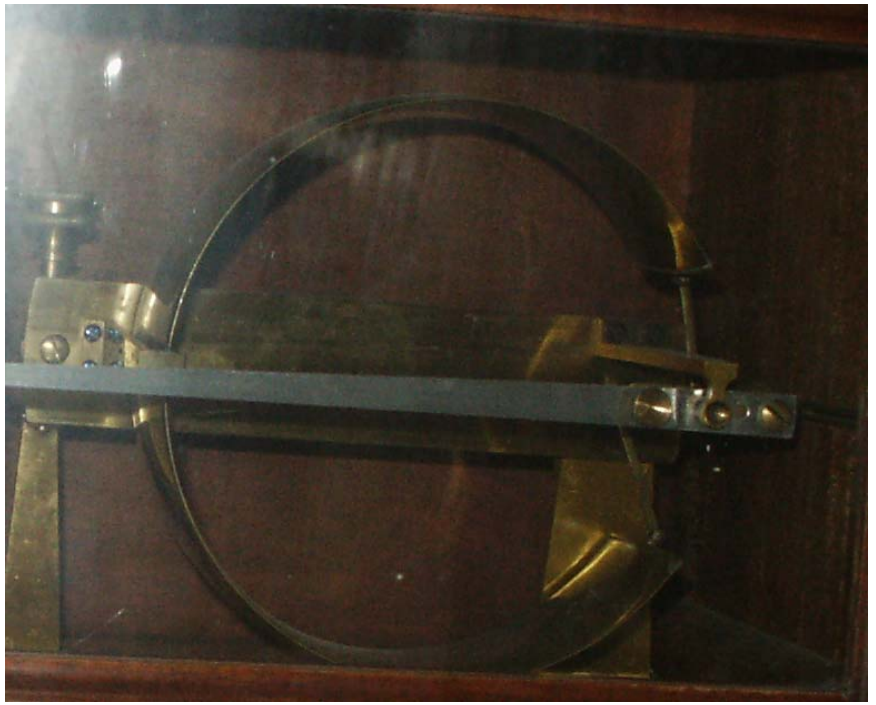
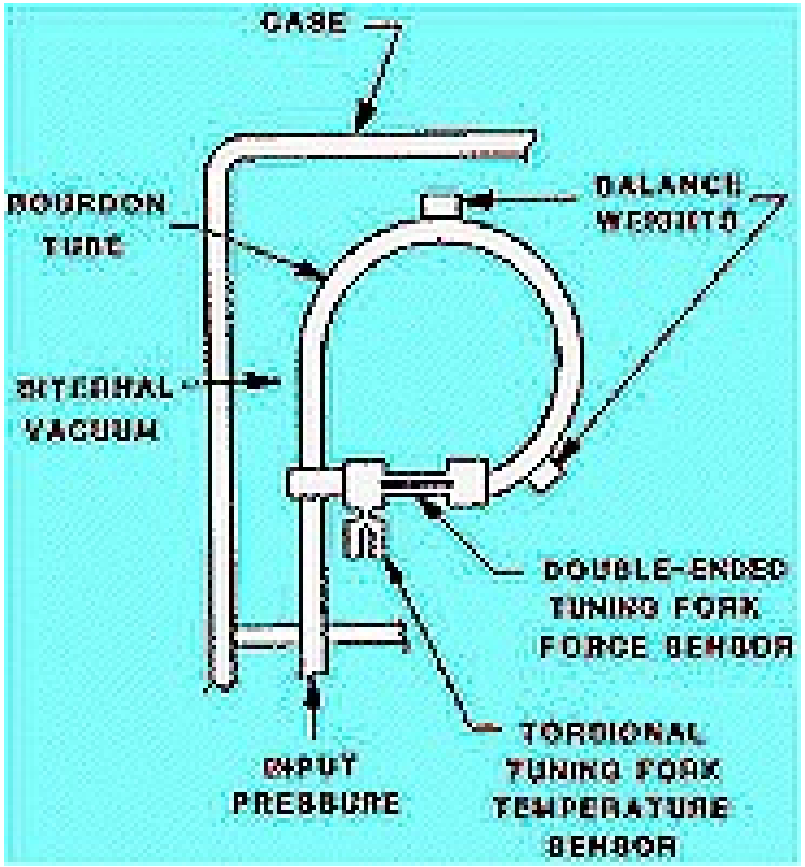


Figure 5-7 Bourdon tube dial gauge



Bourdon Tube

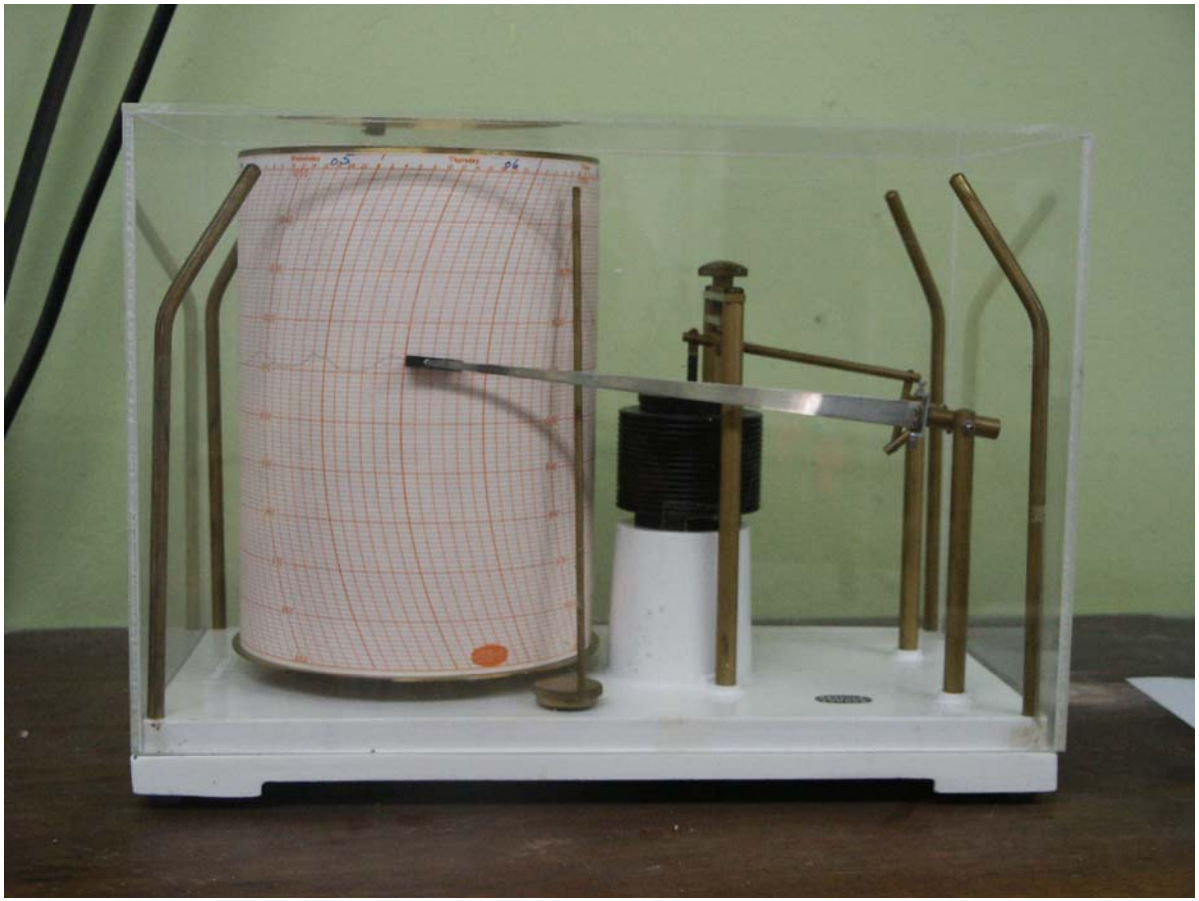


Mechanical deformation sensing

- Mechanic display
- Capacitive technics
- Vibrating structures
- Piezo-electric devices

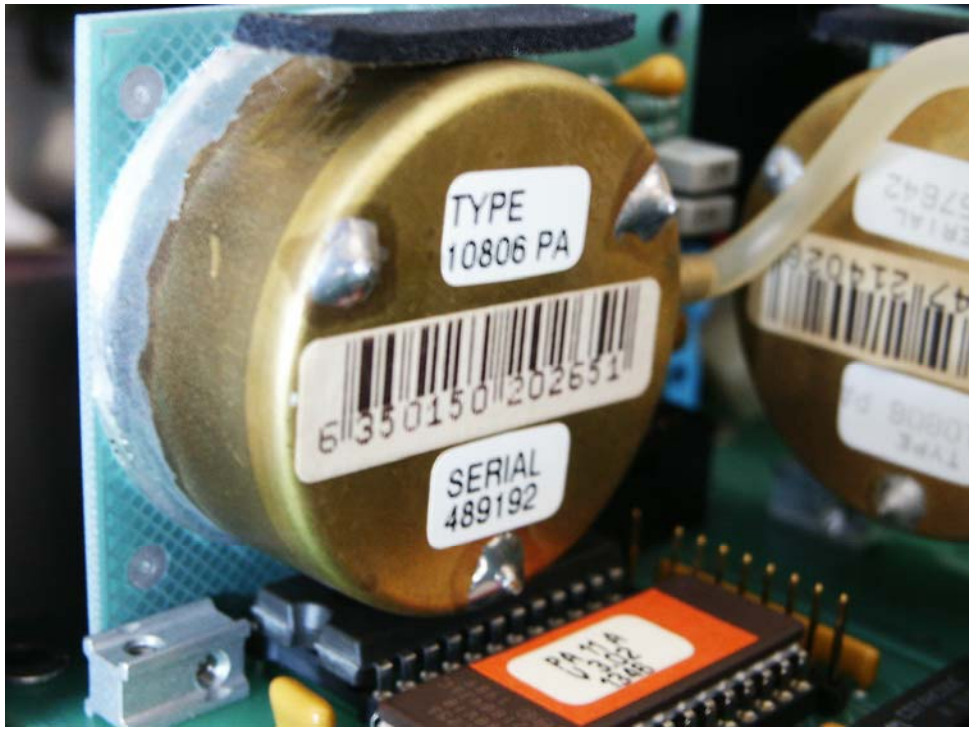
Mechanical deformation sensing

- Mechanic display



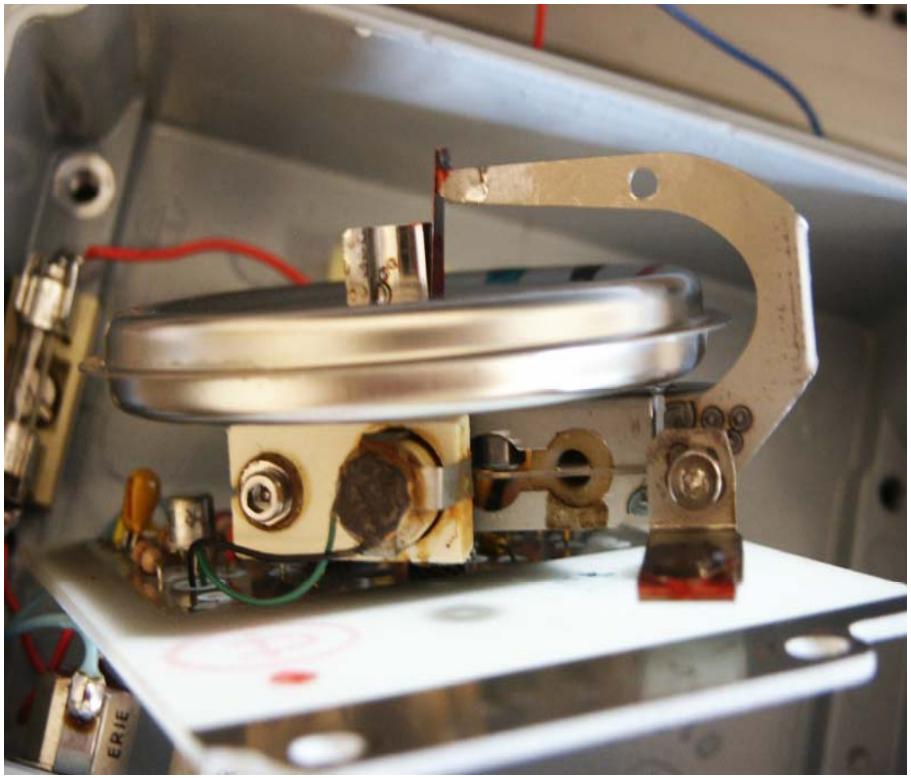
Mechanical deformation sensing

- Capacitive technics

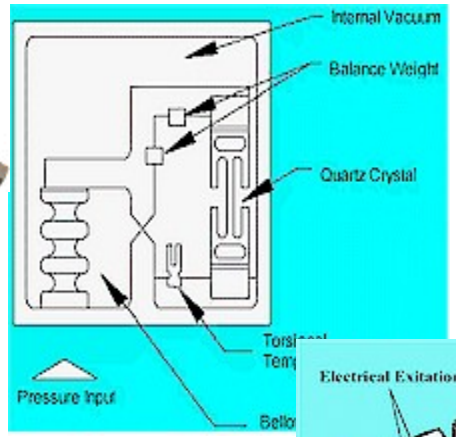


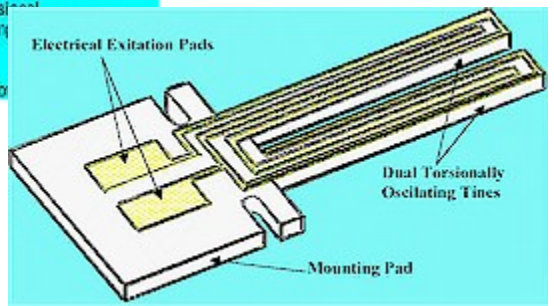
Mechanical deformation sensing

- Vibrating structures



Mechanical deformation sensing



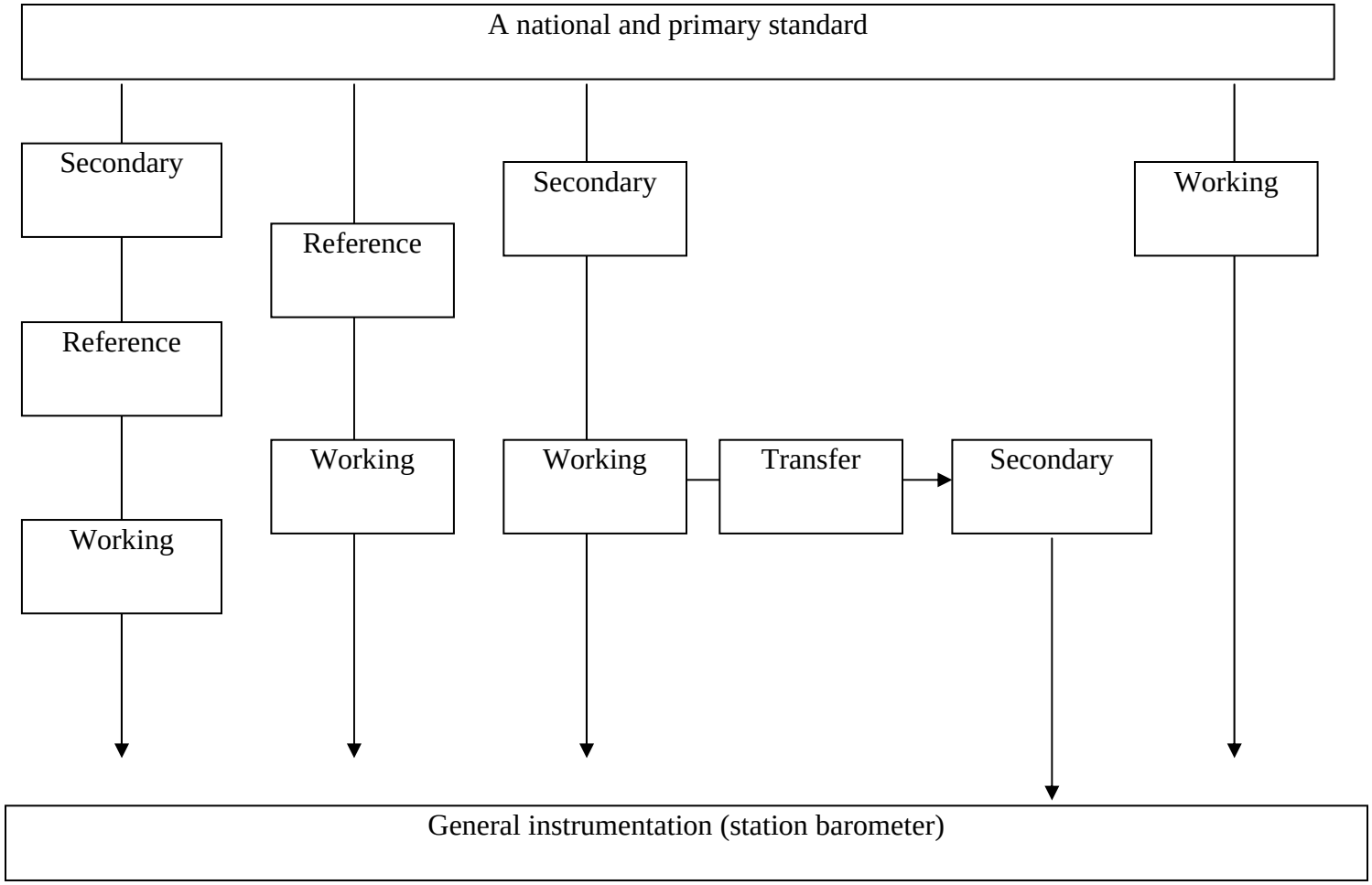


- Piezo-electric devices

CALIBRATION

- operation that, under specified conditions, in a first step, establishes a relation between the **quantity values** with **measurement uncertainties** provided by **measurement standards** and corresponding **indications** with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a **measurement result** from an indication

NMHS & Pressure Measurement

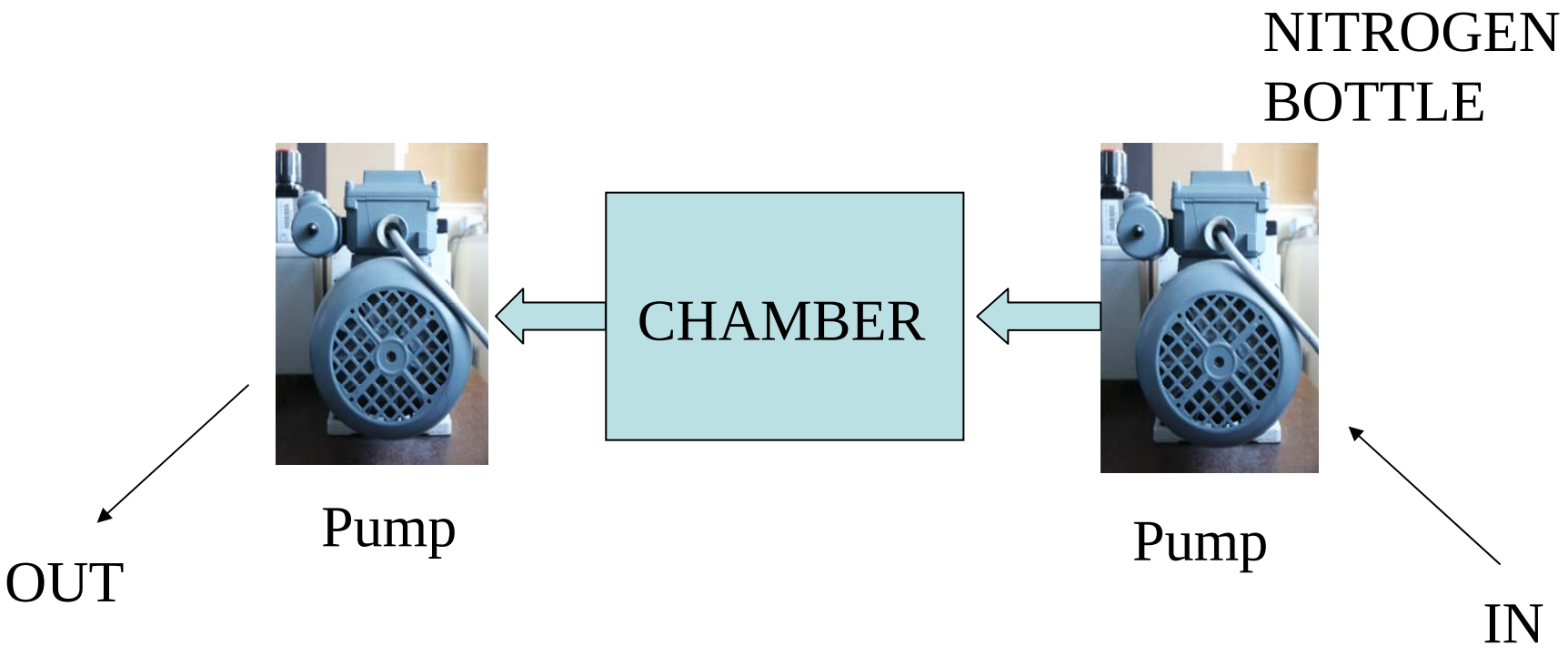


NMHS & Pressure Measurement

- A suitable environment
- An appropriate standard
- A set of pressure connection
- A method of generating and regulating the pressure
- A system of recording measurements
- A method for calculating results
- A procedure
- Trained staff

NMHS & Pressure Measurement

Calibration generator, principle



Met Office & Pressure Measurement

Calibration generator

Barometer without socket

NMHS & Pressure Measurement

Calibration generator

Barometer with socket

BIBLIOGRAPHY

- Guide to the Measurement of Pressure and Vacuum
  The Institut of Measurement and Control
  87 Gower Street
  London

- **WMO GUIDE TO METEOROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION**
  WMO-No. 8 (Seventh edition)

- Calibration Book Vaisala
  http://www.vaisala.com/en/services/technicalsupport/calibrationbook/Pages/default.aspx

Conclusion

- Pressure is the most important parameter in Meteorology and Aviation
- Calibration is needed
- For most contries, it is a turning point: mercury and electronic devices are present

Australian Government
Bureau of Meteorology