Pressure sensors

- definition:

$$p = \frac{dF}{dS}$$

F .. force [N]
S .. area [m^2]

1 atm = 100 kPa

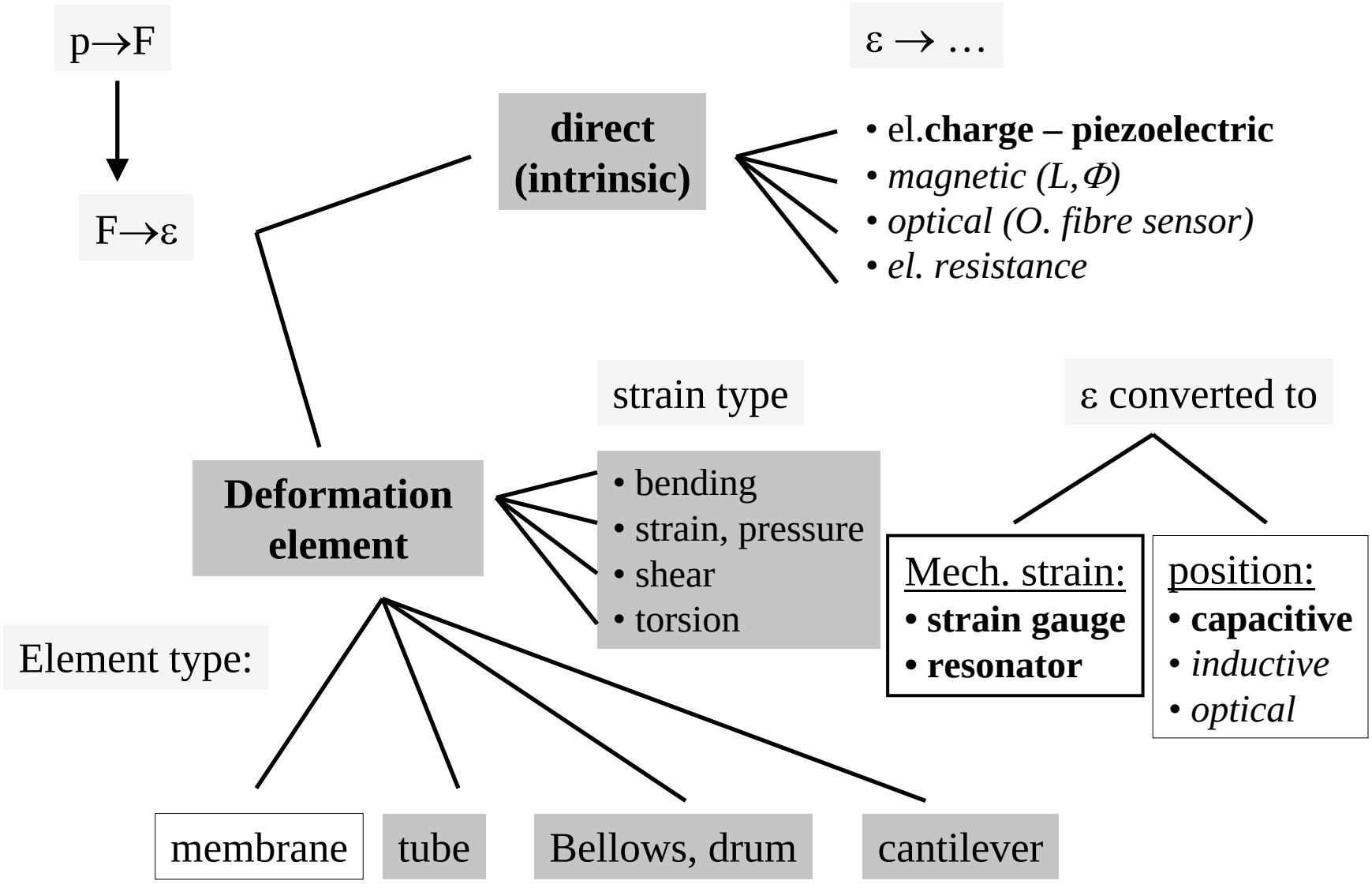
2 ways of measurement:

$p \rightarrow F \rightarrow \varepsilon$ deformation element $\rightarrow$ change in dimensions

direct (intrinsic) sensor

Strain gauge

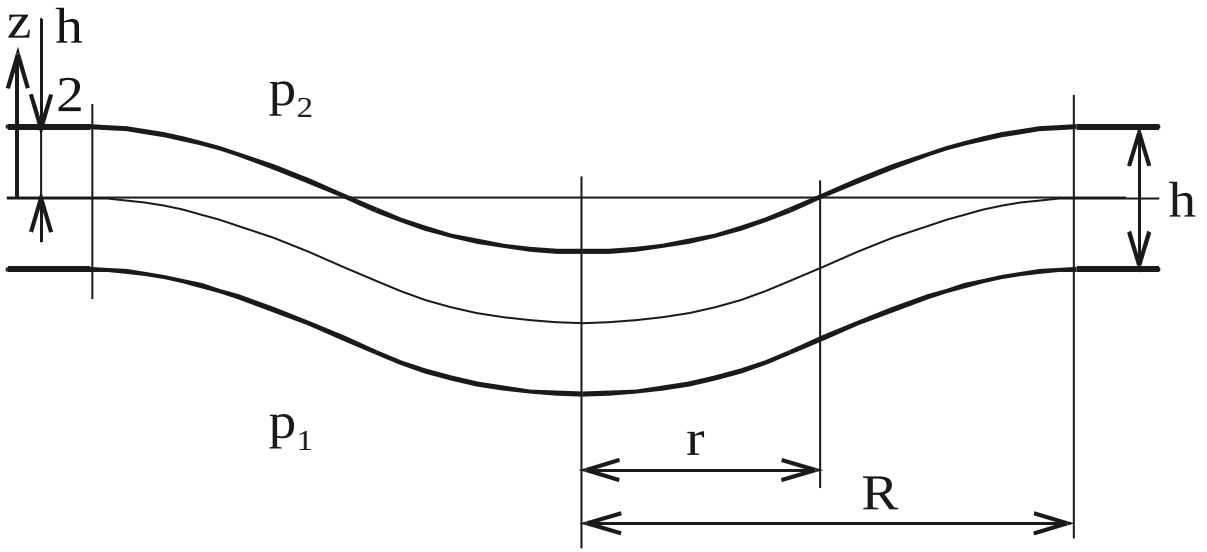
Basic principles of pressure sensors



1. Membrane with strain gages

- most widely used

- membrane deformation:

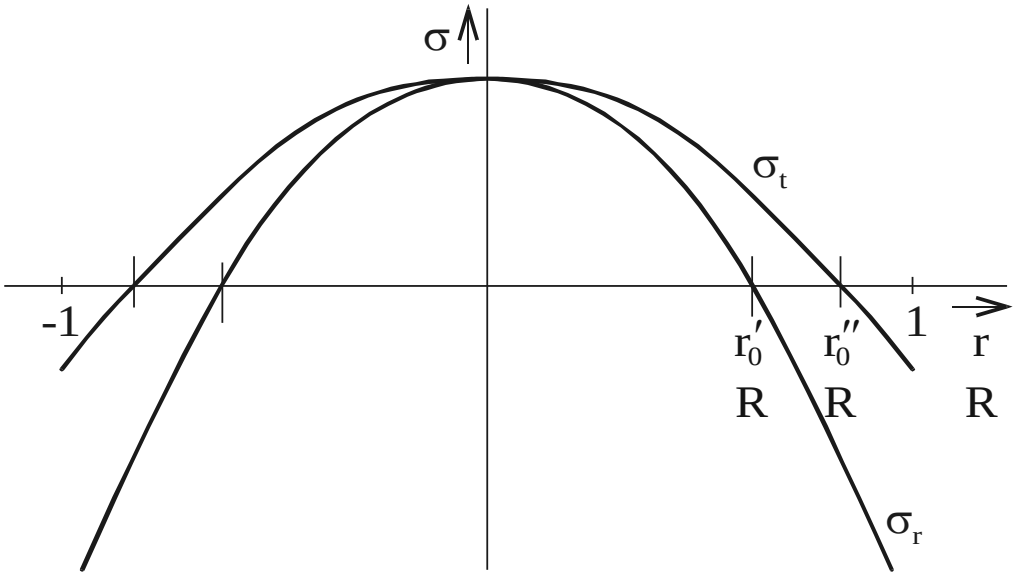


Action of pressure $\Delta p = p_2 - p_1$ results in strain σ composed of:

σ_r - radial component

σ_t - tangential component

Distribution of radial and tangential strain under pressure-deformation



$$\sigma_r = f_r(r/R)$$

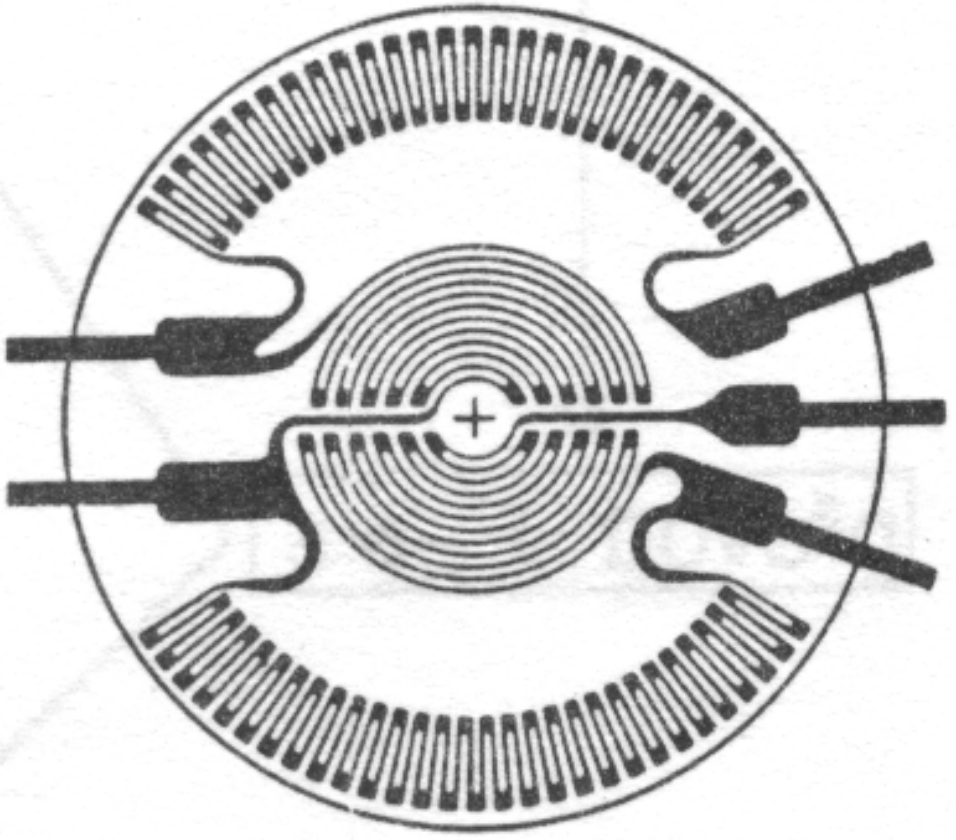
$$\sigma_t = f_t(r/R)$$

Metallic membrane:

- glued semiconductive strain gauges
- metallic foil strain gauges
- thick layer deposition technology

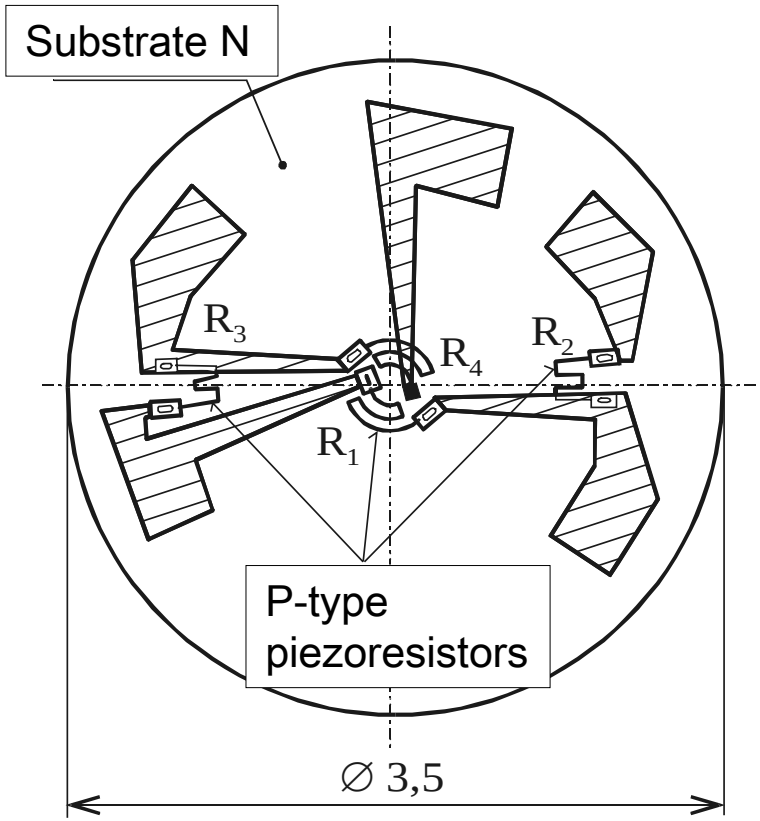
Strain gauge „roseta“

- ideal strain gauge (-foil) for membranes
- 2 sensors at periphery and 2 in the middle



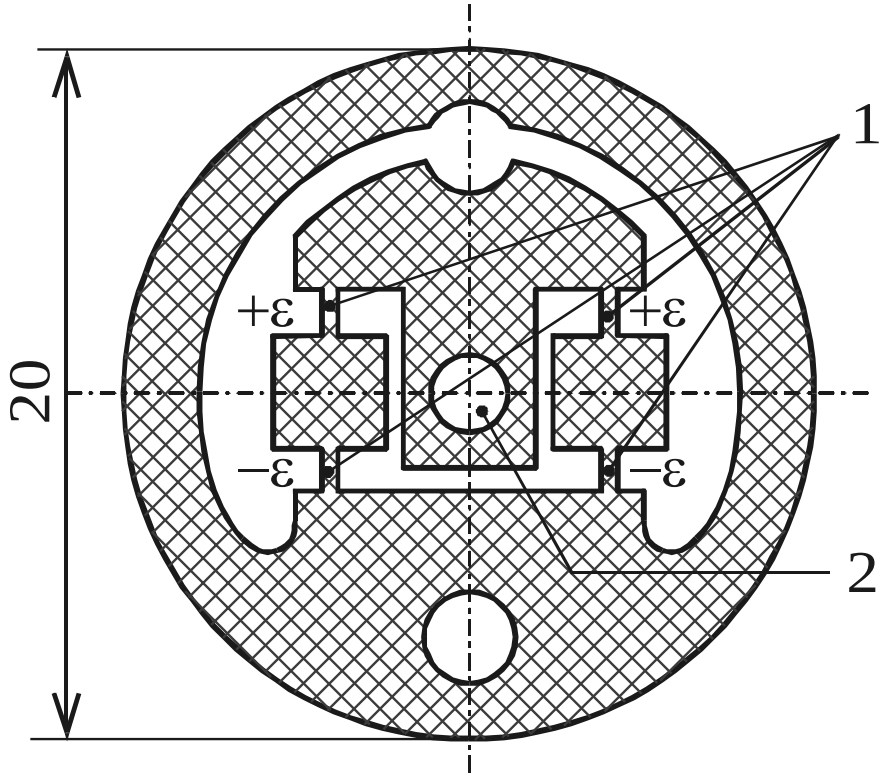
semiconductive membrane

+ difusion implemented piezoresistors
- made by integrated circuit technology ⇒ cheap
- Si, SiC, diamond



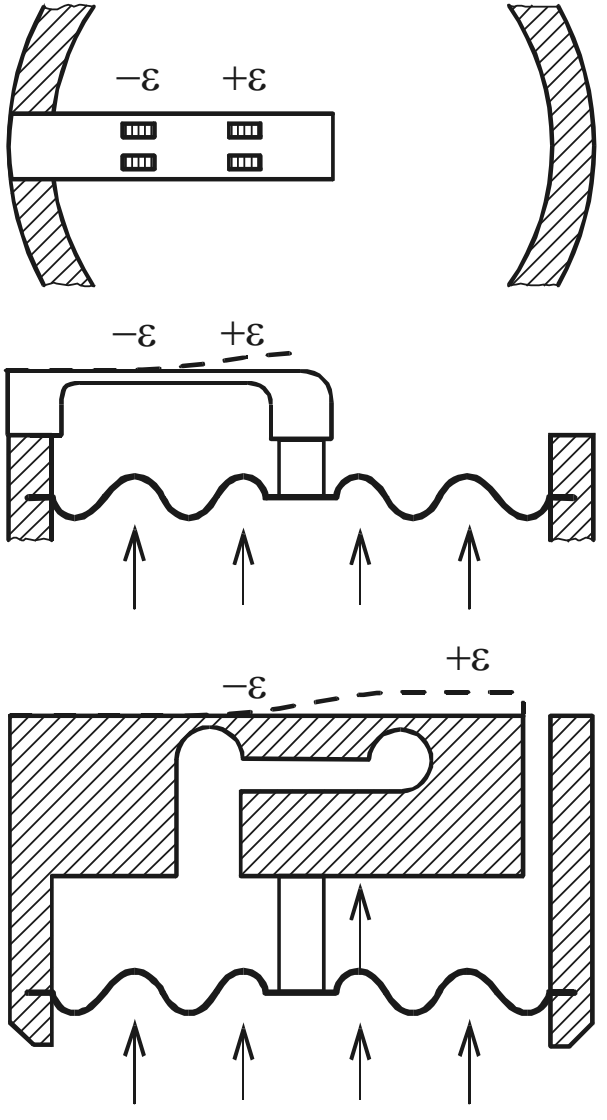
Thin-layer pressure sensors

-Separation of measured environment from the sensor ⇒ use e.g. In measuring pressure in melting (transfer of deformation from outer durable membrane via connecting rod)



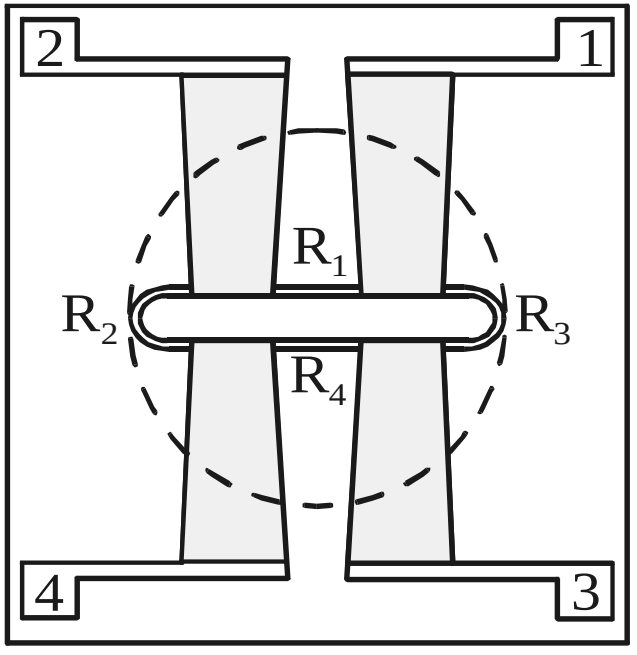
1 – four beams = deformation element
2 – connecting rod from outer membrane

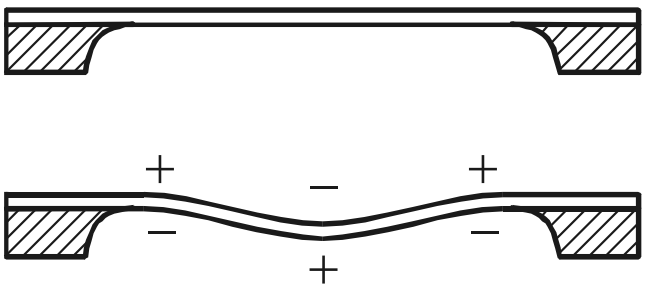
Deformation elements with cantilever and bellows

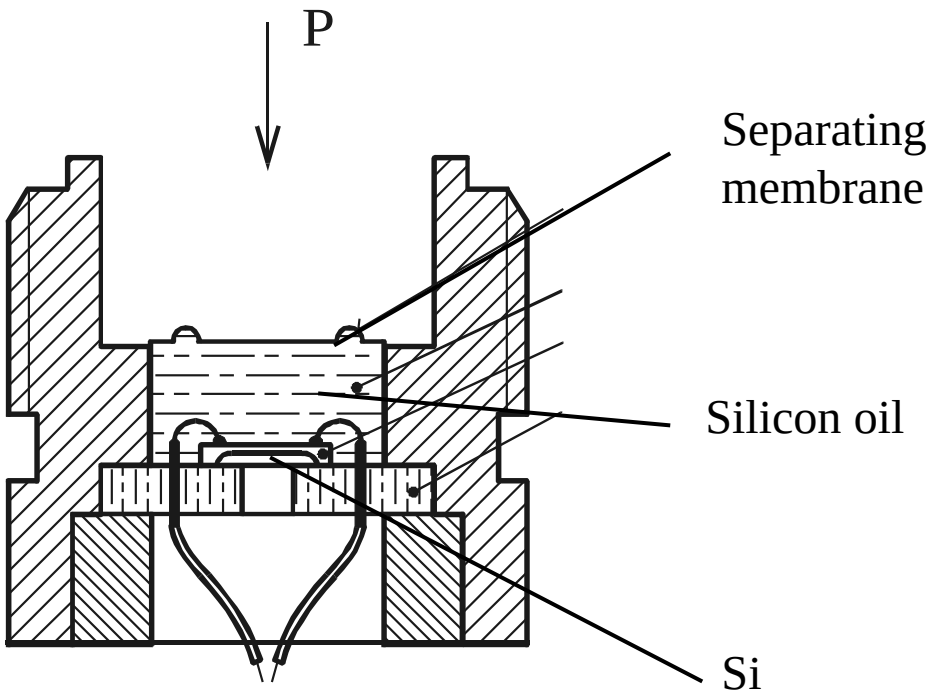


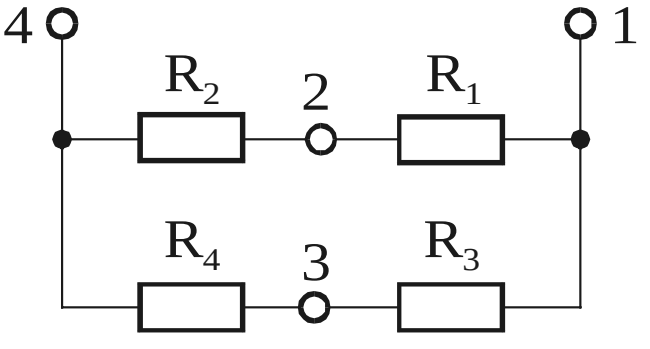
Immersible pressure sensors

-Measuring of liquid level
- separation membrane, hermetic cable





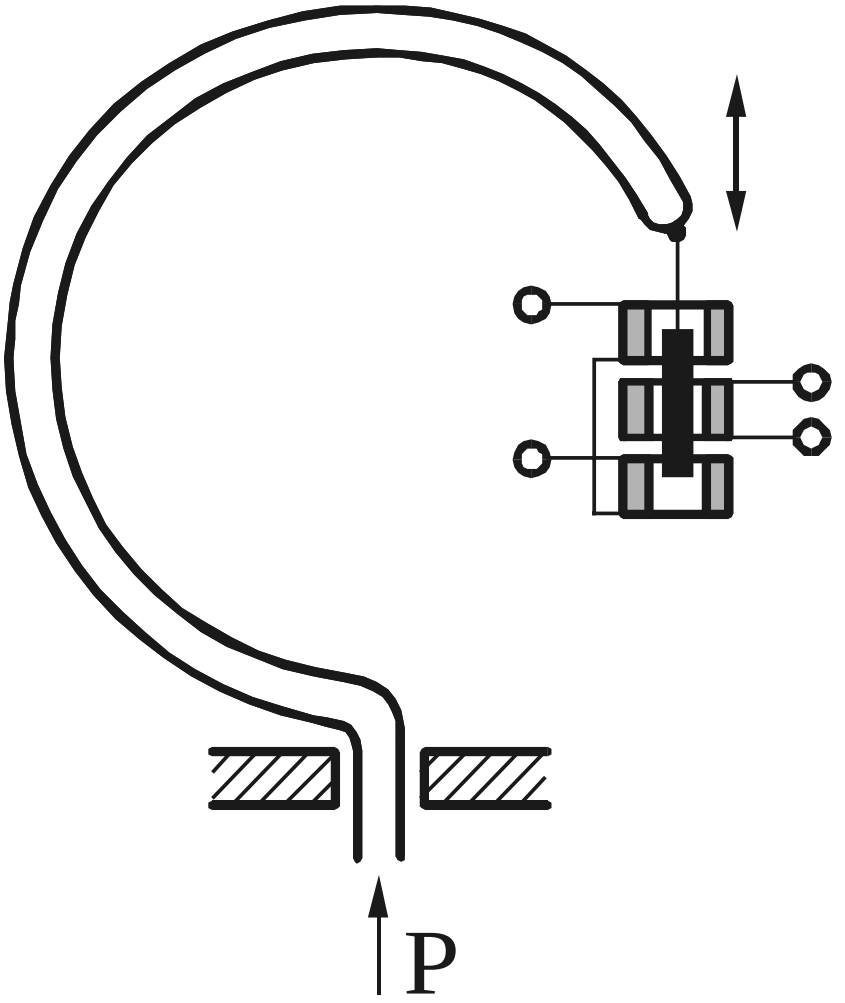


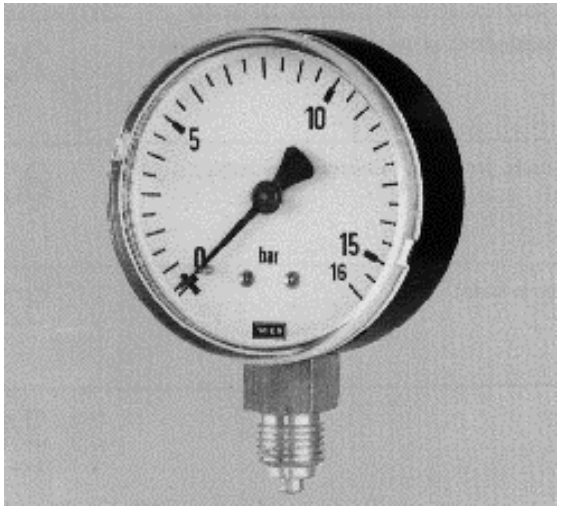


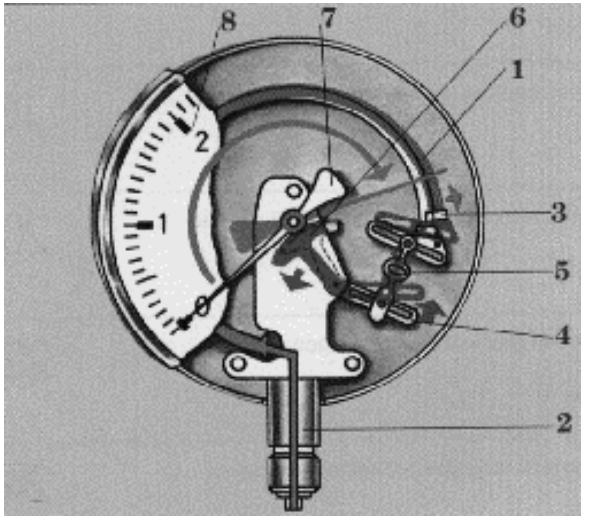
Membrane sensor with separating membrane

2. Deformation pressure sensors - tubes

Bourdon tube

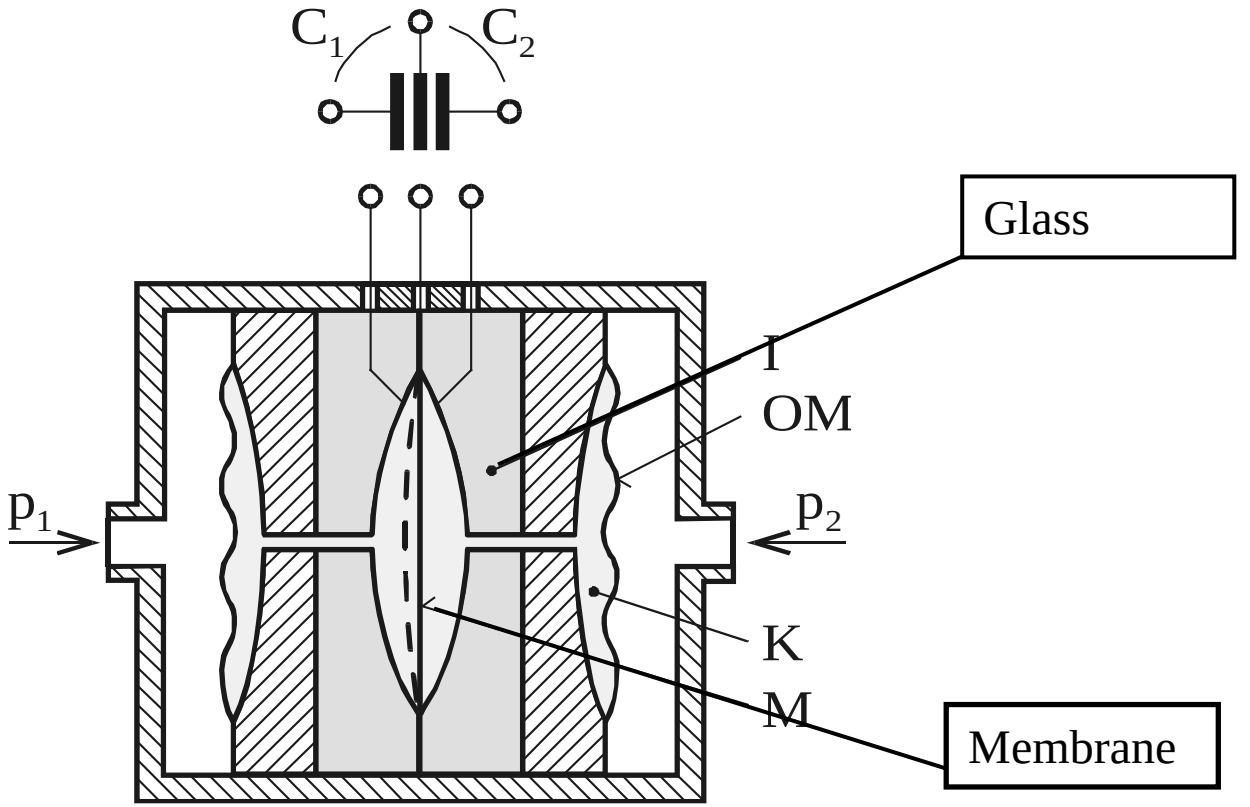






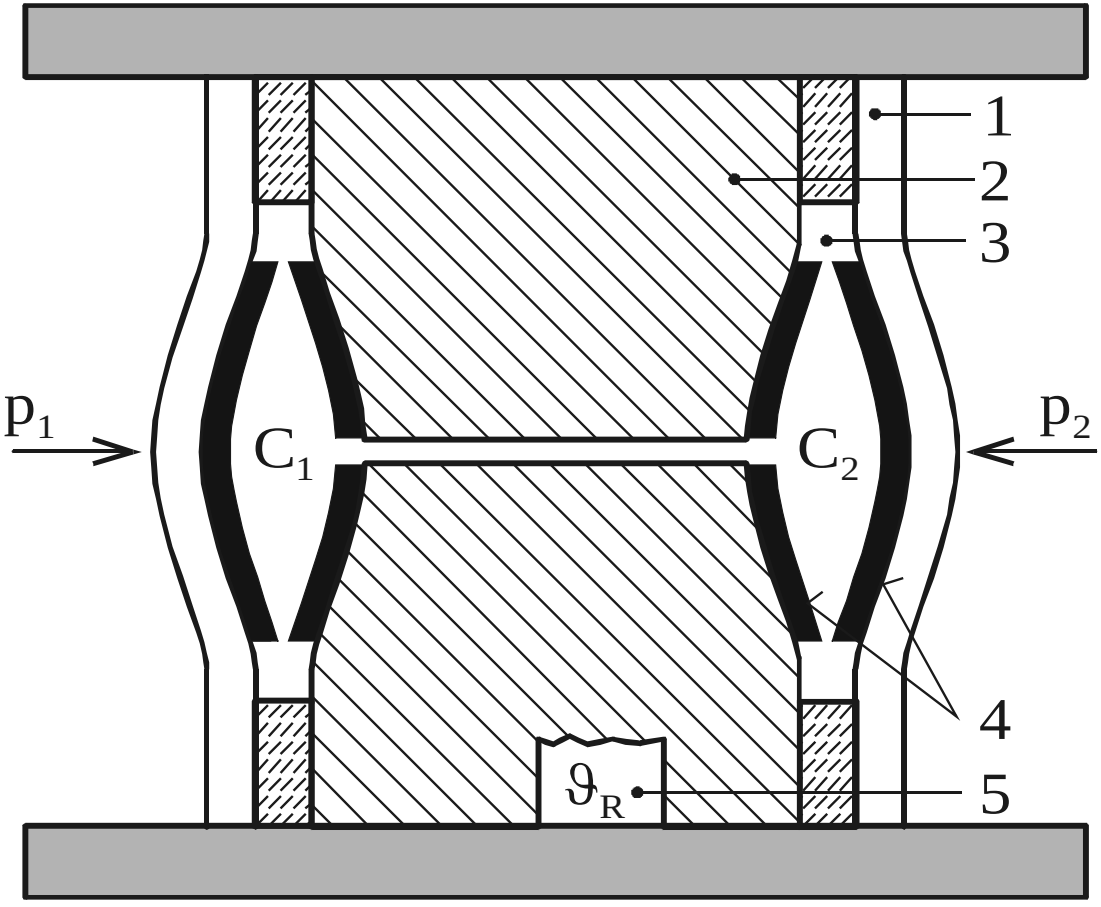
3. Capacitive pressure sensors

- capacitor – usually differential
-Deformation element = pre-strained metallic membrane – serves as grounded electrode
-Range: Δp = 1 mbar – 10 bar, total p up to 400 bar



Differential capacitor with separating liquid

Pressure sensor with ceramic membranes

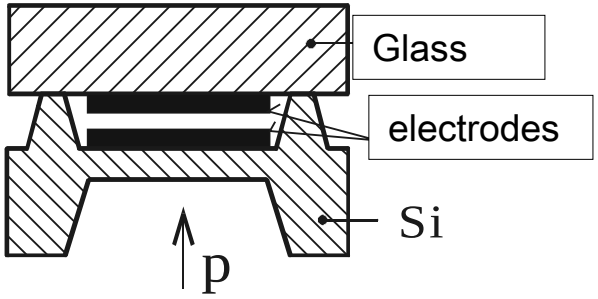


1- membrane
2 – central piece Al_2O_3
3 - hydraulic liquid
4 - electrodes
5 - temperature sensor

0,1 %, max. 350°C

Range 2,5 to 300 kPa

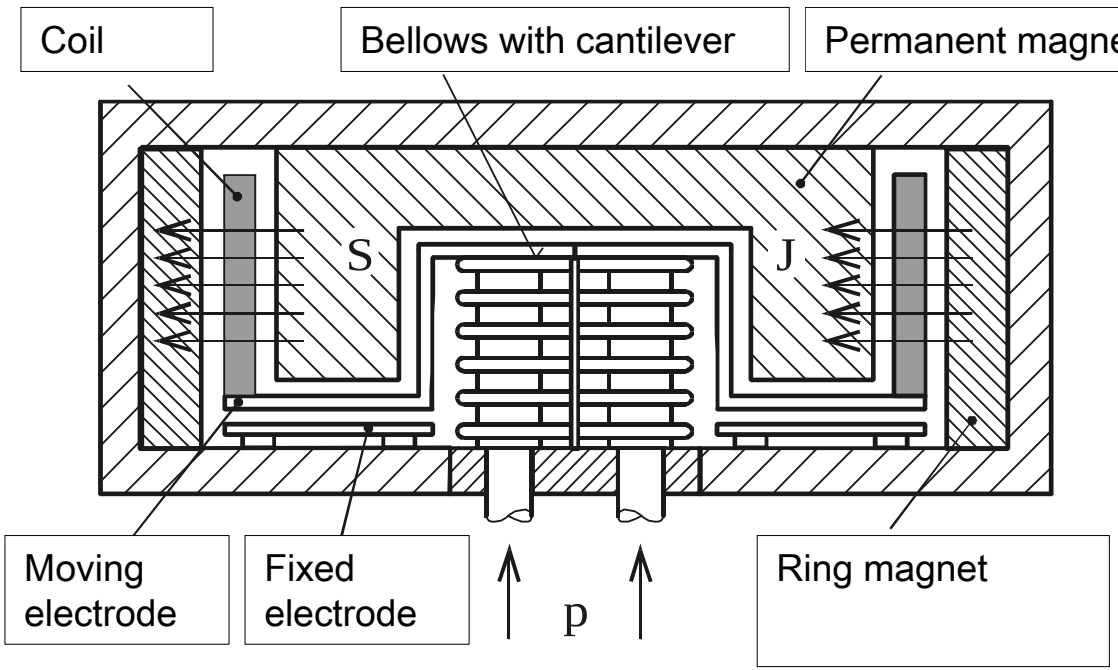
MEMS sensor



- combination of Si membrane and capacitive sensor

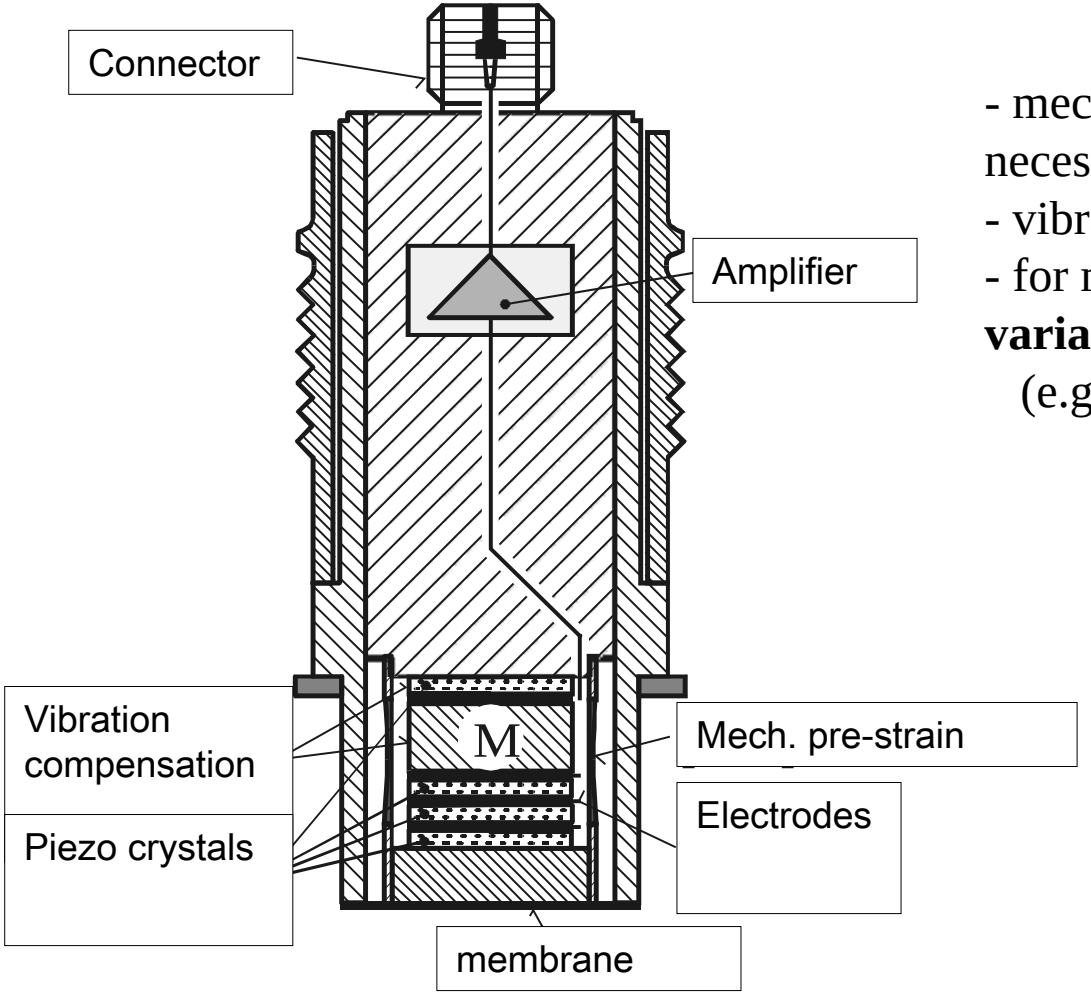
Feedback sensor with bellows

- returning membrane to idle position through electrostatic force
- range – up to 200 kPa



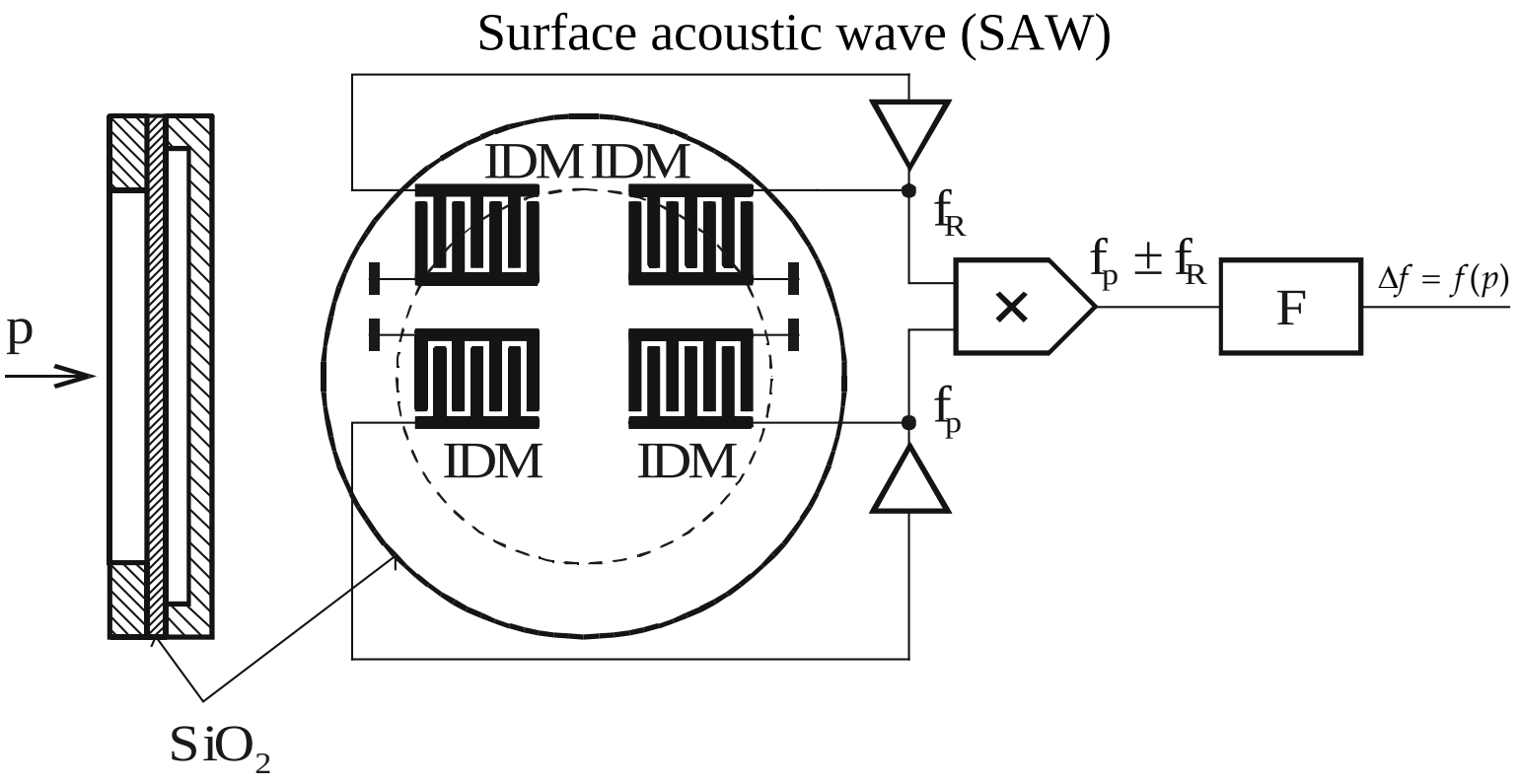
Very precise and expensive

4. Piezoelectric pressure sensor



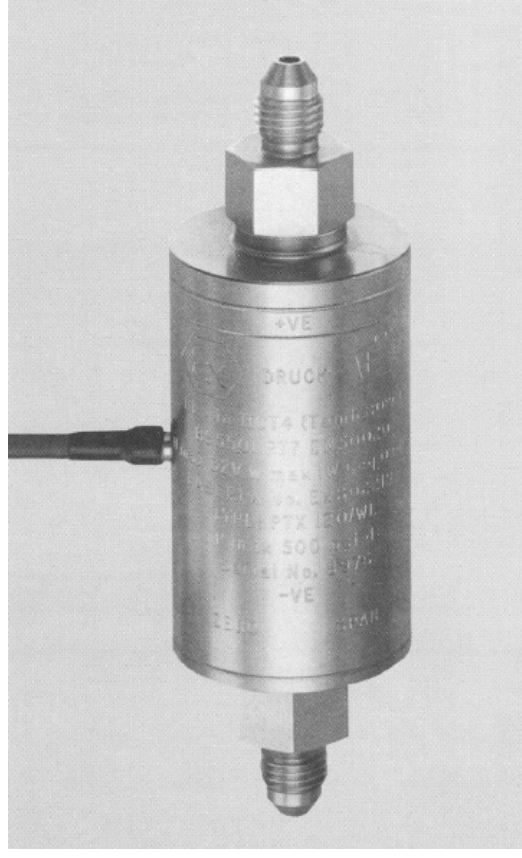
- mechanical pre-strain of crystal is necessary
- vibration compensating necessary
- for measuring **fast pressure variations**
  (e.g. engine pistons)

7. Resonant pressure sensors



Examples of pressure sensors

- (separating metallic membrane) Si measuring membrane, piezoresistors, (integrated amplifier):
  PTX 120
- Process pressure sensor: HART or current loop: Capacitive
  STX 2100
- Resonant sensor „double fork“



Cressto, Druck, Yokogawa,…

Sensors - Microsoft Internet Explorer
Soubor Úpravy Zobrazit Oblíbené Nástroje Nápověda
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Adresa http://www.druck.com/uk/sensors-new.htm Přejít

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Smart/HART® differential pressure transmitter

- Ranges from 3.75 mbar to 20 bar
- Accuracy ±0.1%
- 16:1 rangeabilty
- Line pressures up to 140 bar
- 2-wire 4-20mA with HART® protocol
- Robust and modular design
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At the heart of the instrument is a micro-capacitance silicon sensing element which floats remotely from the isolation diaphragr
Silicon has excellent mechanical properties, being perfectly free from hysteresis, and enables repeatability of better than 0.01%
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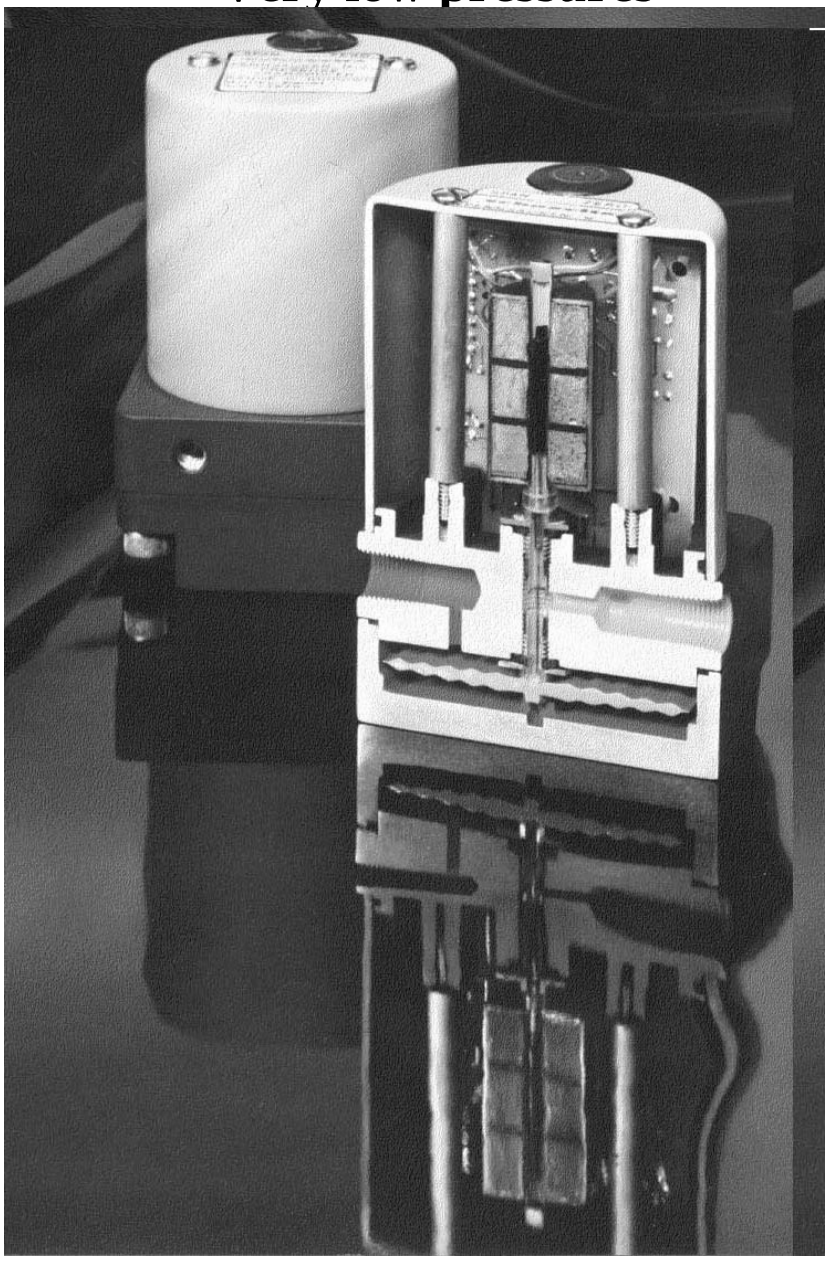
Very low pressures

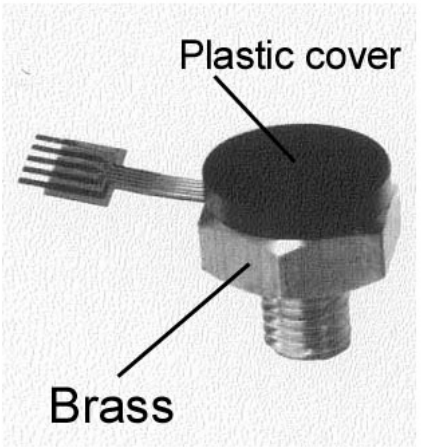
Principle: LVDT

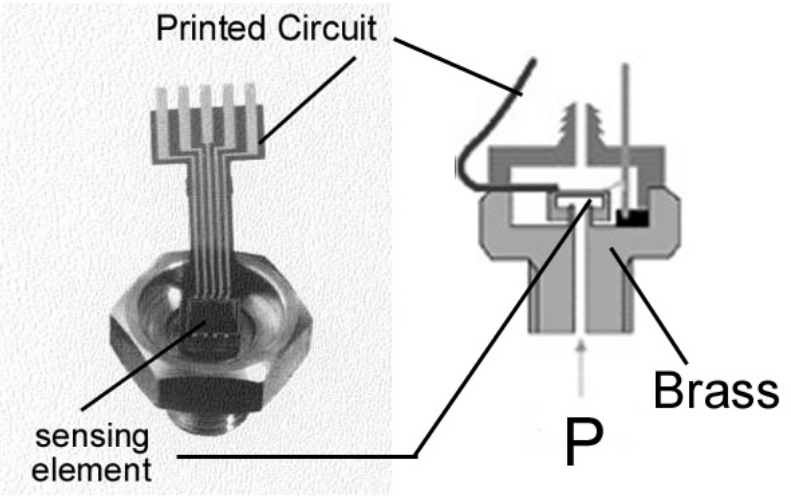


SCHAEVITZ

Piezoresistive pressure sensors

KELLER

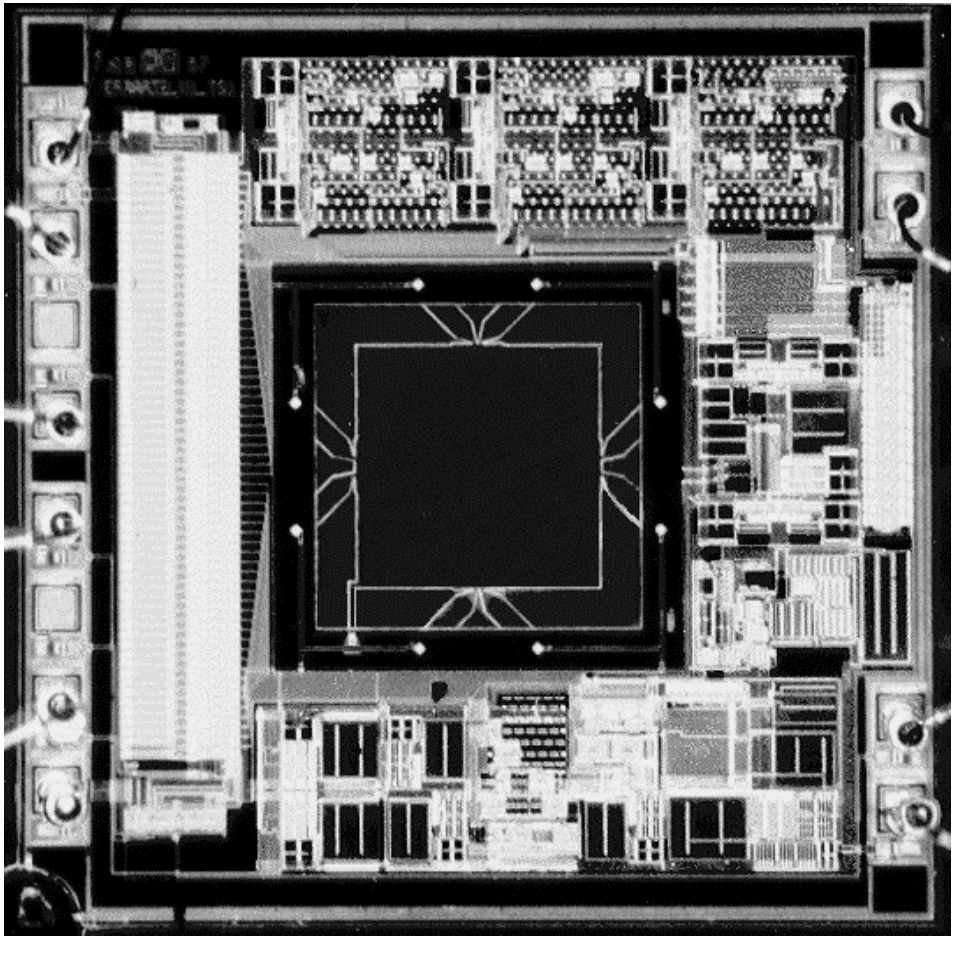




SPECIFICATIONS (at 4 mA excitation)	
Pressure Ranges (FS	1-20 bar
Linearity	0,25% FS typ. 1% FS max.
Stability	0,5 mV typ. 2 mV max.
Operating Temperature Range	-10…80°C (optionally)
Storage Temperature	-20…100°C
Temperature-Coefficients of…	
- Zero (without Comp.)	0,05 mV/K typ. 0,2 mV/K max.
- Sensitivity	0,01%/K typ. 0,02%/K max.

Integrated pressure sensors

- Pure CMOS based sensor
- calibrated to automotive specifications



SINGAPORE