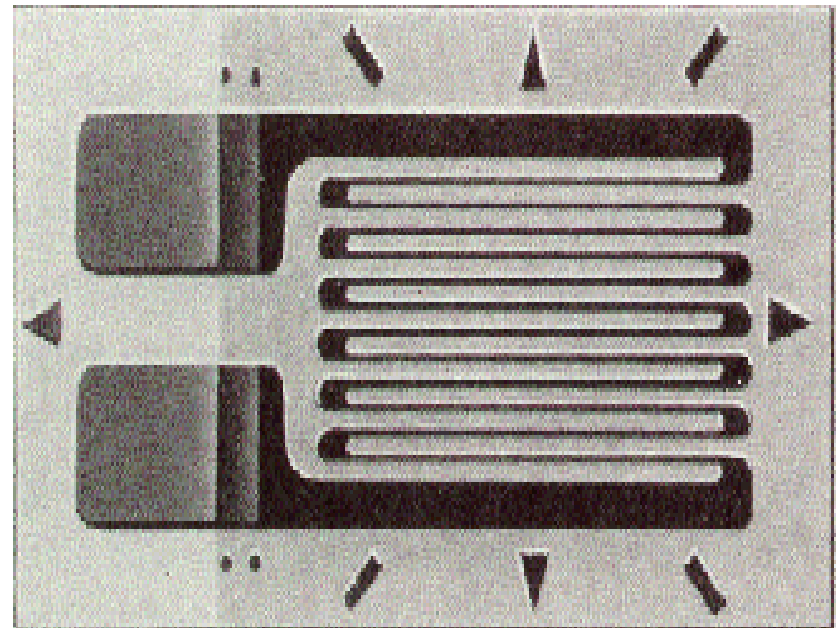# Rosette Strain Gages & Wheatstone Bridges

Jessica Goetz

Strain Gages

⌘ The most common type of strain gage is an electrical resistance strain gage

⌘ It measures strain based on the change in resistance of the wire as the object is strained
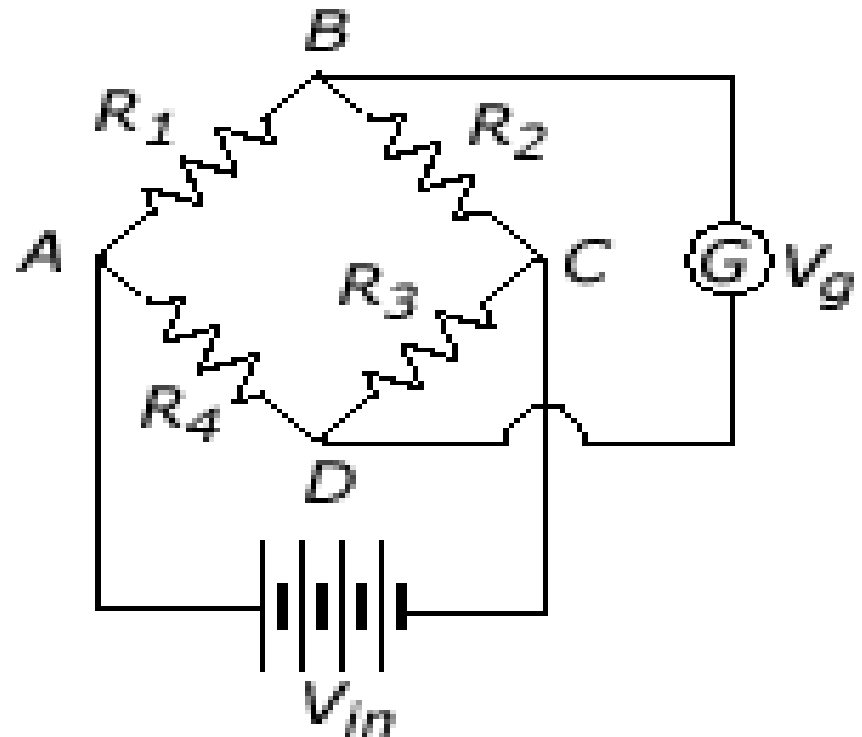
Strain Gages

⌘ When a wire is strained, the wire's resistance changes according to changes in the wire's diameter, length and resistivity

$$\text{⌘} R = \rho * L/A$$

Wheatstone Bridges

- The changes in resistance of the strain gages are most easily measured by a Wheatstone bridge

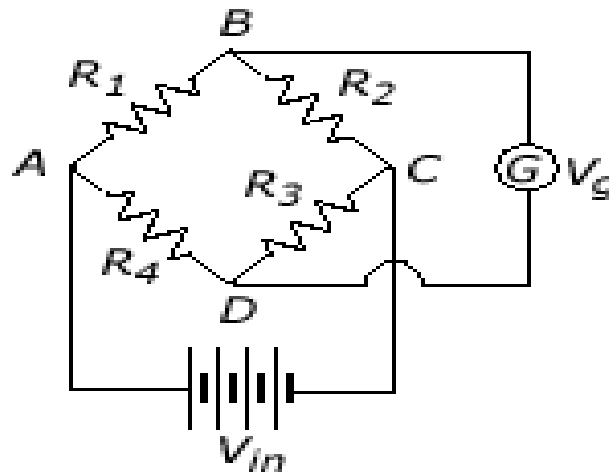- Determines the change in resistance by comparison to known resistances
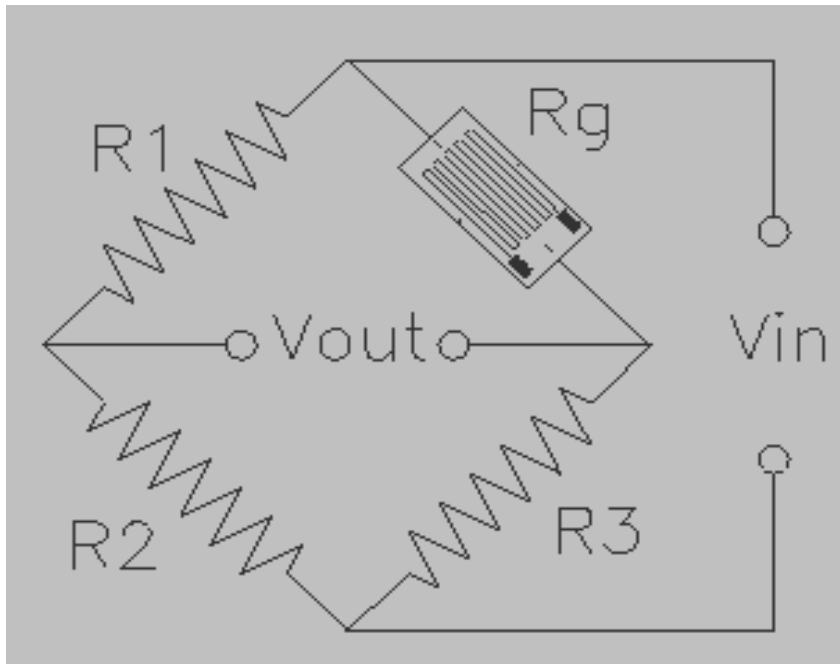
Wheatstone Bridges

⌘ Bridges are balanced when the voltage read across the middle of the circuit is zero

⌘ $R_1/R_2 = R_4/R_3$

⌘ Vg will read zero and the bridge will be balanced

Wheatstone Bridge

- A Wheatstone bridge is four resistors, a constant input voltage and a voltage gage
- Three of the four resistances are known and the fourth can be determined by balancing the bridge

Wheatstone Bridges

- Resistors in a Wheatstone bridge can be of variable resistance, such as a strain gage

- If the resistance in the strain gage changes, a voltage will develop across the Wheatstone bridge

- The measured voltage can be used to calculate the change in resistance in the strain gage and therefore the strain

$$V_g + \Delta V_g = \frac{(R_1 + \Delta R_1)\,(R_3 + \Delta R_3) - (R_2 + \Delta R_2)\,(R_4 + \Delta R_4)}{(R_1 + \Delta R_1 + R_2 + \Delta R_2)\,(R_4 + \Delta R_4 + R_3 + \Delta R_3)} * V_{in}$$

Rosette Strain Gages
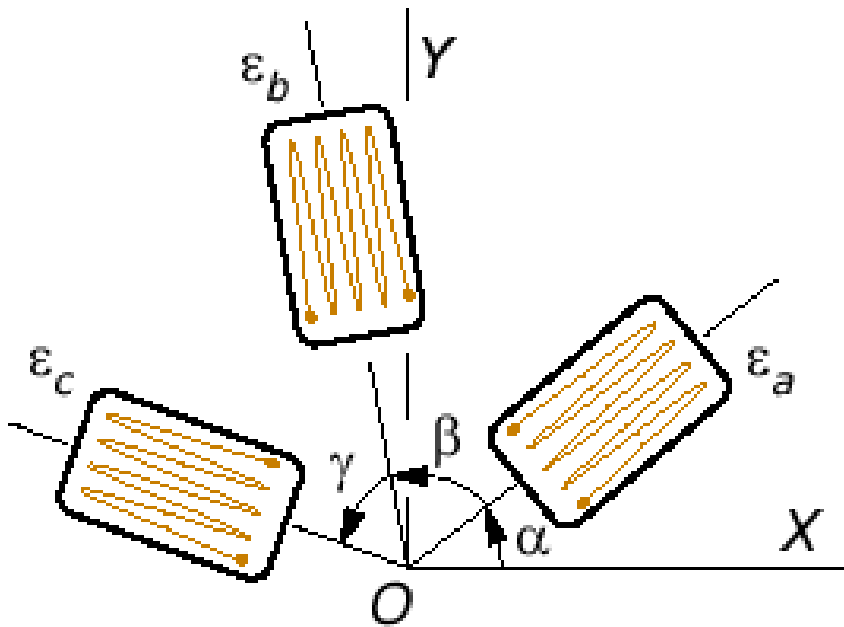
- A strain gage only measures strain in one direction
- To get principal strains, it is necessary to use a strain rosette
- A strain rosette is a cluster of 3 strain gages oriented at different angles

Rosette Strain Gauges

⌘ The set of equations relating rosette measured strains to principal strains are:

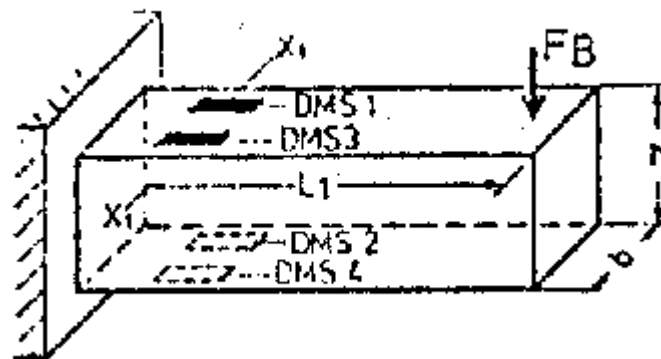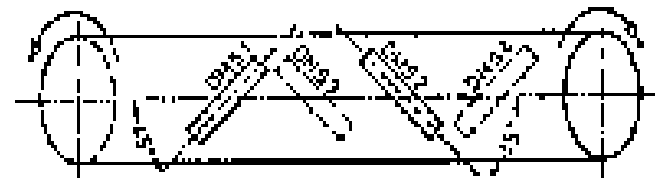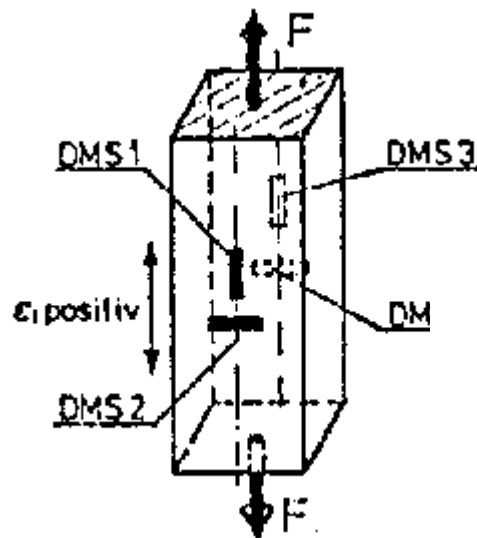⊠ $\varepsilon_a = \varepsilon_x \cos^2\theta_a + \varepsilon_y \sin^2\theta_a + \gamma_{xy}\sin\theta_a\cos\theta_a$

⊠ $\varepsilon_b = \varepsilon_x \cos^2\theta_b + \varepsilon_y \sin^2\theta_b + \gamma_{xy}\sin\theta_b\cos\theta_b$

⊠ $\varepsilon_c = \varepsilon_x \cos^2\theta_c + \varepsilon_y \sin^2\theta_c + \gamma_{xy}\sin\theta_c\cos\theta_c$

⊠ $\varepsilon_a, \varepsilon_b, \varepsilon_c$ are the strains measured by the individual strain gages in the rosette

Uses of Strain Gages

⌘ Strain gages attached to Wheatstone bridges can be used for measurement of tension, bending, and torsion

Uses of Strain Gages

- ⌘ In biomedical applications, strain gages can be used for determining forces in bones

- ⌘ Slightly modified strain gages can be used for muscle contraction and blood pressure measurement

References

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⌘ Hoffmann, Karl. "Applying the Wheatstone Bridge." Retrieved September 8, 2002 from the World Wide Web: http://www.gisc.co.kr/weigh/wheatstn.html.

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⌘ "Wheatstone Bridge Circuit." Retrieved August 29, 2002 from the World Wide Web: http://civil.colorado.edu/couseware/struct_labs/wheatstone.html.