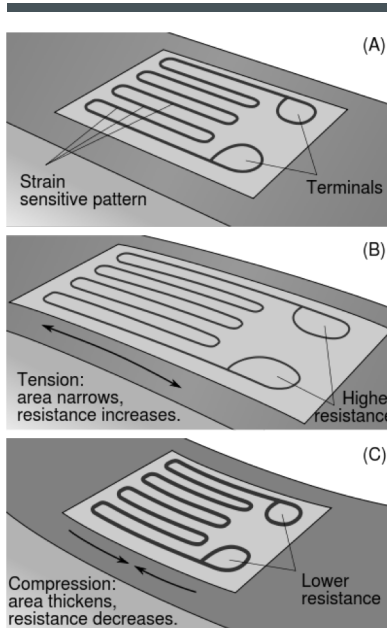


INSTRUMENTATION

FORCE AND TORQUE



STRAIN GAUGES

- Several different types with bonded resistance strain gauge being the most common
- Made of a grid of very small wires bonded to a small plastic film
- Resistance of this network varies linearly with strain and is measured with a Wheatstone bridge
- Low cost, small size, high accuracy
- Needs to be recalibrated to keep accurate

MEASUREMENTS

BENDING, AXIAL, SHEAR, AND TORSION

STRAIN IS A FUNCTION OF THE FORCE APPLIED, GEOMETRY, AND A MATERIALS PROPERTIES

| Stress | Equation |
|-------------------------|--|
| Bending Stress | $\sigma_{bending} = \frac{M * c}{I}$ |
| Axial Stress | $\sigma_{axial} = \frac{F_{axial}}{A}$ |
| Transverse Shear Stress | $\tau_{transverse} = \frac{F_{transverse}}{A_{shear}}$ |
| Torsional Shear Stress | $\tau_{torsion} = \frac{T * c}{J}$ |

| | |
|------------------|---|
| Bending strain | $\epsilon_{bending} = \sigma_{bending}/E$ |
| Axial strain | $\epsilon_{axial} = \sigma_{axial}/E$ |
| Shear strain | $\gamma = \tau_{shear}/G$ |
| Torsional strain | $\gamma = \tau_{torsion}/G$ |

APPLICATIONS

- Mechanical- Measure deflection or deformations in parts.
- Civil- Monitor loadings in bridges, dams and other structures
- Biological- Blood flow and tissue swelling

LOAD CELLS

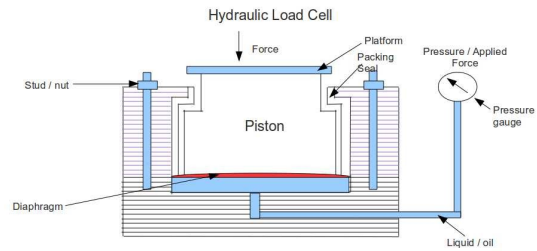


- Types of transducers that convert force into measurable output.
- Used in fields demanding high accuracy and precision.
- Typically measure mechanical force of objects.

TYPES

Different classes of load cells, based on type of signal generated

- Hydraulic
 - Accuracy within 0.25% or better.
 - Measure change in pressure of internal fluid.
 - Good for hazardous areas and can take high impacts (up to 5000 tons)

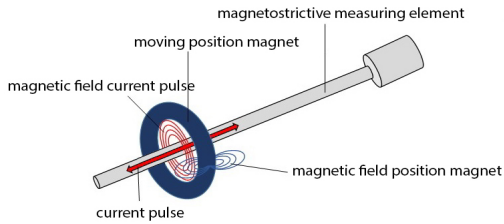
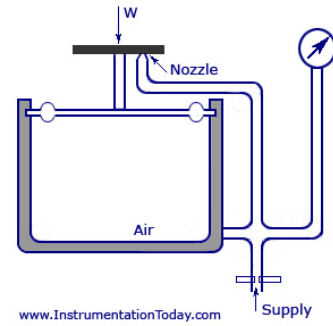


TYPES

- Pneumatic
 - Multiple chambers for higher accuracy than hydraulic cells.
 - Inherently explosion proof.
 - Safe for areas where cleanliness is needed.
- Electric
 - Typically measure fluctuations in electric field that are proportional to the load.
 - Many types: strain gauge load cell, piezoresistive load cell, inductive load cell, magnetostrictive load cell.



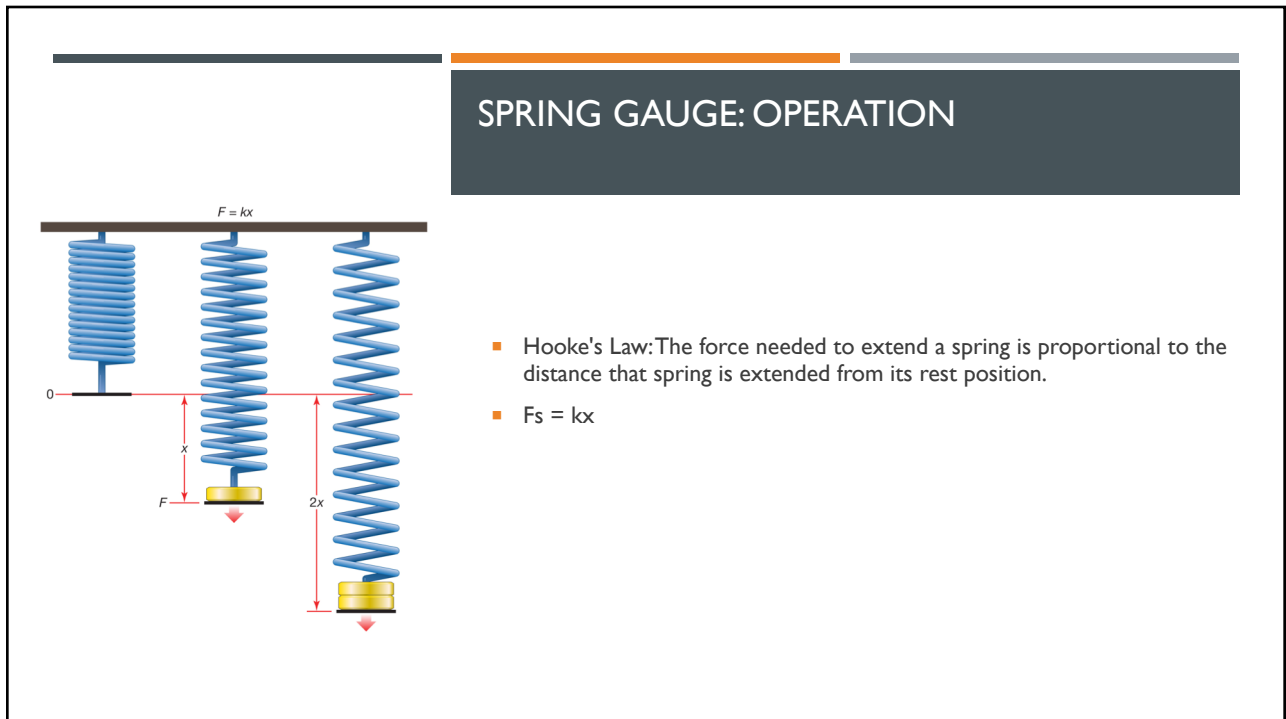
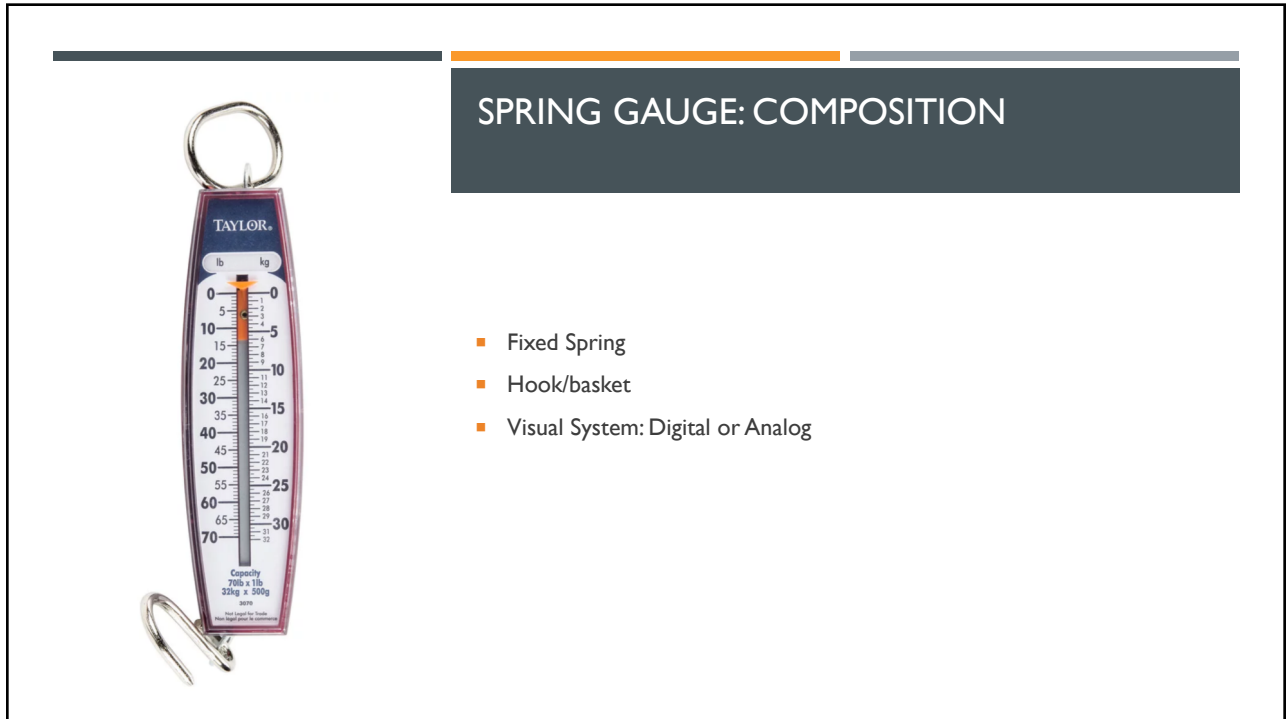
Pneumatic Load Cell



SPRING GAUGE



- Spring Scale
- Spring Balance
- Newton Meter



SPRING GAUGE: VARIETY



SPRING GAUGE: USE



- Weight
- Cheap Accelerometer

SPRING GAUGE: PROS AND CONS



- Pros: Cheap, simple, and robust
- Cons: Not as accurate as other measuring methods



QUESTIONS

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