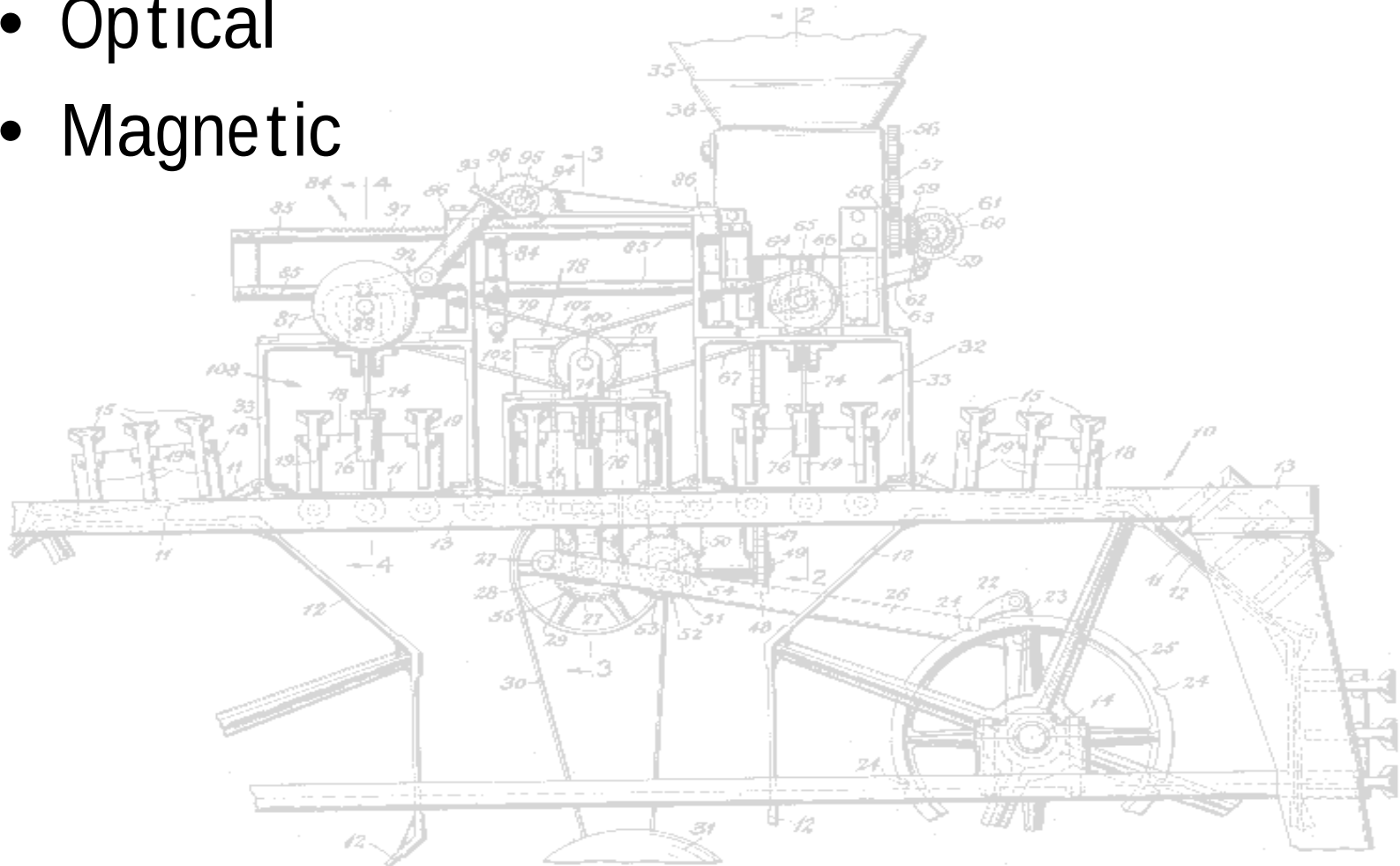
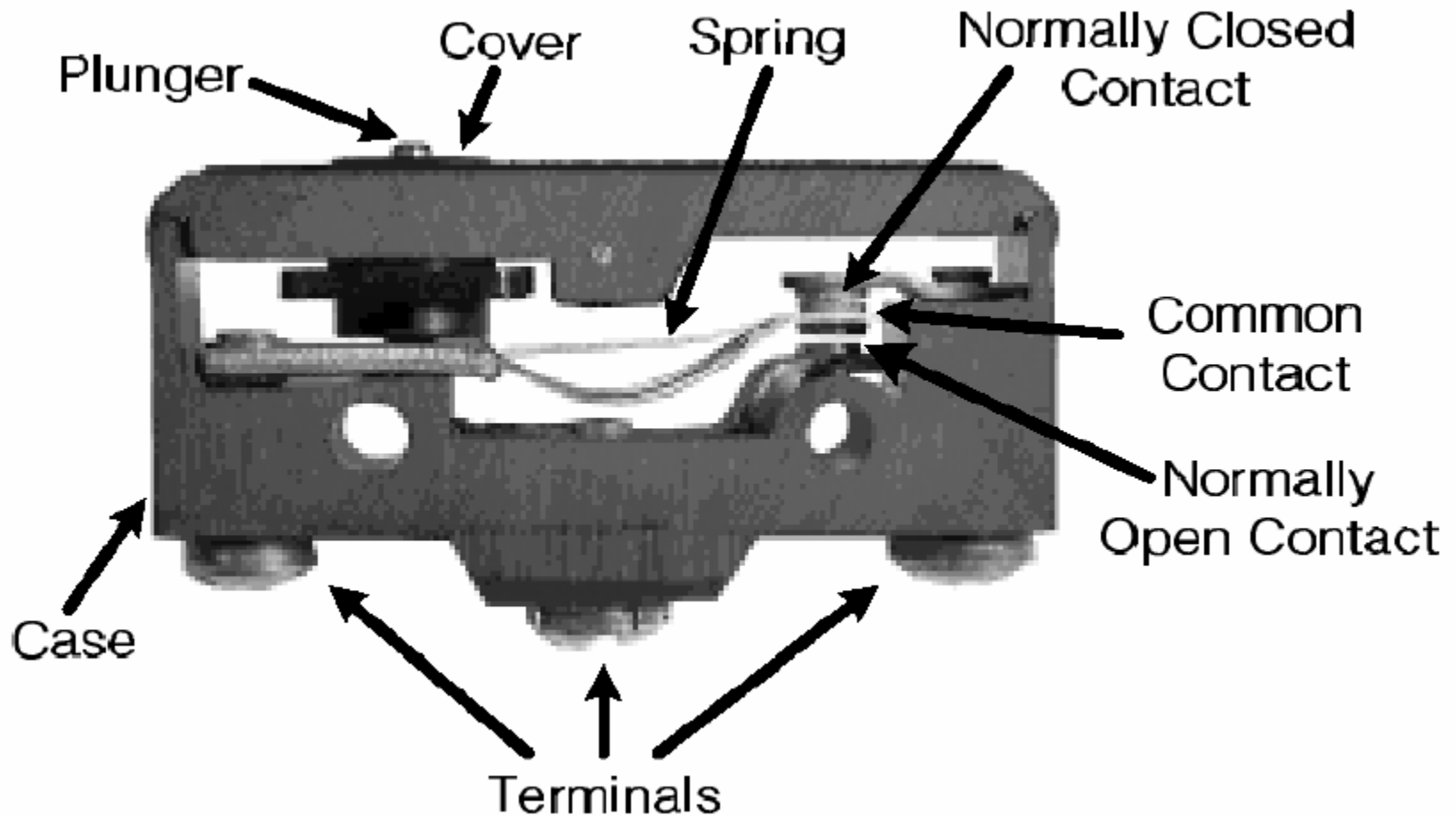


Position Sensing

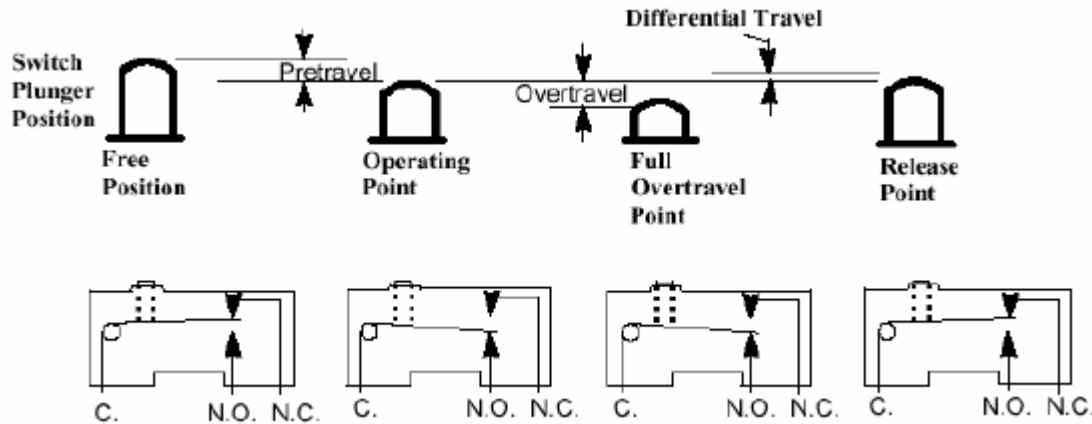
- Mechanical
- Optical
- Magnetic



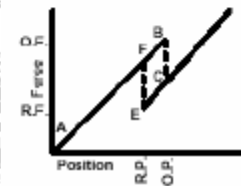
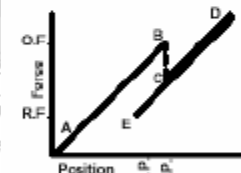
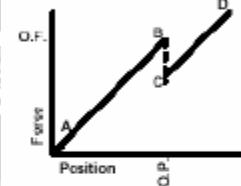
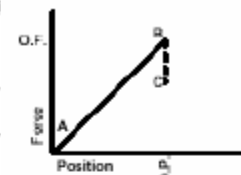
Mechanical Sensing - Microswitch



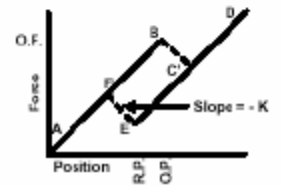
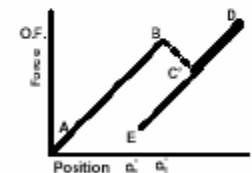
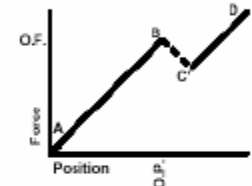
Microswitch Operation



With Rigid Actuating Device



With Resilient Actuating Device Having Spring Rate K

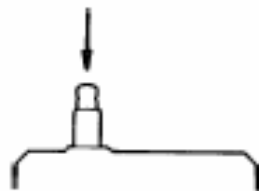


Switch exhibits mechanical hysteresis.

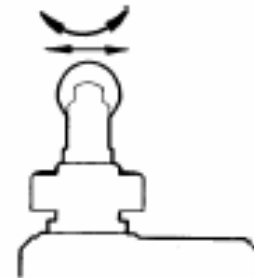
Microswitch Actuators



Pin plunger; in-line motion



Overtravel plunger; in-line applications requiring additional overtravel



Added overtravel in a panel mount roller plunger; Actuation by cams



Leaf; Low-force, slow moving cams or slides



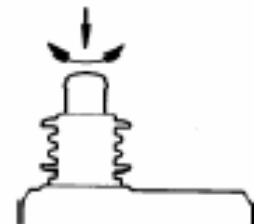
Roller lever; Very low force, fast moving cams



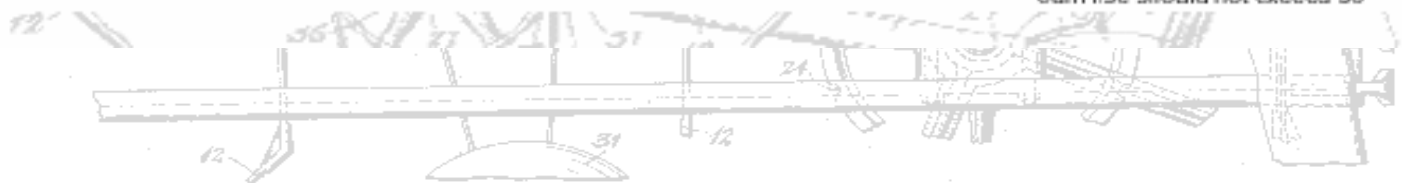
Roller leaf; Low force, large movement actuation



Lever; Very low force, slow cams and slides

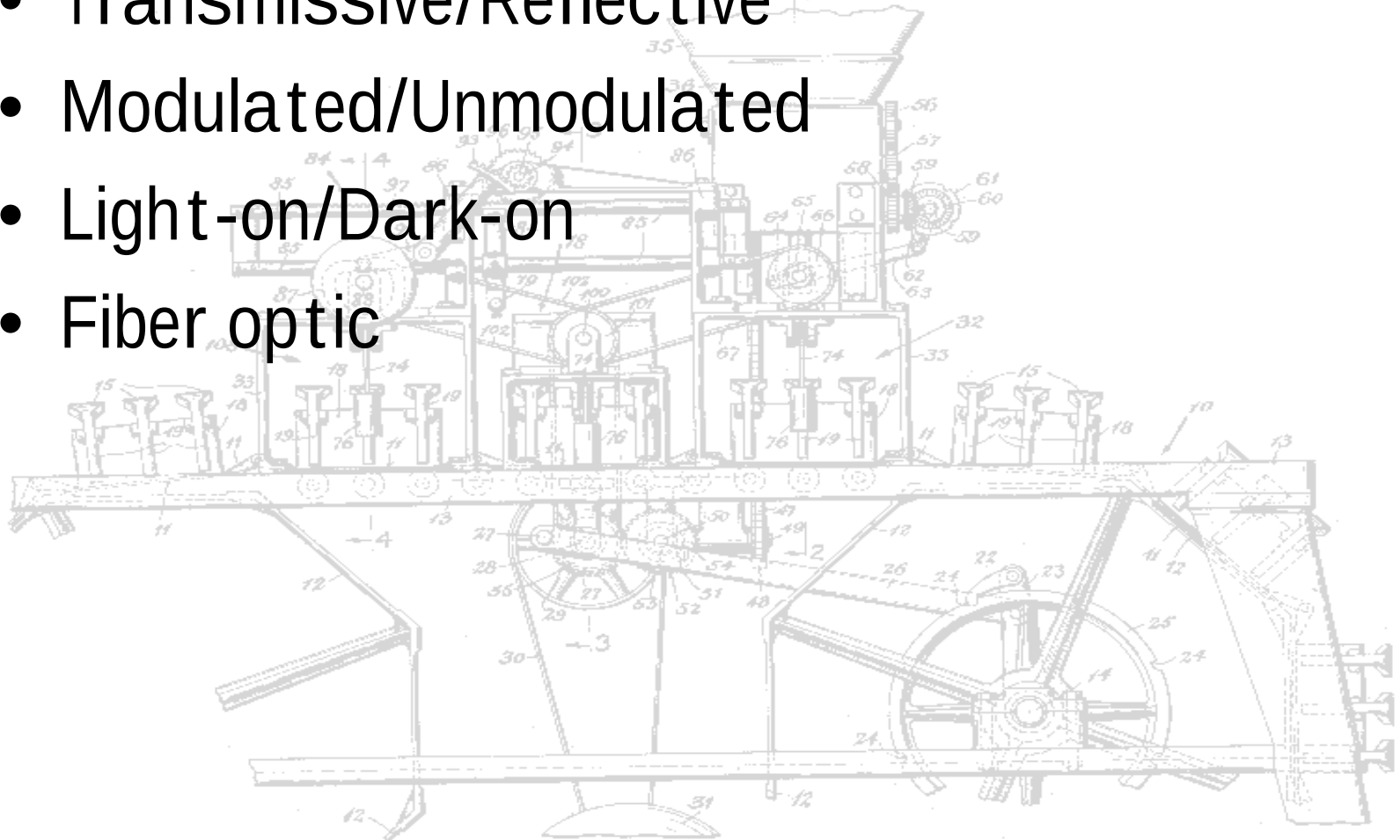


Added overtravel in a panel-mount plunger; Heavy-duty in-line applications or slow cams. Cam rise should not exceed 30°



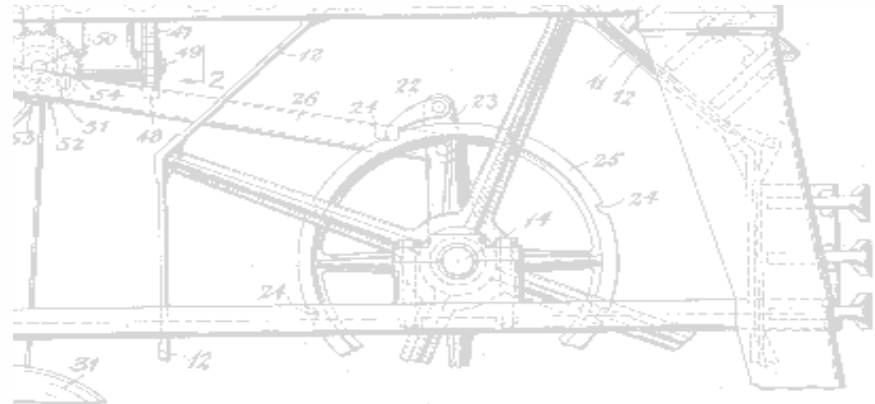
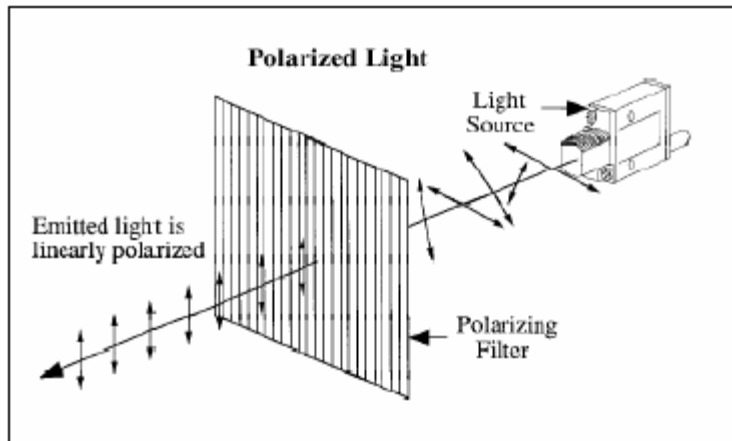
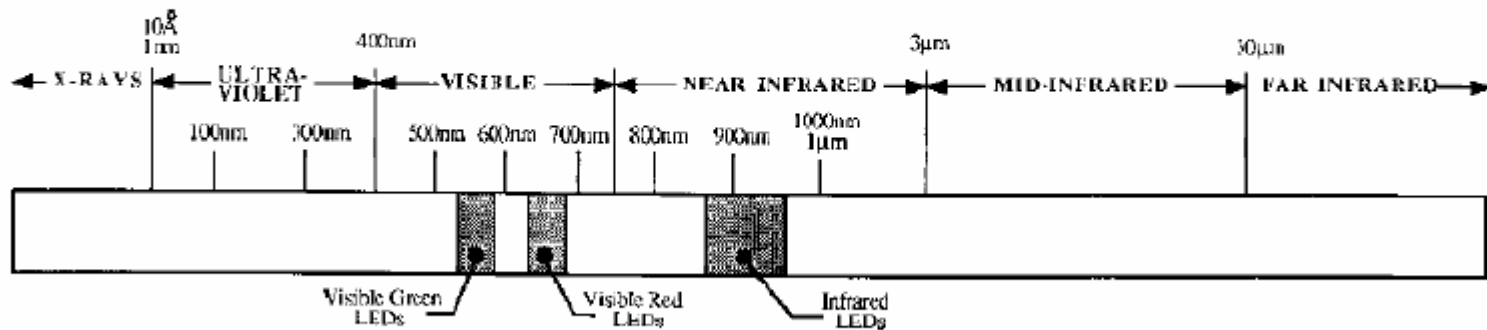
Optical Sensing

- LED's and Photodiodes
- Transmissive/Reflective
- Modulated/Unmodulated
- Light-on/Dark-on
- Fiber optic



LED and Photodiode Characteristics

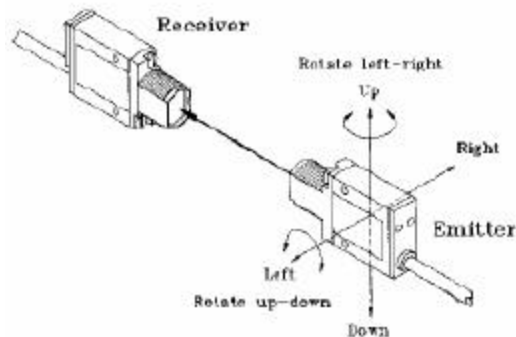
Wavelengths of Commonly-used Light Emitting Diodes (LEDs)



Transmissive & Reflective Sensors

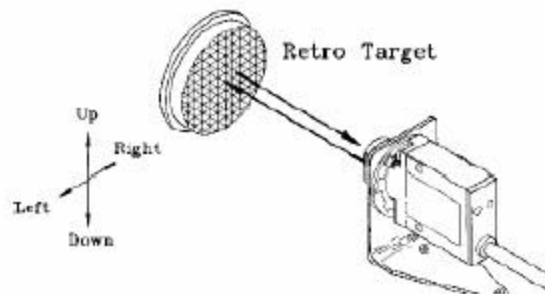
Opposed Mode Alignment

Opposed Mode Alignment: Move Emitter or Receiver Up-Down, Left-Right, and Rotate



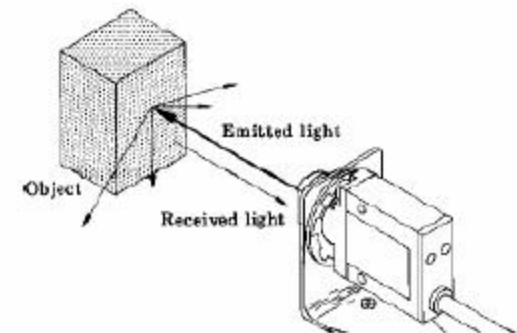
Retroreflective Mode Alignment

Retroreflective Mode Alignment: Move Target Up-Down, Left-Right

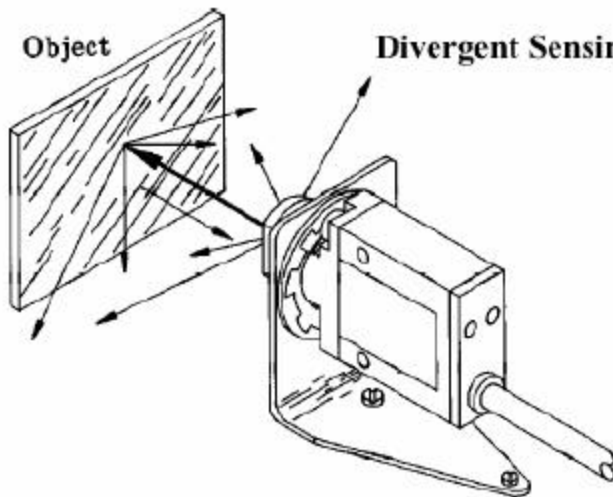


Proximity (Diffuse) Mode Alignment

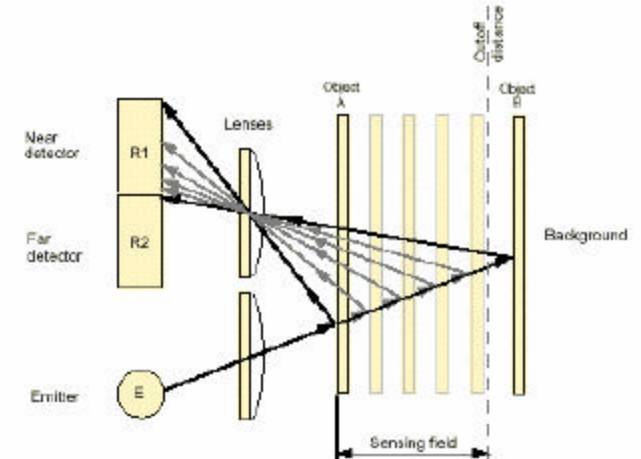
Diffuse Mode Alignment: Rotate Up-Down, Left-Right



Object Divergent Sensing Mode



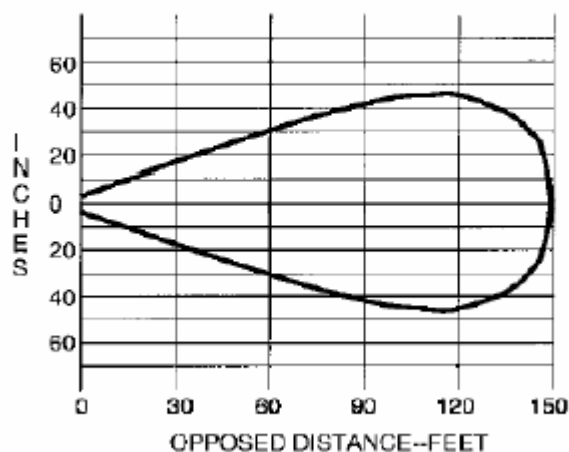
Fixed-field Diffuse Sensing



Object is sensed if amount of light at R1 is greater than the amount of light at R2

Beam Pattern and Reflectance

Typical Beam Pattern

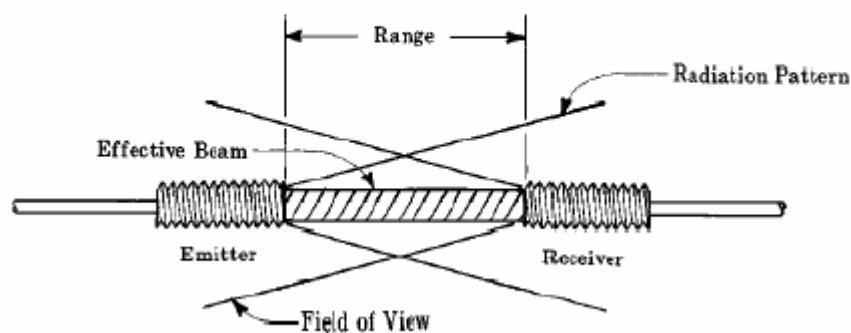


RELATIVE REFLECTIVITY TABLE

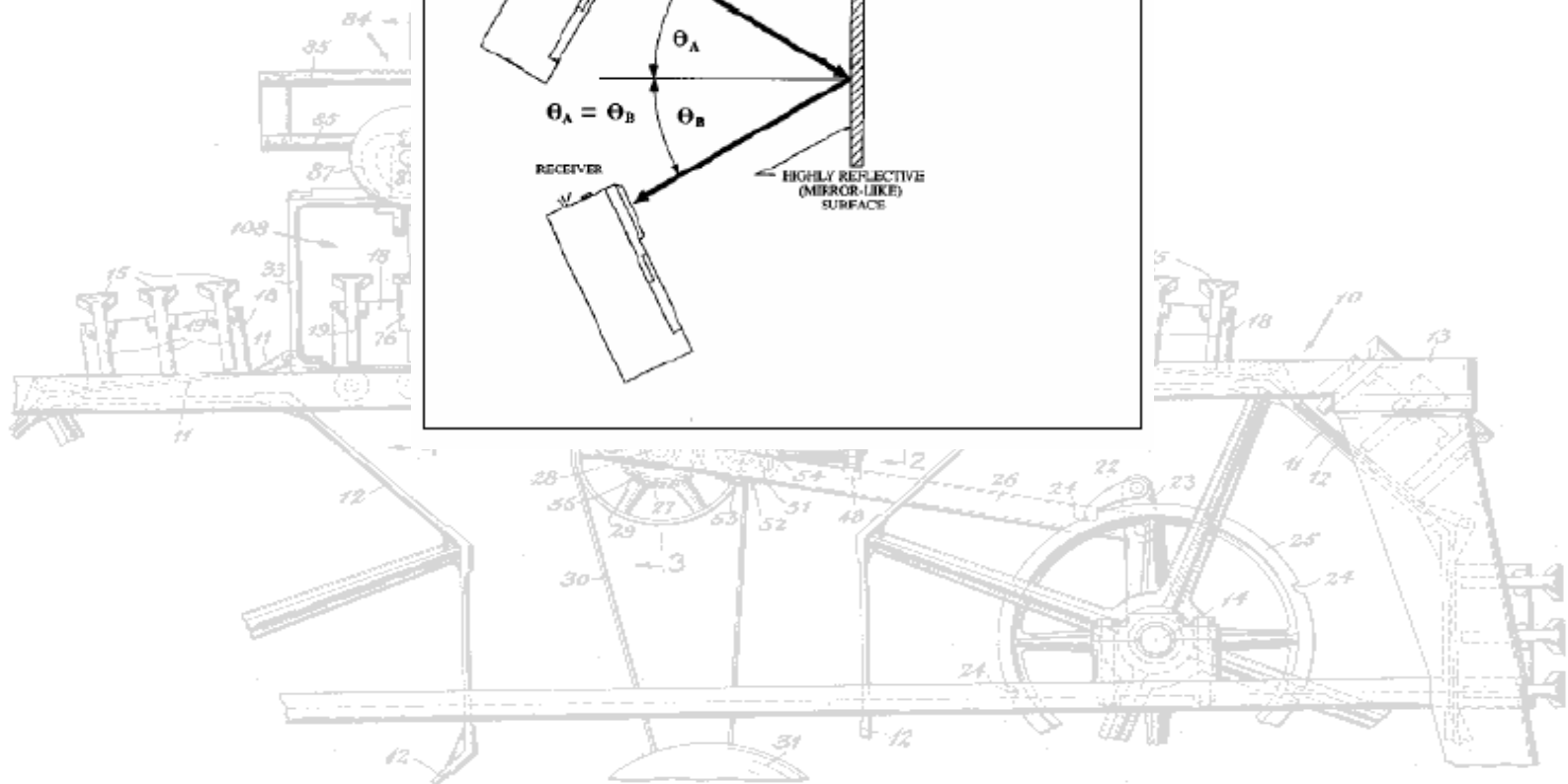
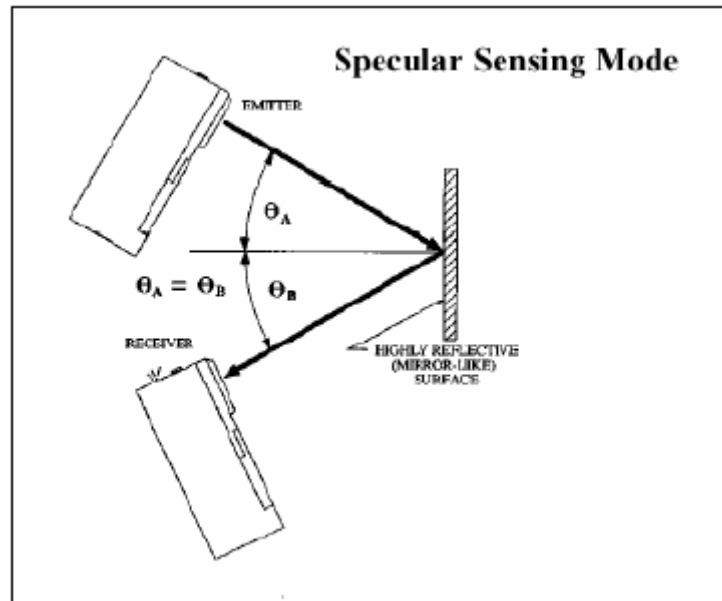
<u>Material</u>	<u>Reflectivity (%)</u>	<u>Excess Gain Required</u>
Kodak white test card	90%	1
White paper	80%	1.1
Masking tape	75%	1.2
Beer foam	70%	1.3
Clear Plastic*	40%	2.3
Rough wood pallet (clean)	20%	4.5
Black neoprene	4%	22.5
Natural aluminum, unfinished*	140%	0.6
Stainless steel, microfinish	400%	0.2
Black anodized aluminum*	50%	1.8

*NOTE: For materials with shiny or glossy surfaces, the reflectivity figure represents the maximum light return, with the sensor beam exactly perpendicular to the material surface

Effective Beam

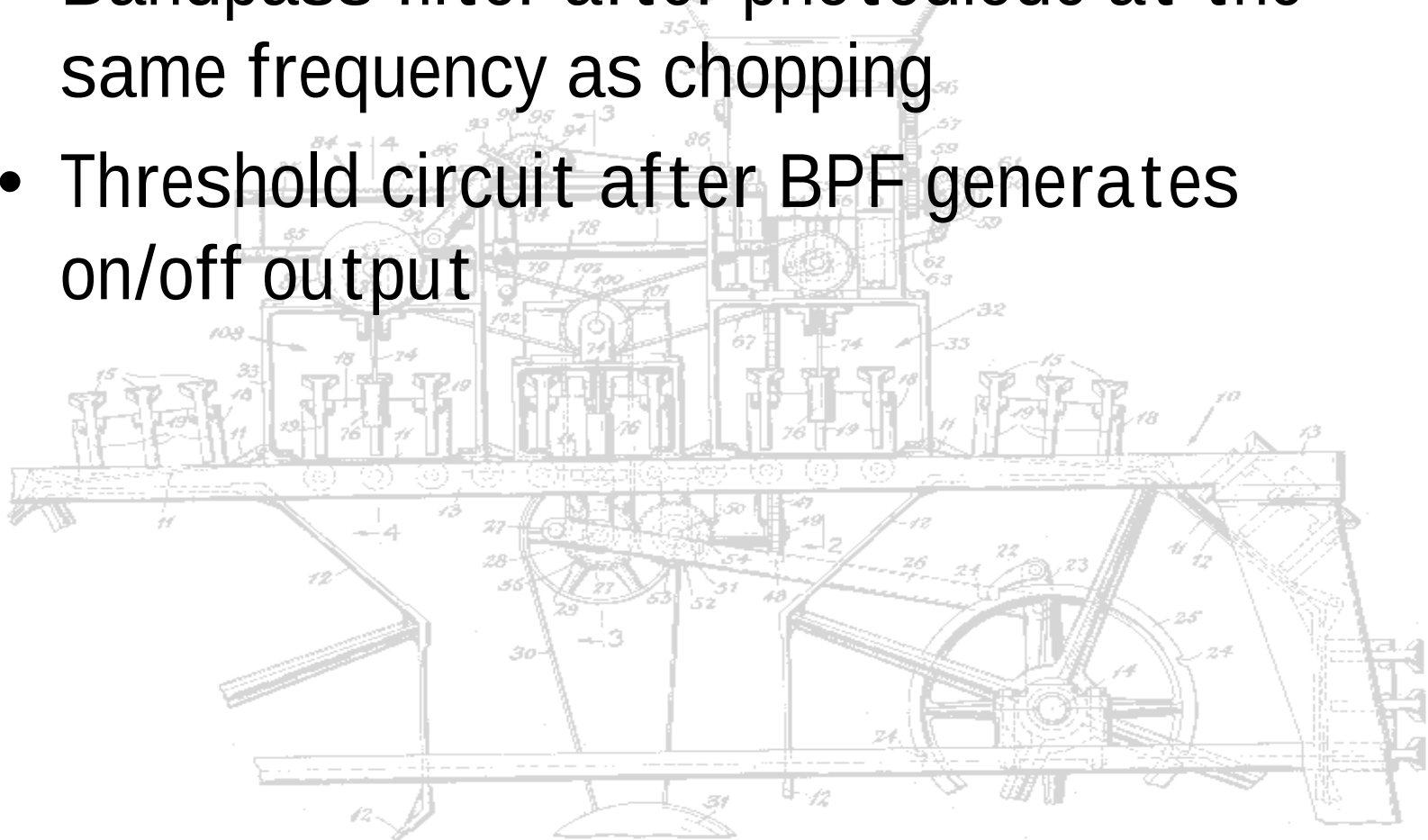


Specular Reflection



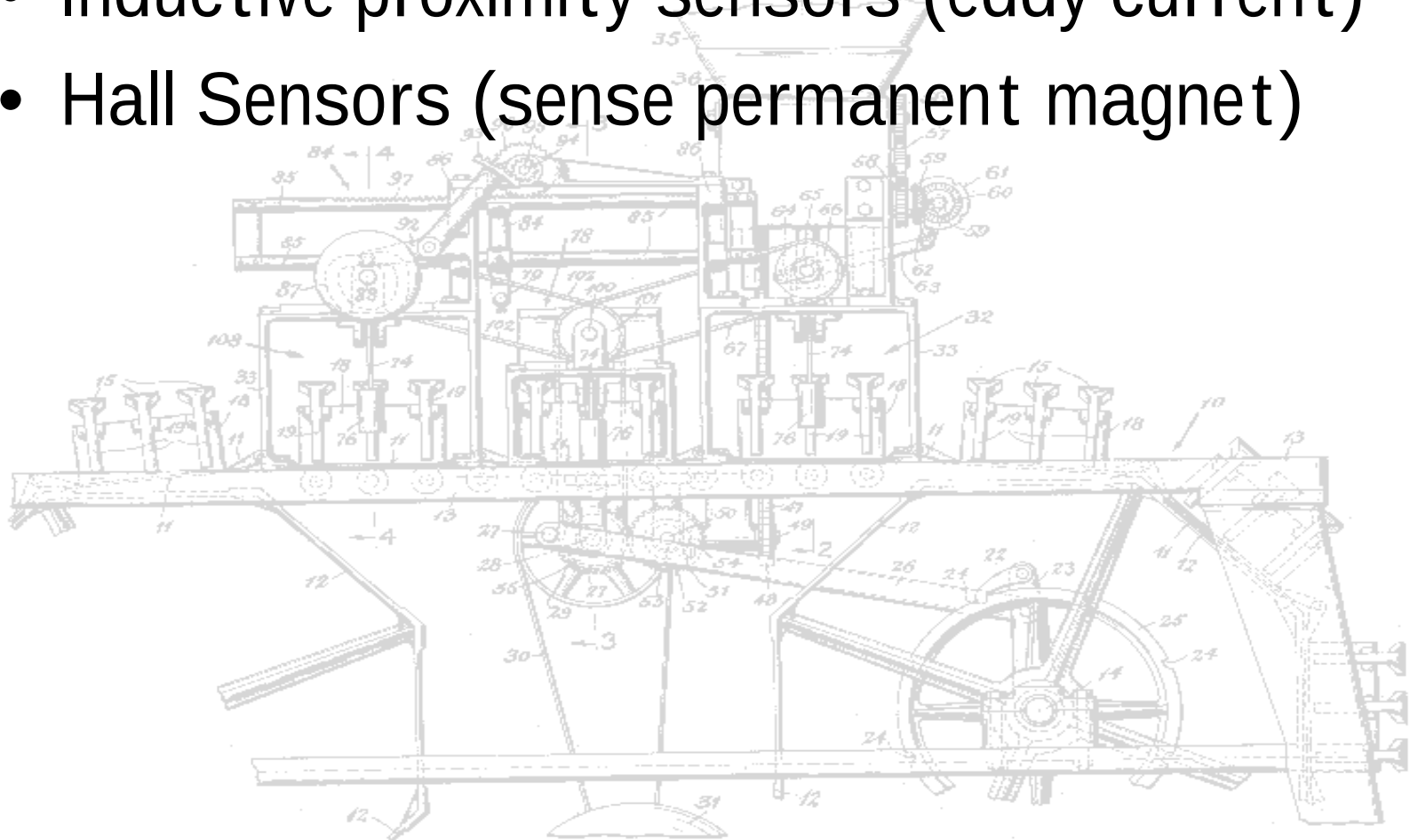
Modulation

- “Chop” LED on and off at many kHz rate
- Bandpass filter after photodiode at the same frequency as chopping
- Threshold circuit after BPF generates on/off output

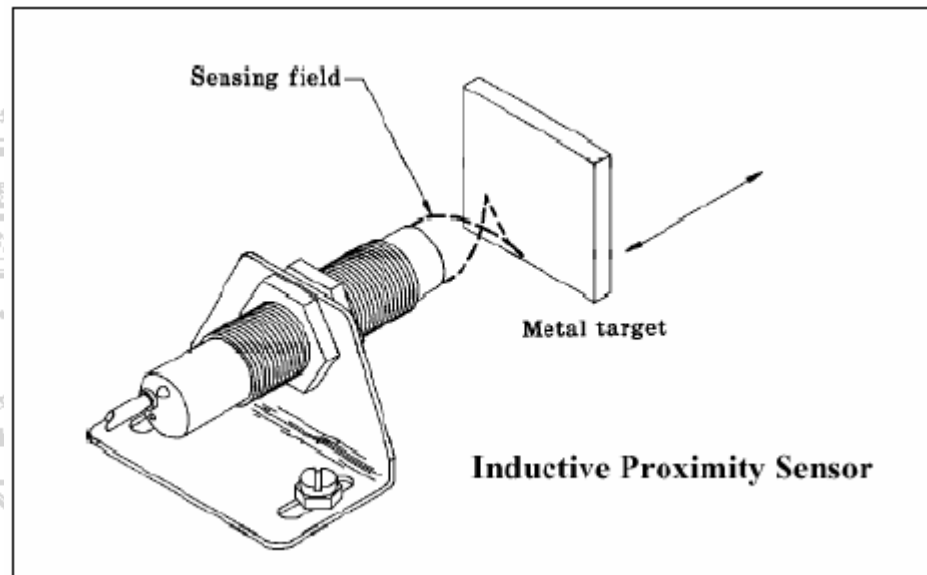


Magnetic Position Sensors

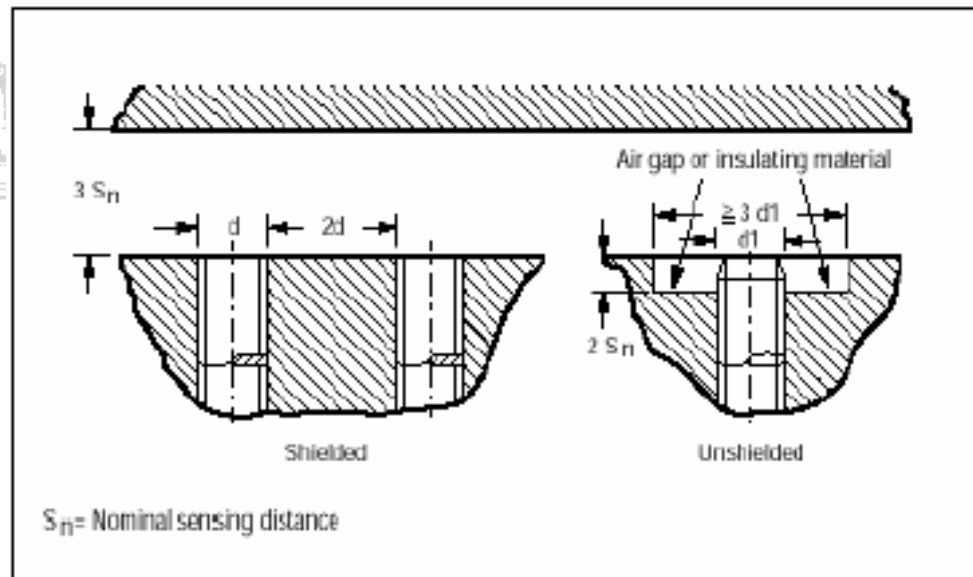
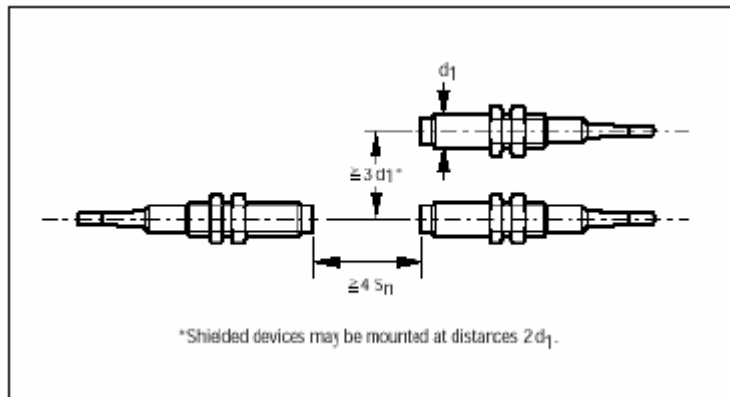
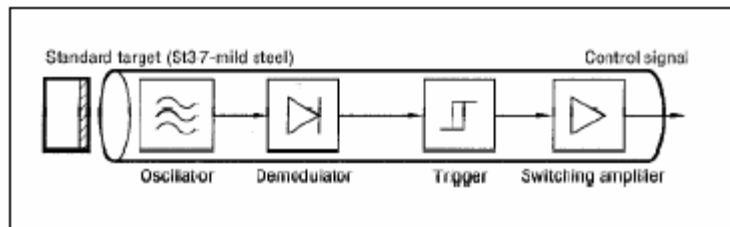
- Reed switches (sense permanent magnet)
- Inductive proximity sensors (eddy current)
- Hall Sensors (sense permanent magnet)



Inductive Proximity Sensor



Inductive Proximity Sensors



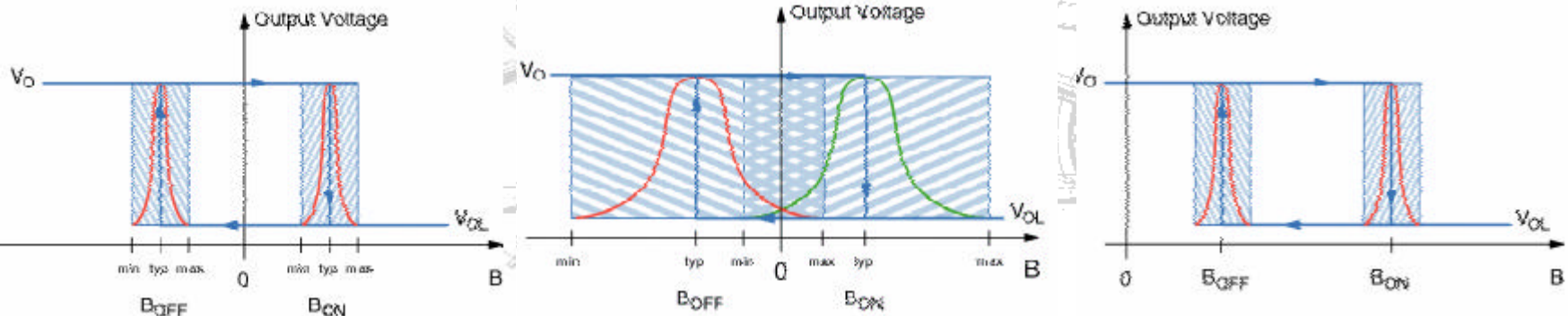
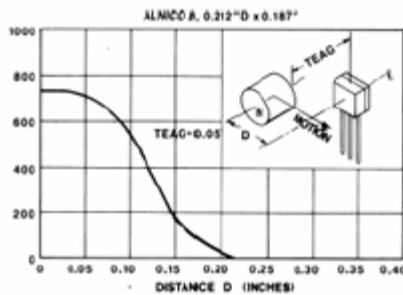
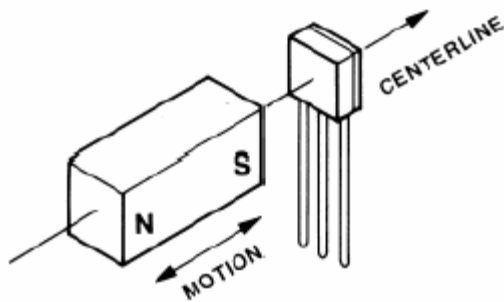
Hall Sensors

- Hall effect:
 - constant voltage forces a constant current in semiconductor sheet
 - magnetic field flux lines perpendicular to current cause proportional voltage across sheet.
 - discovered by E.F.Hall in 1879
- Linear sensor needs voltage regulator and amplifier
- Switch also needs threshold circuit, with hysteresis



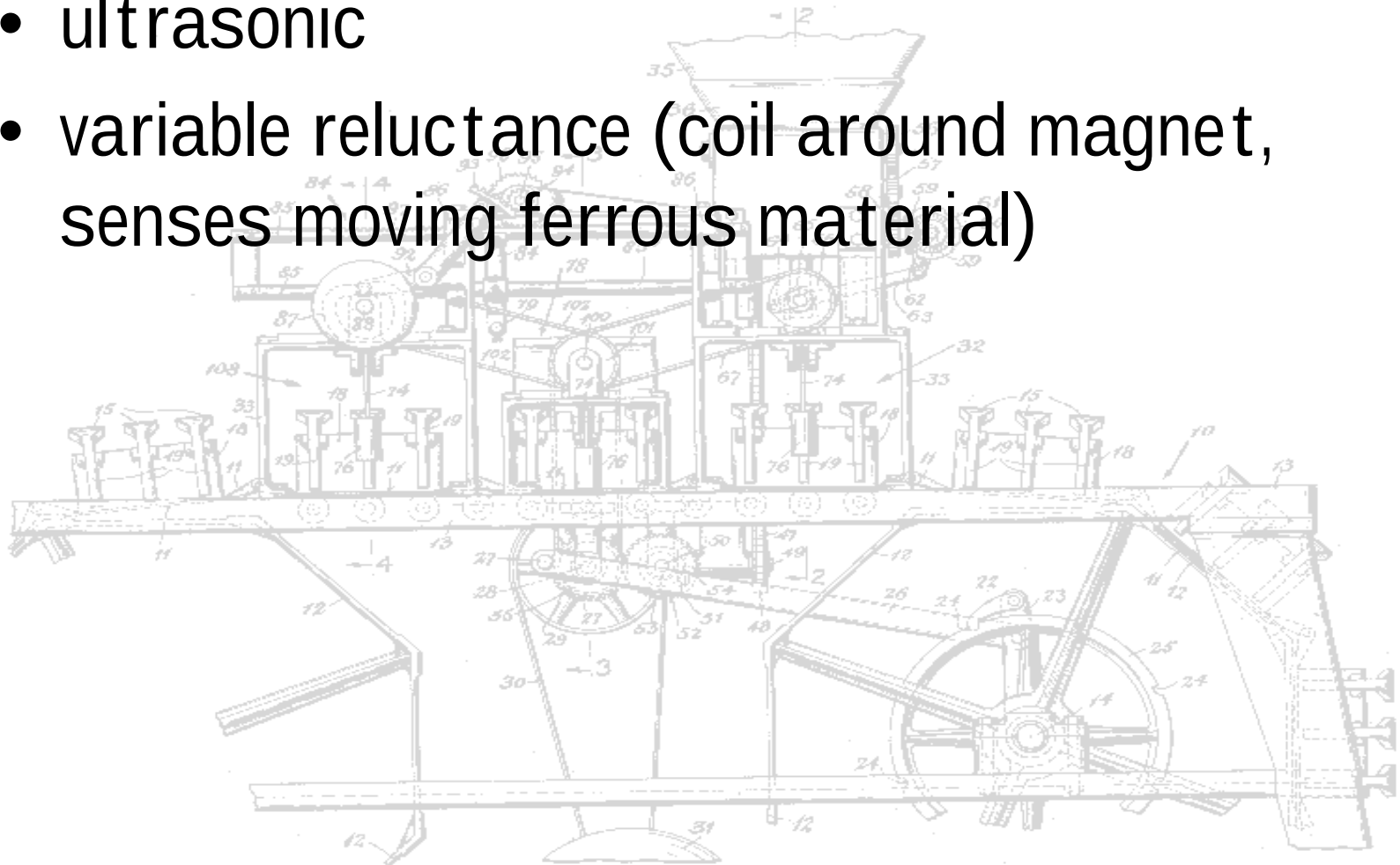
Hall Switch

- Magnet motion
 - head-on
 - bypass or slide-by
- Total effective air gap (TEAG)
- Sensitivity, Hysteresis, & Temperature

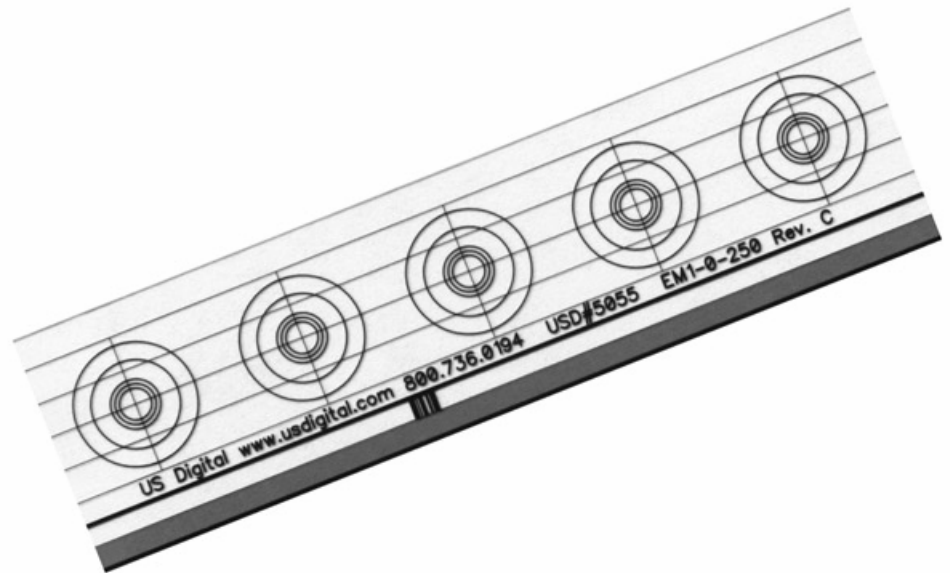
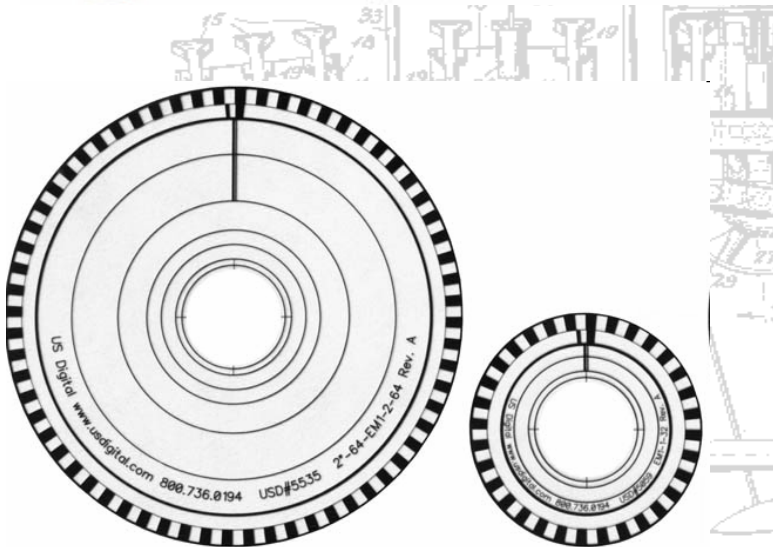
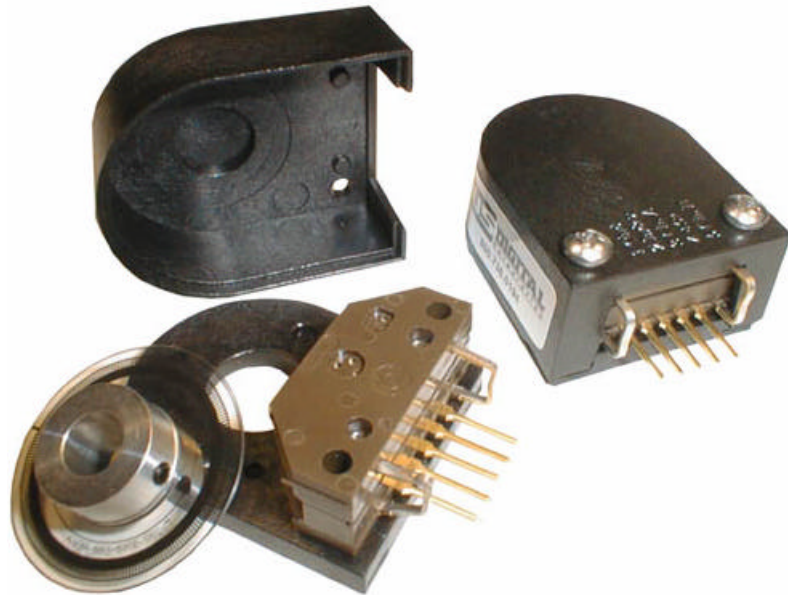


Other Discrete Position Sensors

- capacitive
- ultrasonic
- variable reluctance (coil around magnet, senses moving ferrous material)



Incremental Encoders

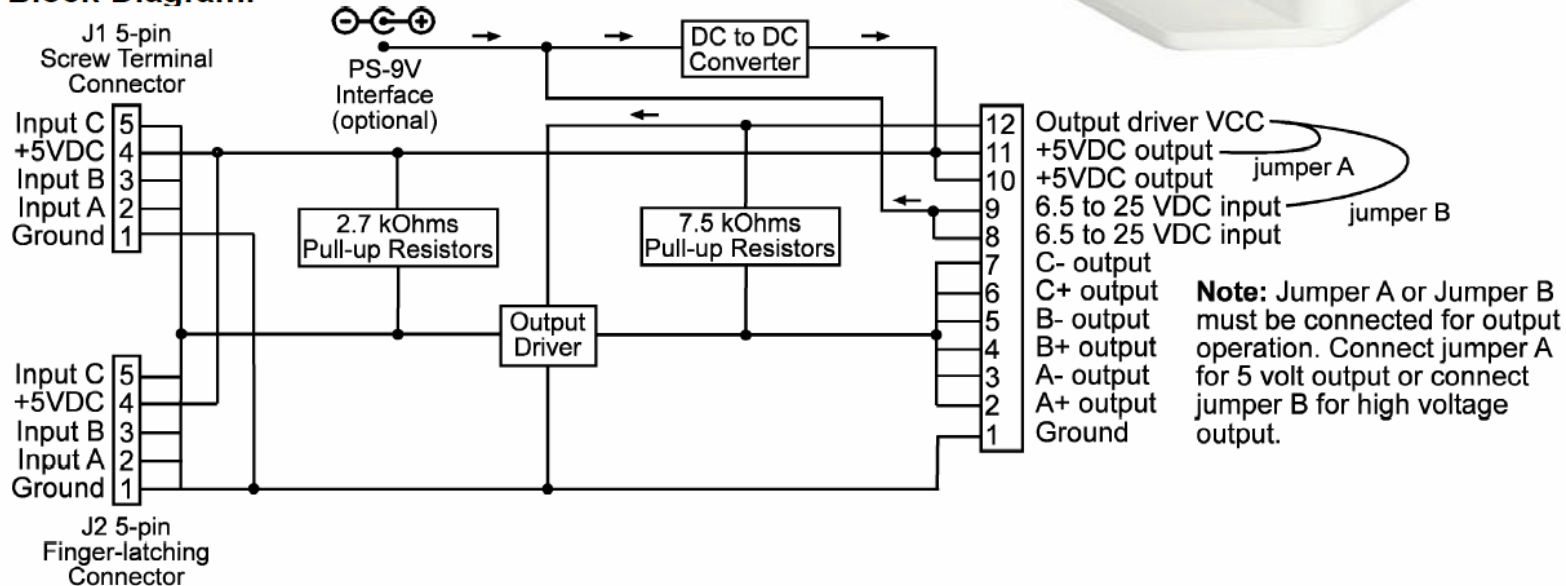


Incremental Encoders

- Encoders typically run on +5V, not +24V
- Outputs are typ. not 24V compatible either

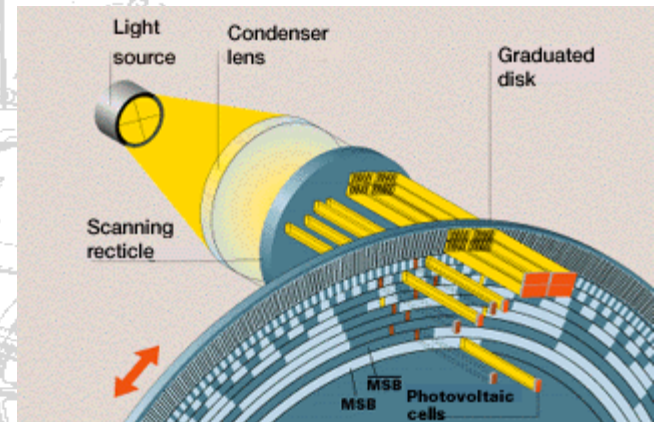
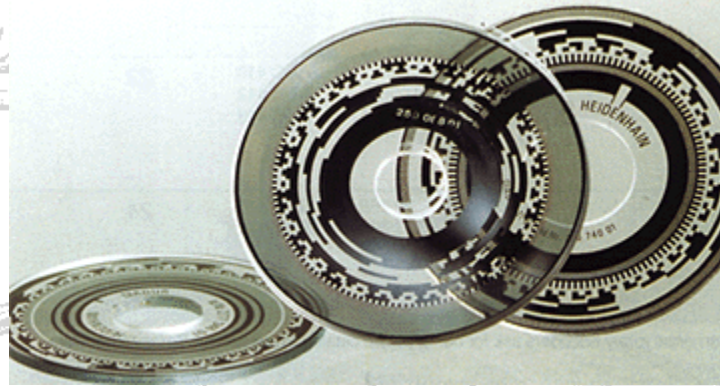


Block Diagram:



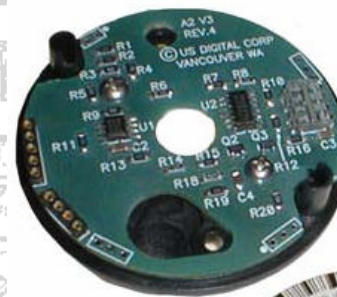
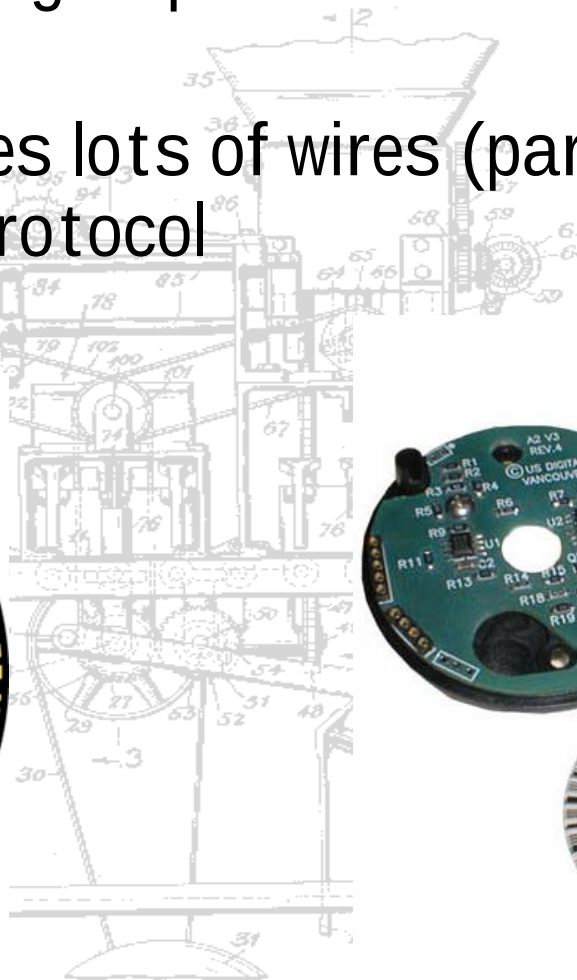
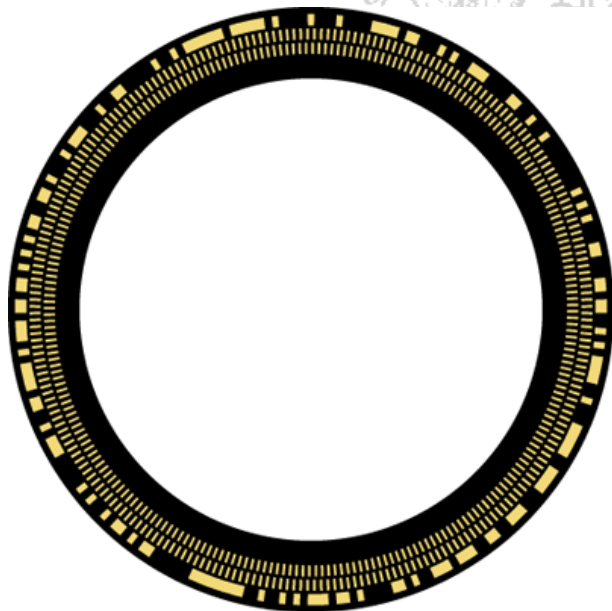
Absolute Encoders

- doubling resolution requires adding another photodiode/LED pair
- cost is much higher than incremental
- does not require seeking to establish reference location



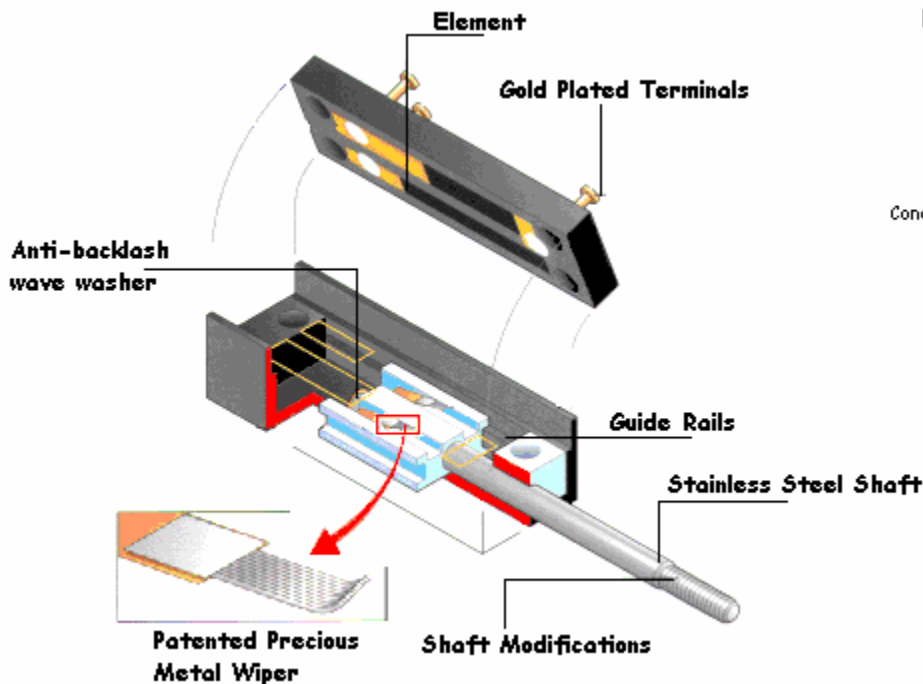
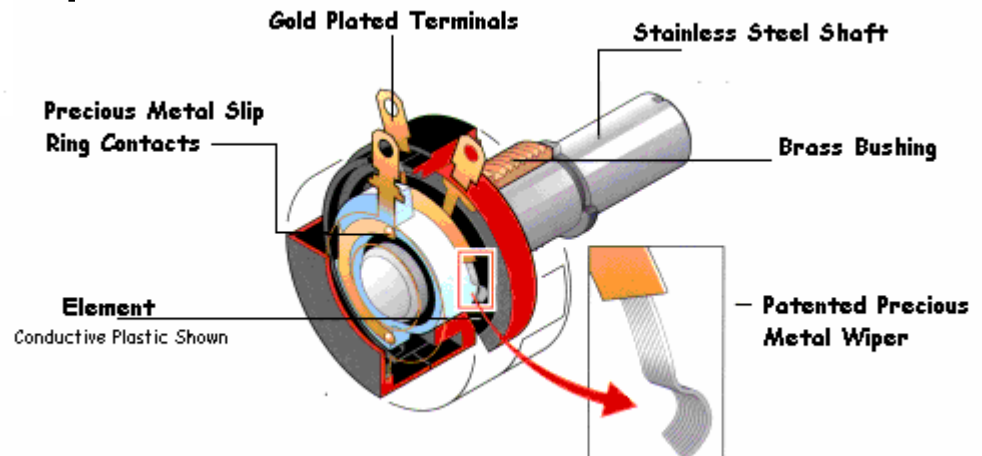
hybrid incr / absolute encoders

- add more information to index channel to reduce amount of seeking required to find reference position.
- interface requires lots of wires (parallel) or a special comm. protocol



Potentiometer

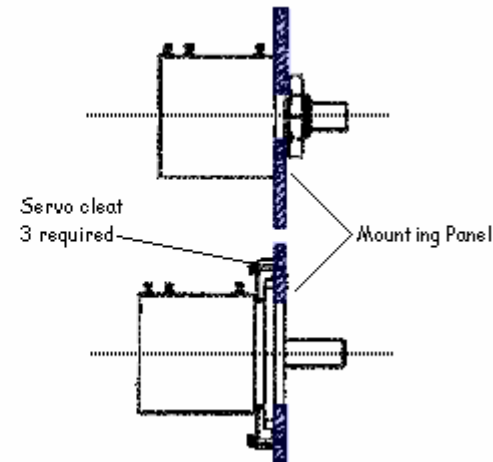
- A potentiometer (or pot) is a variable resistor wired to obtain a variable DC voltage proportional to position



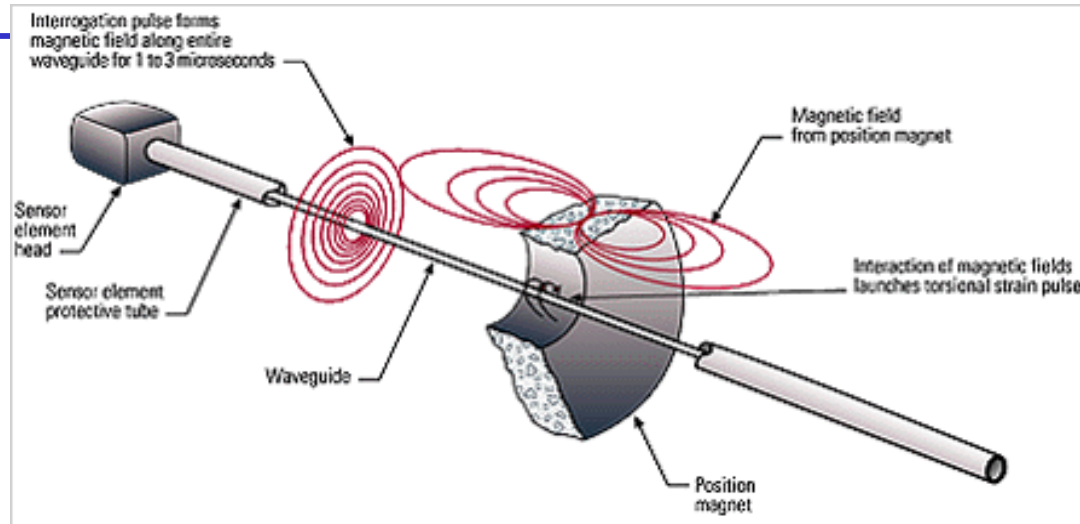
Mounting Types

Bushing mount: Most commonly used. Mounts easily in the panel hole and secures with a mounting nut.

Servo mount: Recommended when the shaft is to be attached to a gear or other mechanism. Allows the operator to index to zero adjustment by turning the potentiometer.



Magnetostrictive Pos. Sensor



- Pulse sent down magnetostrictive material
- Pulse reflects off position magnet's field
- Position is proportional to $t_{\text{rcvd}} - t_{\text{sent}}$
- Pulse propagates at $\sim 2800 \text{ m/s}$
- Resolution is $\sim .001''$ with $t_{\text{update}} \sim 1 \text{ msec/in.}$

Magnetostriuctive Sensor

