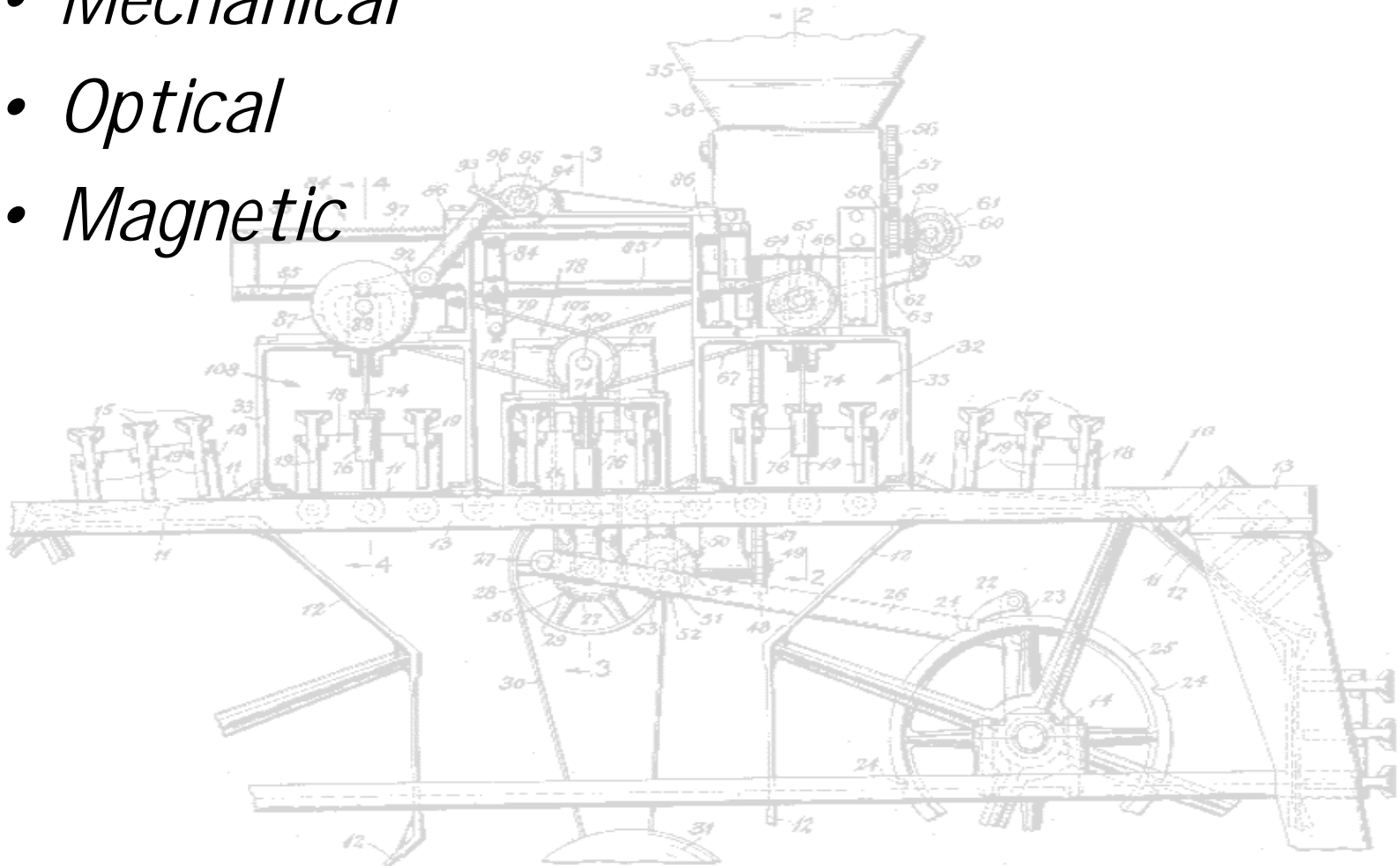


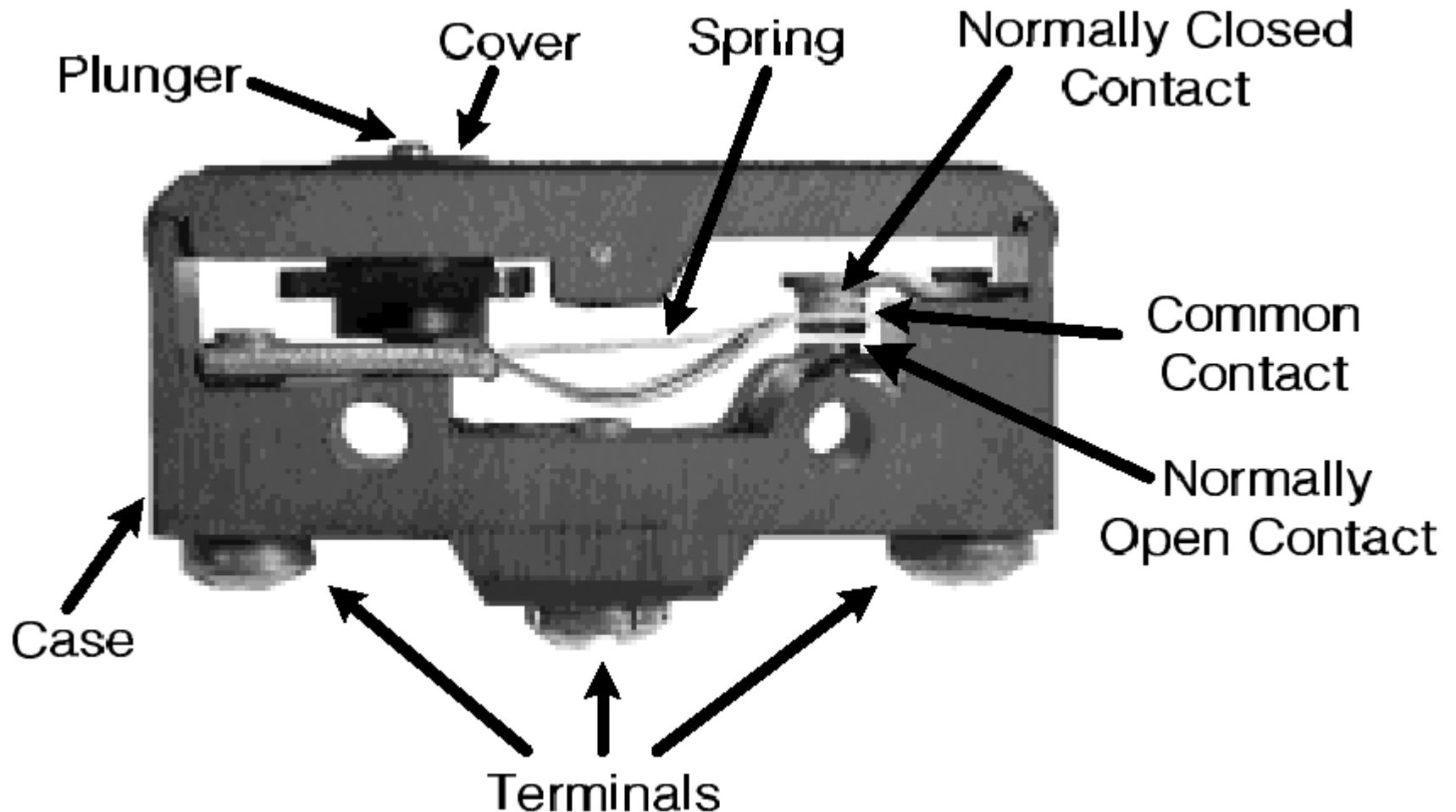
# POSITION SENSING

- *Mechanical*
- *Optical*
- *Magnetic*

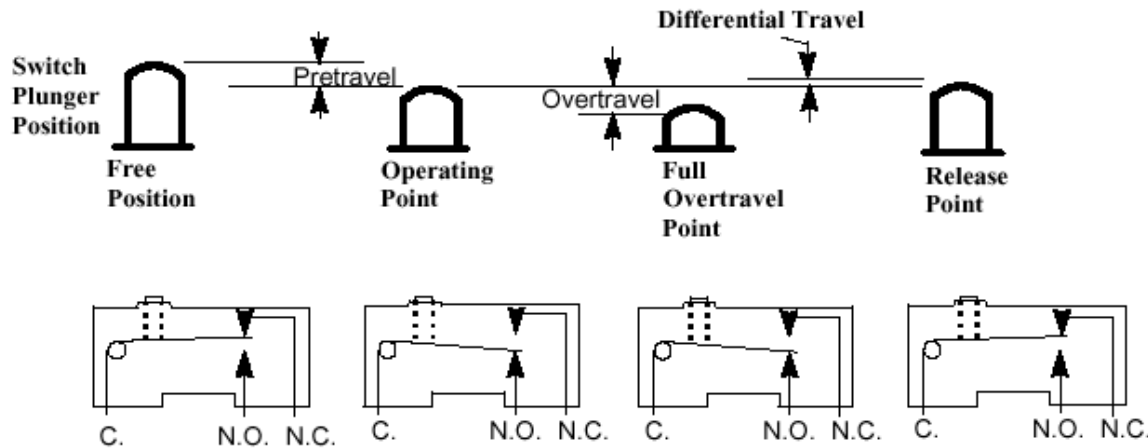


# MECHANICAL SENSING

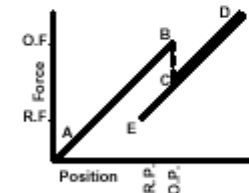
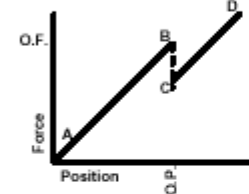
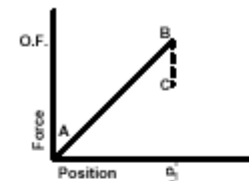
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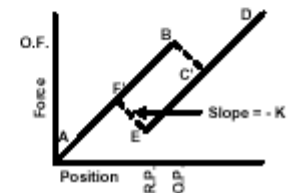
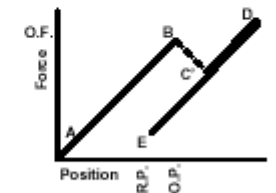
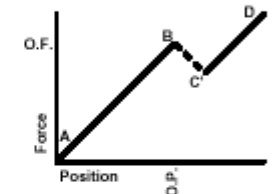
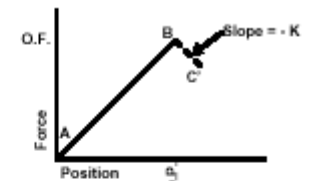
# MICROSWITCH OPERATION



With Rigid Actuating Device

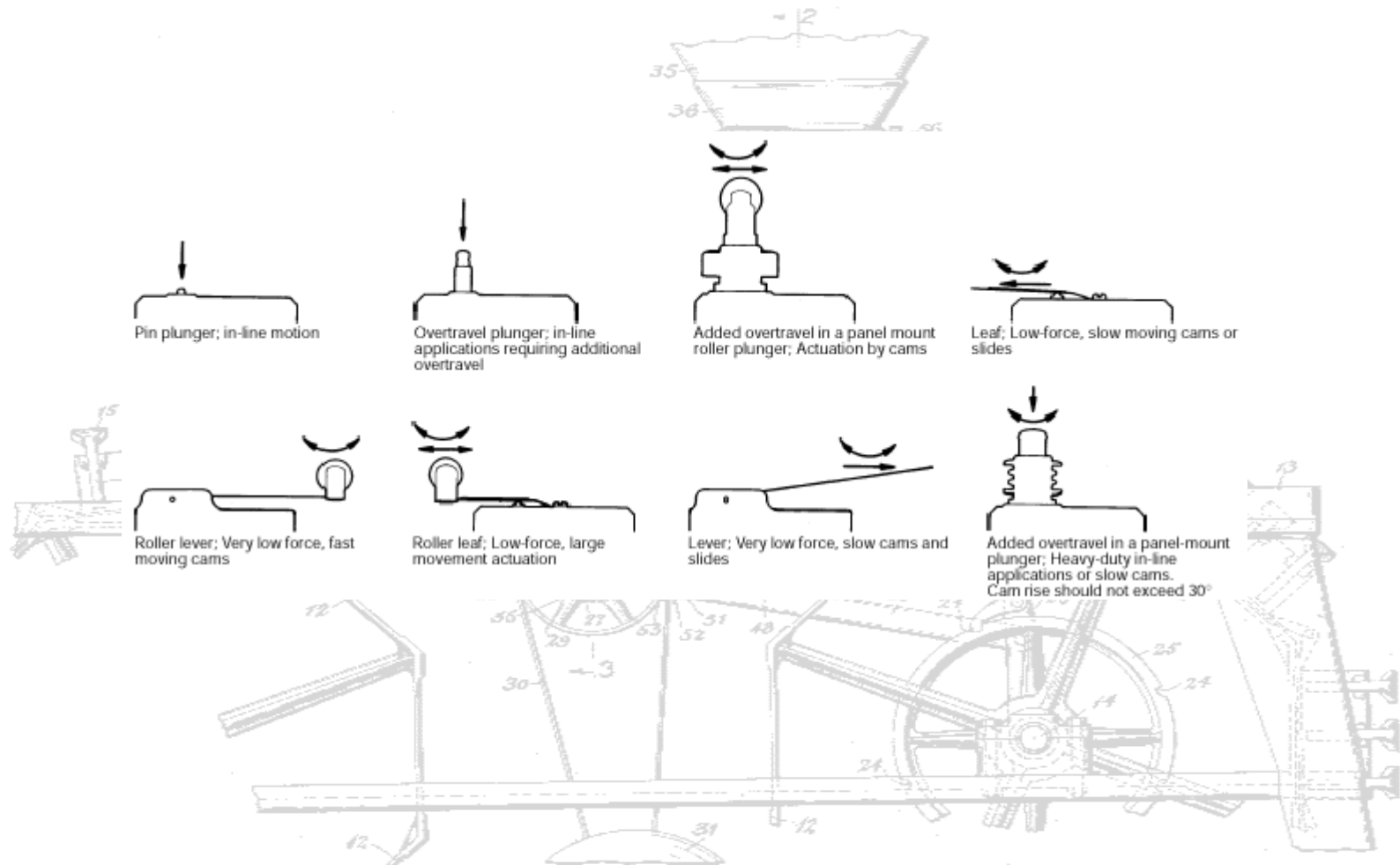


With Resilient Actuating Device Having Spring Rate K



*Switch exhibits mechanical hysteresis.*

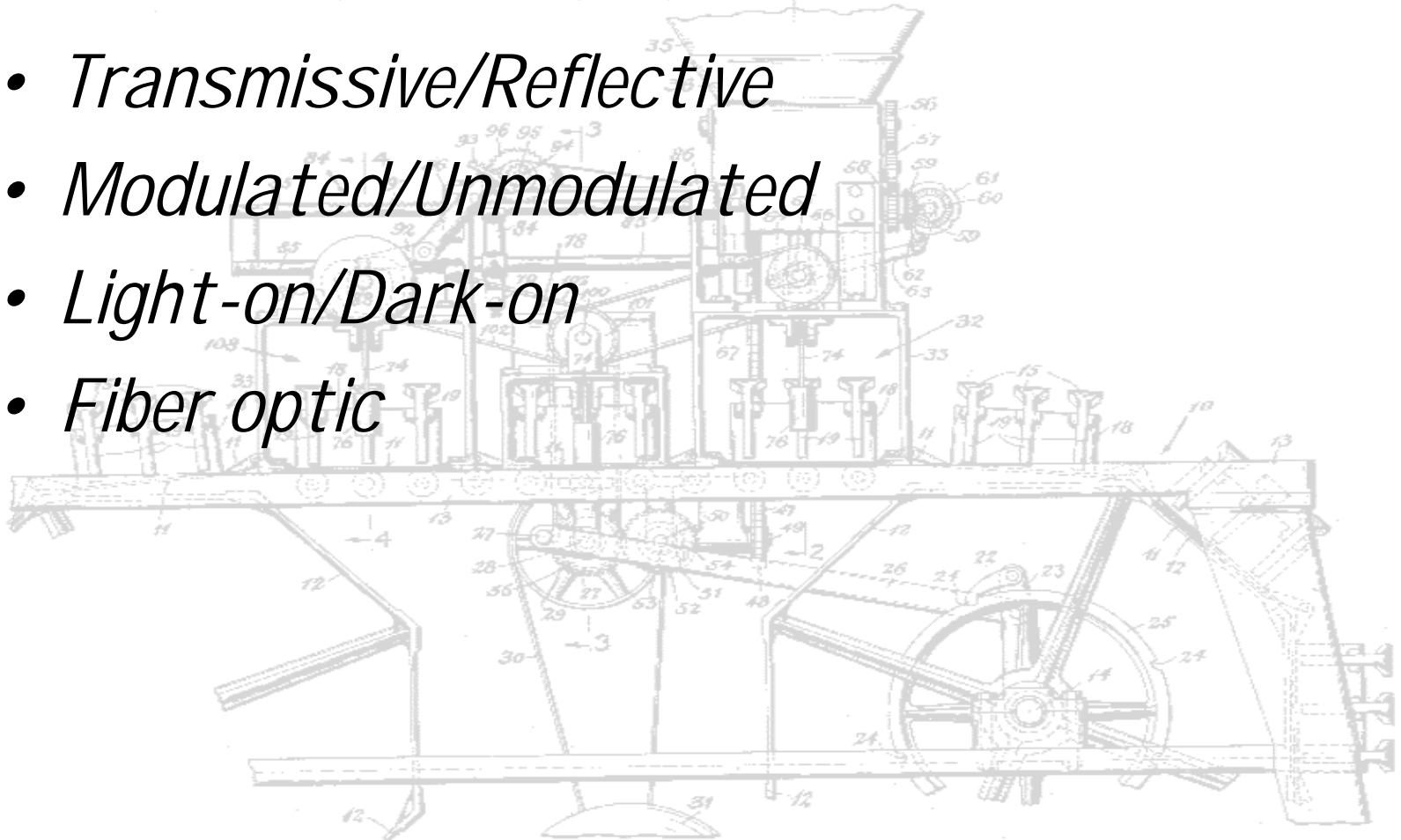
# MICROSWITCH ACTUATORS



# OPTICAL SENSING

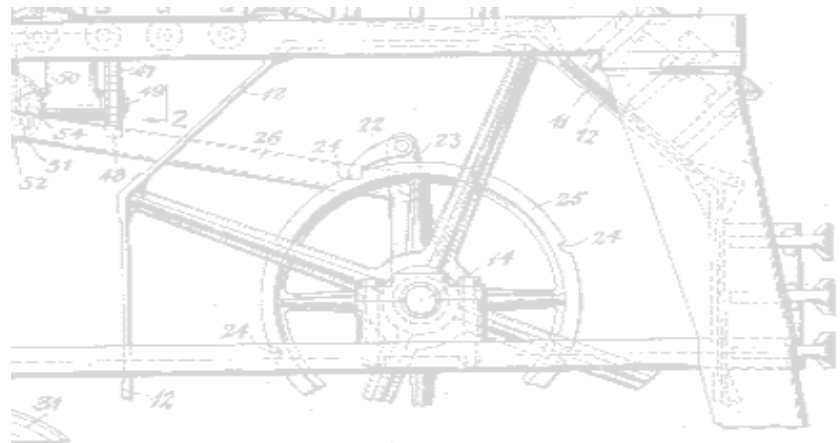
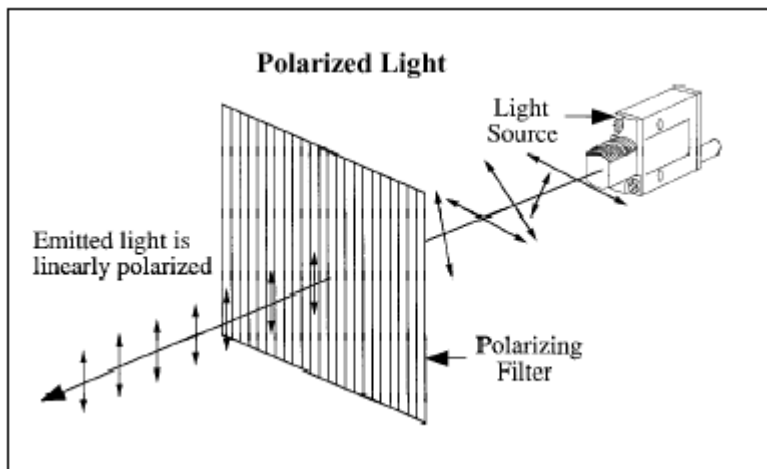
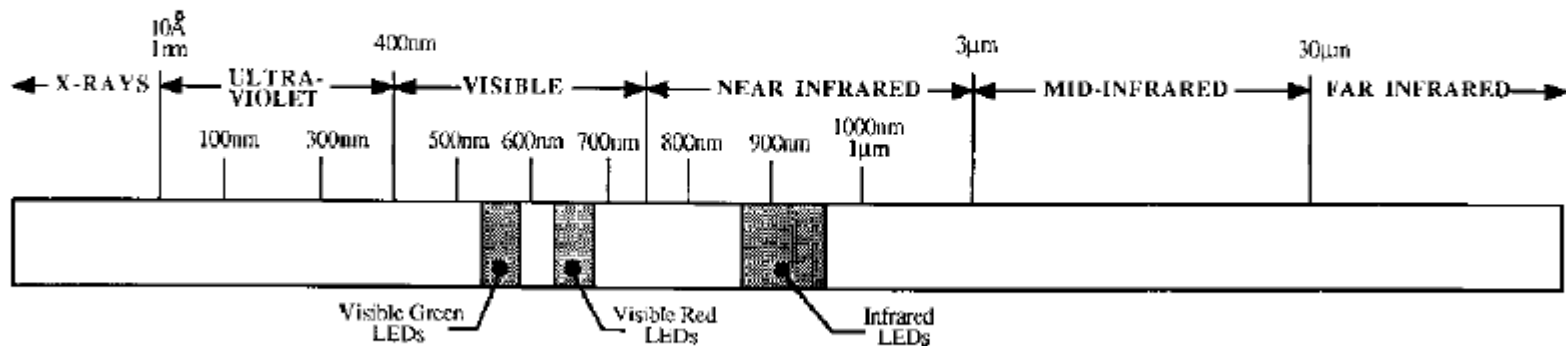
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- *LED's and Photodiodes*
- *Transmissive/Reflective*
- *Modulated/Unmodulated*
- *Light-on/Dark-on*
- *Fiber optic*



# LED AND PHOTODIODE PROPERTIES

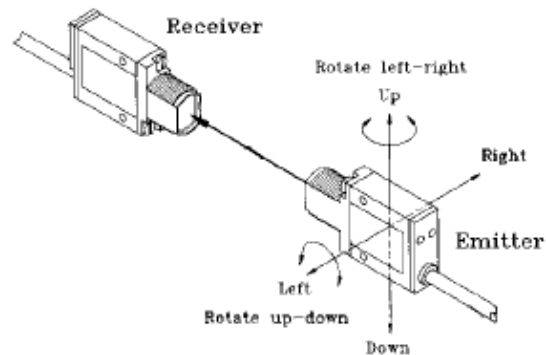
## Wavelengths of Commonly-used Light Emitting Diodes (LEDs)



# TRANSMISSIVE & REFLECTIVE PHOTOSWITCHES

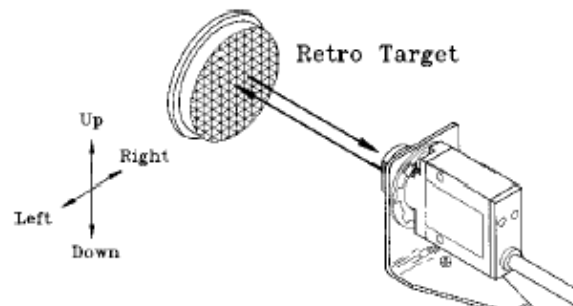
## Opposed Mode Alignment

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



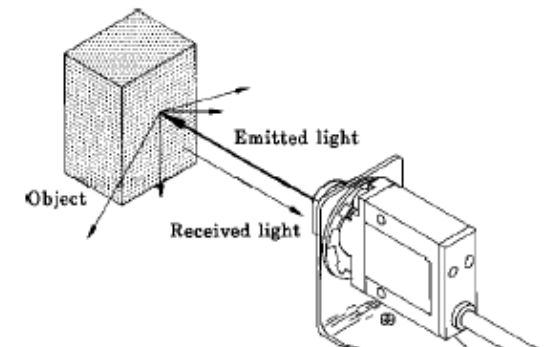
## Retroreflective Mode Alignment

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



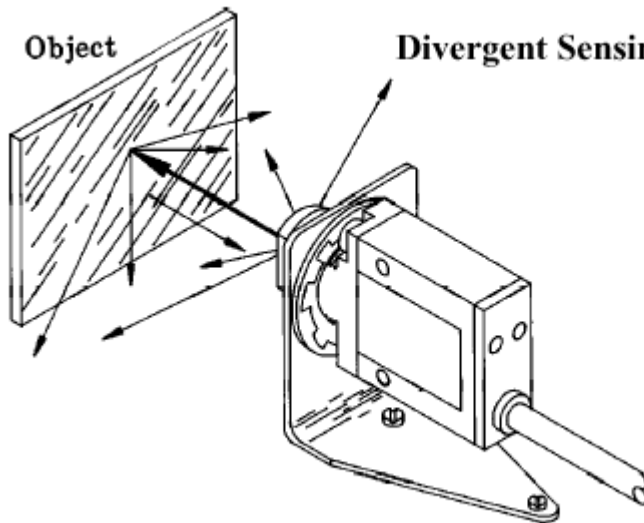
## Proximity (Diffuse) Mode Alignment

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

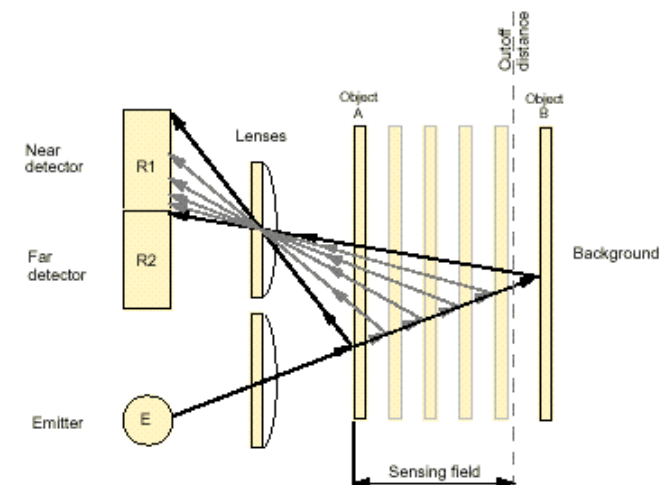


Object

Divergent Sensing Mode



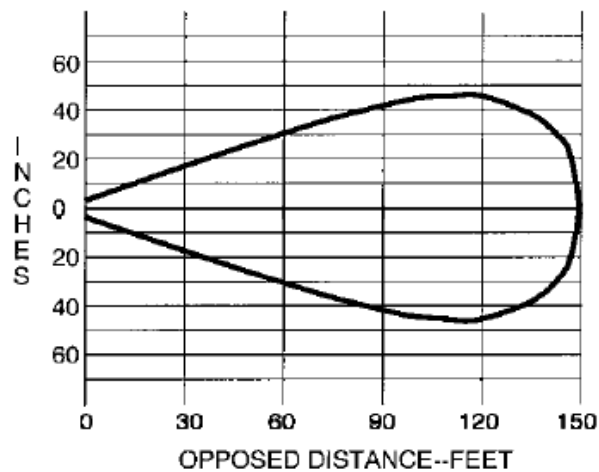
## Fixed-field Diffuse Sensing



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**

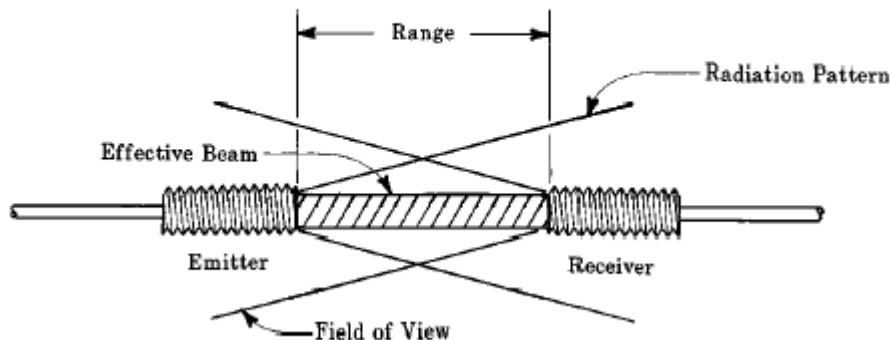


**RELATIVE REFLECTIVITY TABLE**

<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

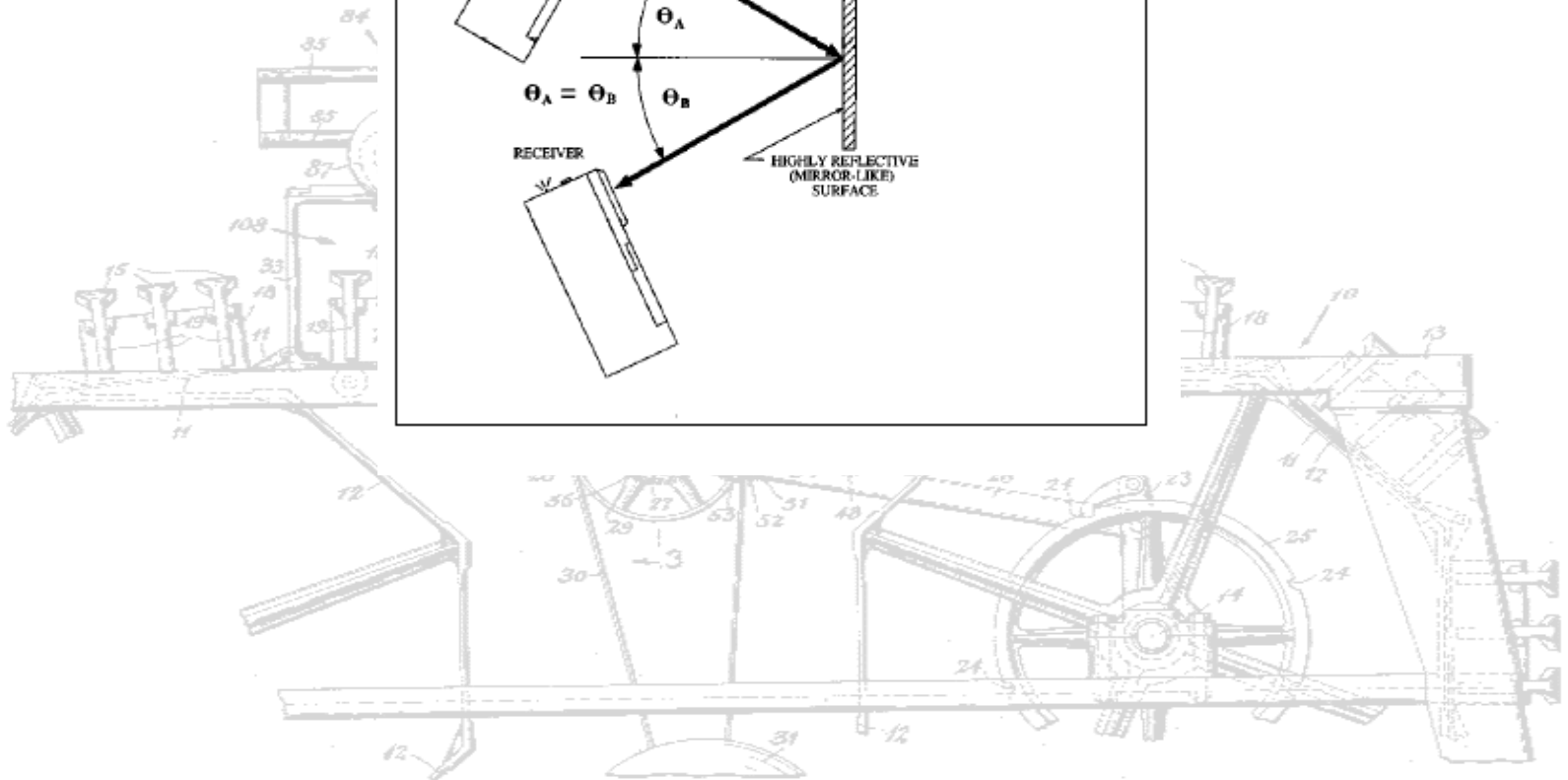
\*NOTE: For materials with shiny or glossy surfaces, the reflectivity figure represents the maximum light return, with the sensor beam *exactly perpendicular* to the material surface

**Effective Beam**



**Specular Sensing Mode**

The diagram illustrates the specular sensing mode. It shows an **EMITTER** and a **RECEIVER** positioned on opposite sides of a **HIGHLY REFLECTIVE (MIRROR-LIKE) SURFACE**. The emitter emits a beam that reflects off the surface and is received by the receiver. The angle of incidence is labeled  $\theta_A$  and the angle of reflection is labeled  $\theta_B$ . The diagram indicates that  $\theta_A = \theta_B$ .



# MODULATION

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- *“Chop” LED drive on and off at many kHz*
- *Bandpass filter after photodiode eliminates other frequencies*
- *Threshold circuit after BPF generates on/off output*

