Interactive LED Street Lighting System

SEYED-ALI NOURI
ARTHUR DANIEL
RYAN TOONDERS
ATIF SIDDIQUI

Current Lighting Situation

High Pressure Sodium Lamps (HPS):

- Low efficiency
  - $$$
  - Bad for the environment
- Light Pollution
- Static System

Figure 1: Standard high pressure sodium [1]

Figure 2: The glare/light pollution caused by high pressure sodium [2]

Original Patent

Goal:

- Improve on an existing patent
- Patent
  - 8057074
  - LED panel
  - Replace current street lights
  - Efficient
  - One colour

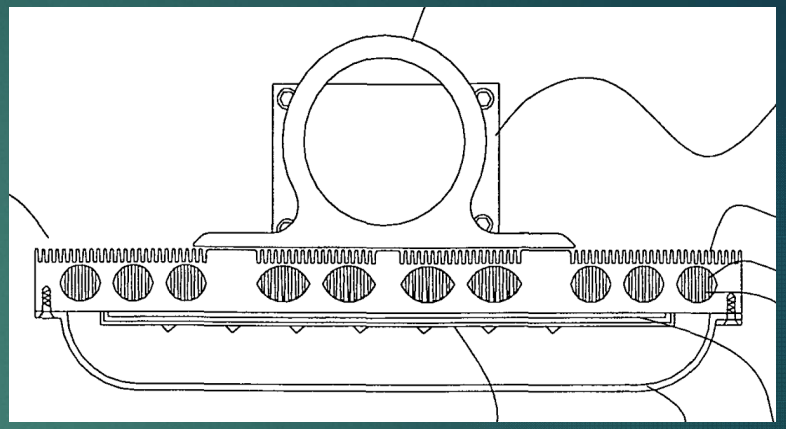


Figure 3: Front view of the patent [3]

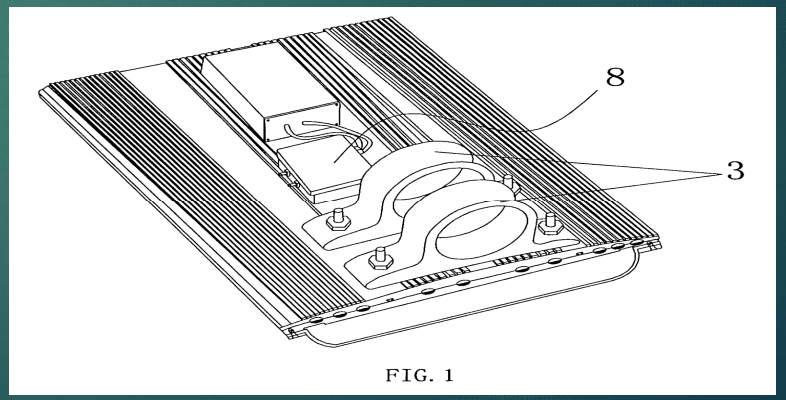


Figure 4: Isometric view of selected patent [3]

Original Patent

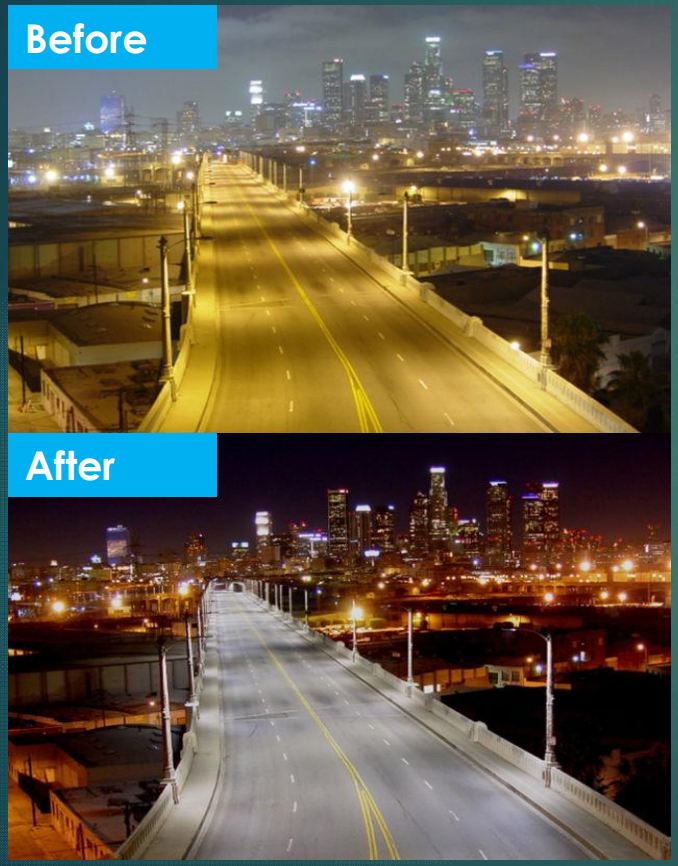


Figure 5: Before and after L.A. replaced their street lights [4]

Around The World

- 141 089 lights replaced in Los Angeles [5]
- 9.5 million dollars saved annually [5]
- 85% more efficient [6]

Here At Home

- 67 000 light to be replaced [7]
- Savings of 5.3 million dollars [7]

Goals

- Improve Safety
- Improve Efficiency
- Static → Dyanmic

The Future Is Here…

Interactive LED Street Lighting System

- Integrated into the curb
- 3 different colours
- Vehicle detections

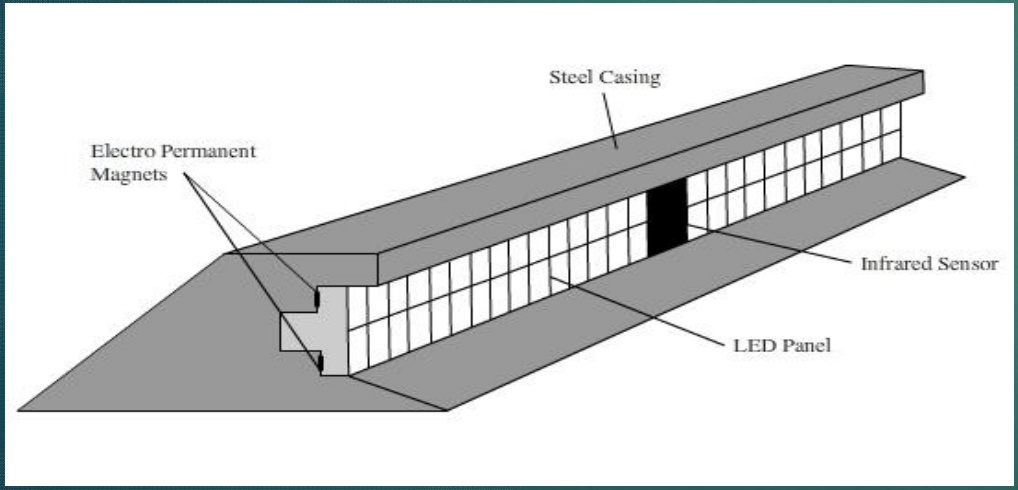


Figure 6: Labelled system diagram.

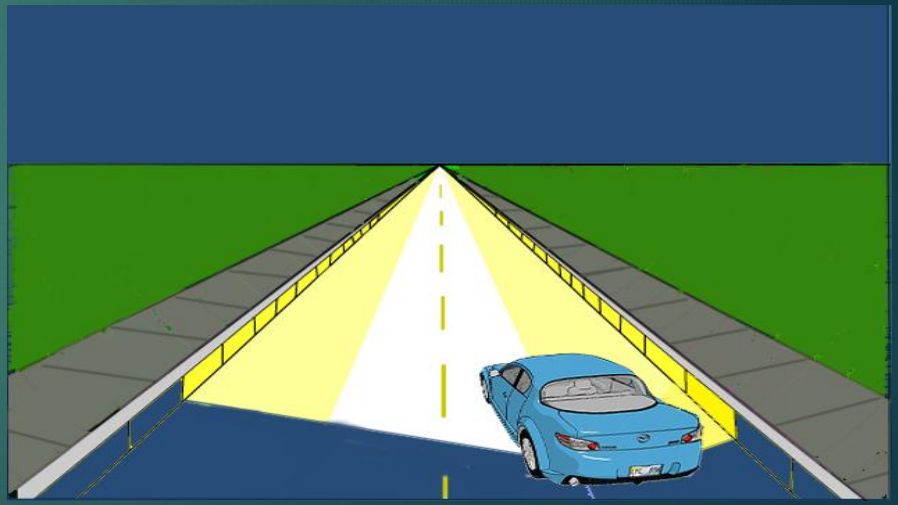


Figure 7: Illustration of how the implemented system will look.

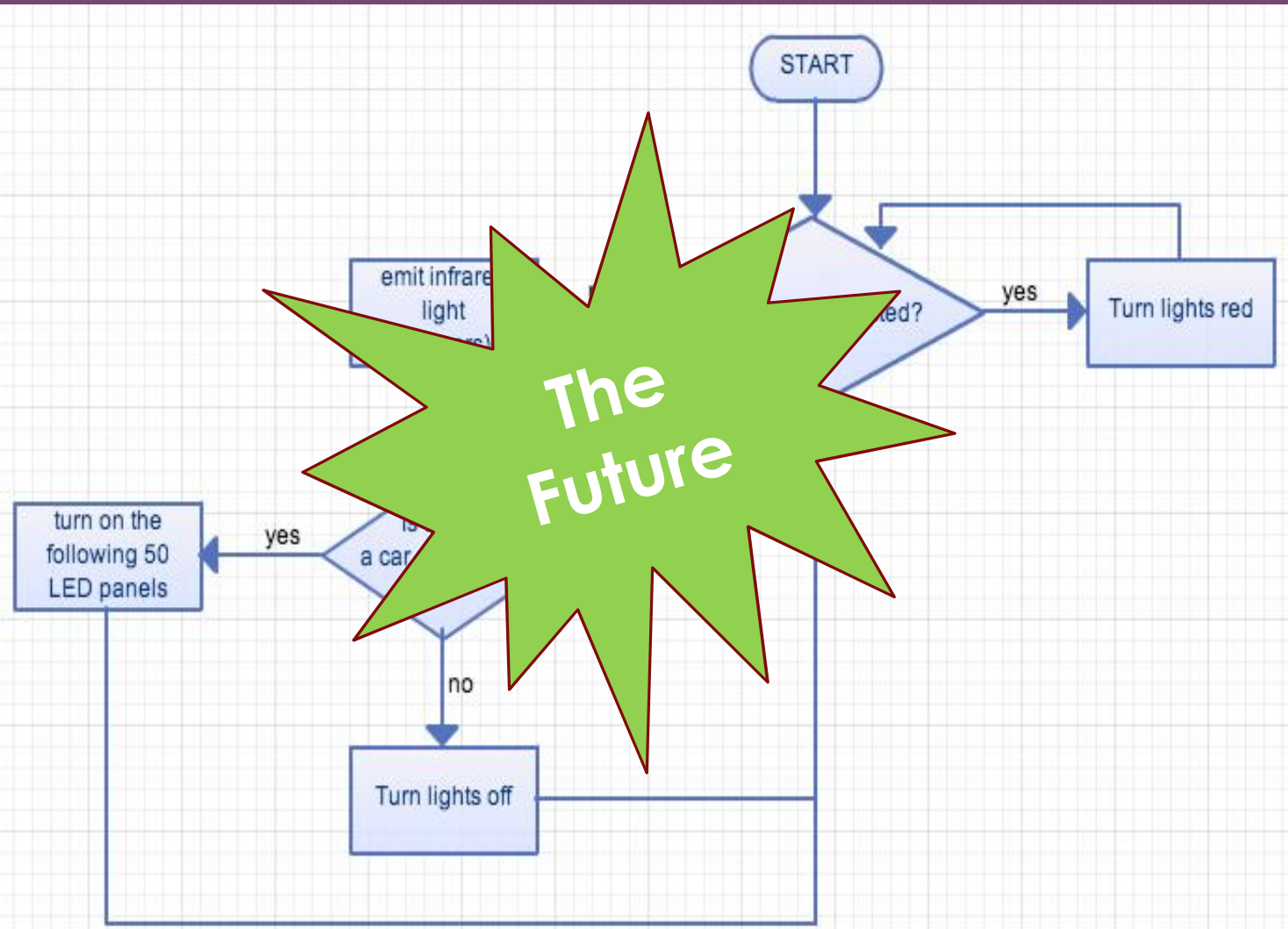
Benefits

- Relays information to driver
- Improved efficiency
- 2X better than the original patent

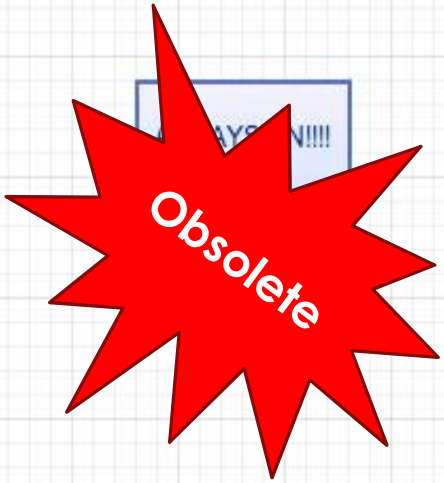
Figure 7: Inspiration for the futur [8]

Innovative, and forward thinking design will lead your city in a modern more efficient direction

Interactive LED Street Lighting system



OLD



Components

Components

LED Panels

- Contains 50 tri-coloured LEDs
- 150 000 hour bulb life [5]
- Easy to replace

Figure 8: LED panel with different colours

Components

Infrared Sensor

- Emits infrared light
- Uses reflection of infrared light
- No car = LIGHTS OFF!
- Increases energy savings

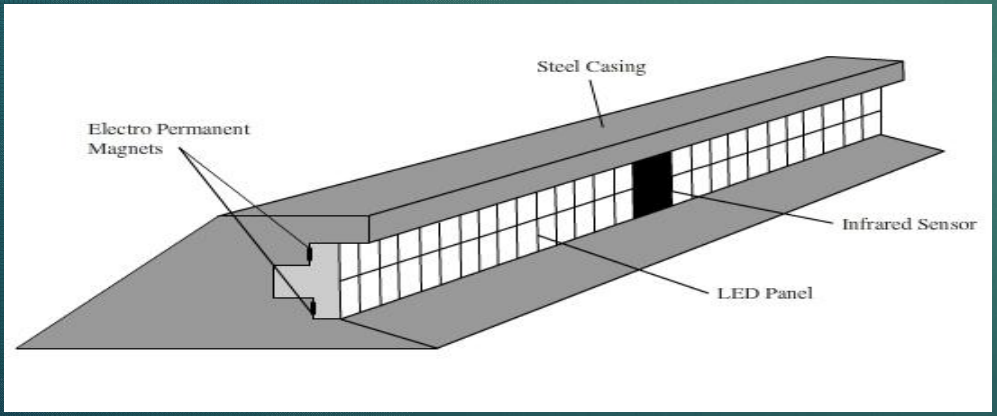


Figure 9: Labelled system diagram.

Figure 10: Sample infrared sensor [8]

Components

LED Casing

- Tempered Steel → Rigidity
- Angled design → minimized dirt build up
- Short Independent panels → easy to install
  - cheap to repair/replace

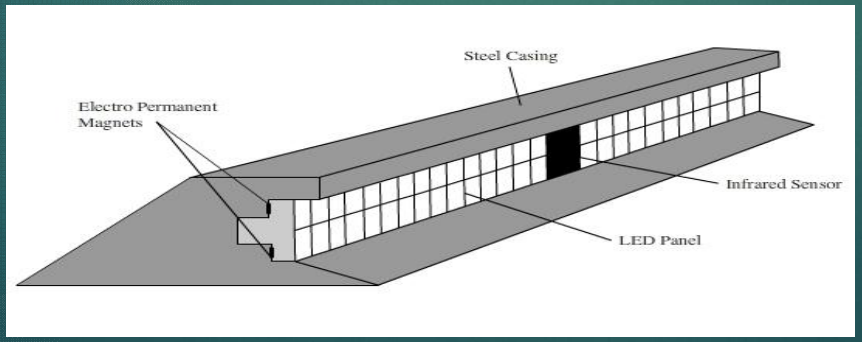


Figure 11: Labelled system diagram.

Components

Electro Permanent Magnets

- SECURLY hold LED panels
- No moving parts
- Easy Replacement

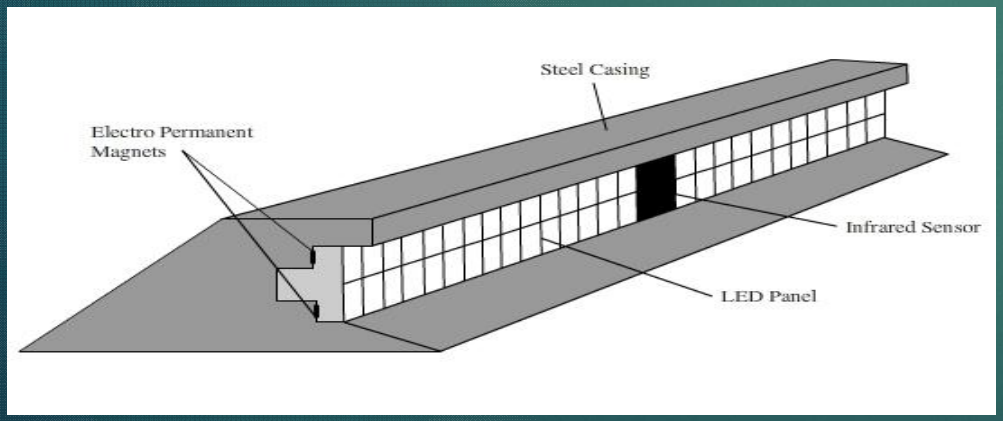


Figure 12: Labelled system diagram.

Figure 13: Industrial application of electro permanent magnets [9]

Engineering Principals

Electromagnetic spectrum

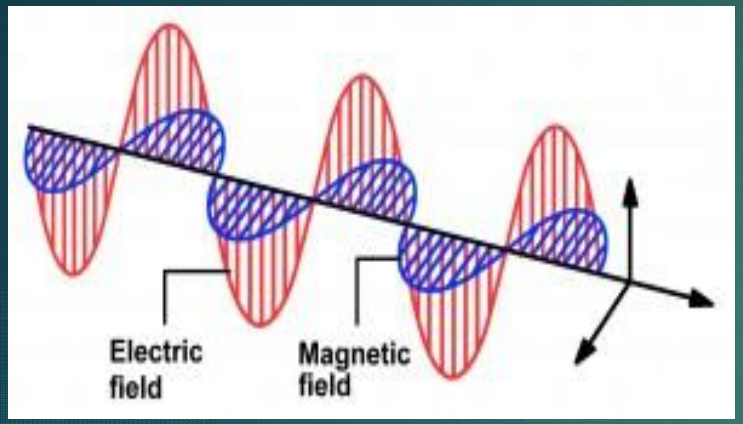


Figure 14: Electromagnetic waves [27]

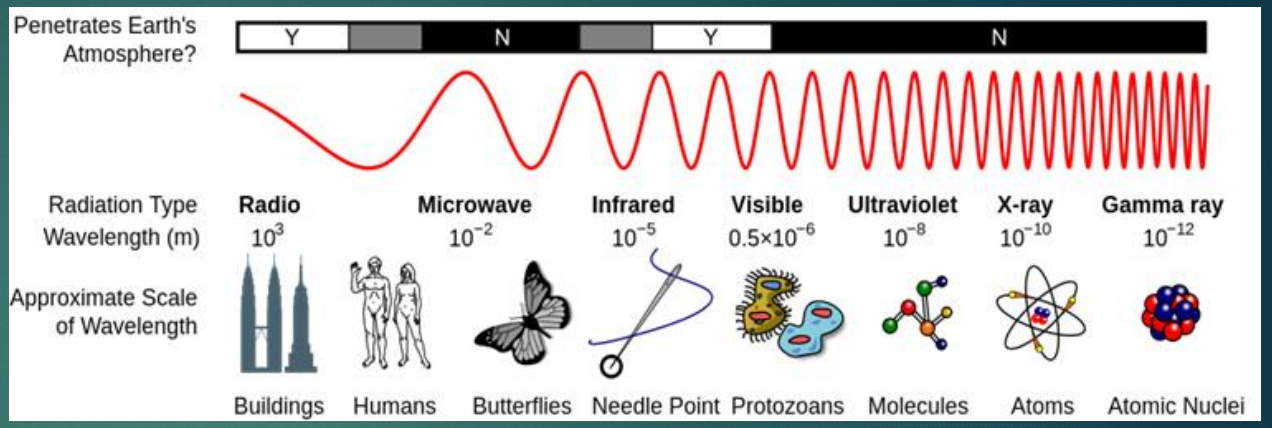


Figure 15: Electromagnetic wave spectrum [25]

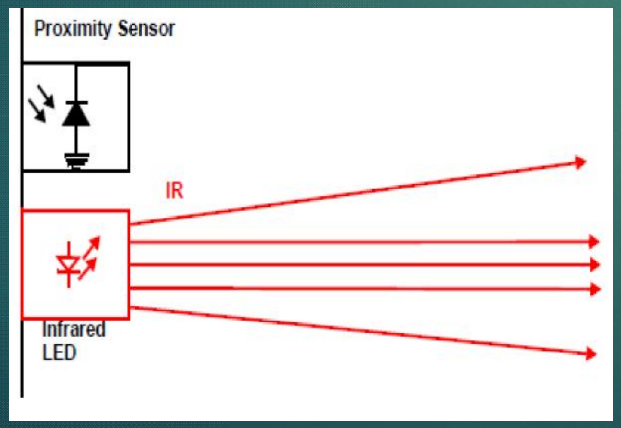


Figure 16: infrared sensor-no object [26]

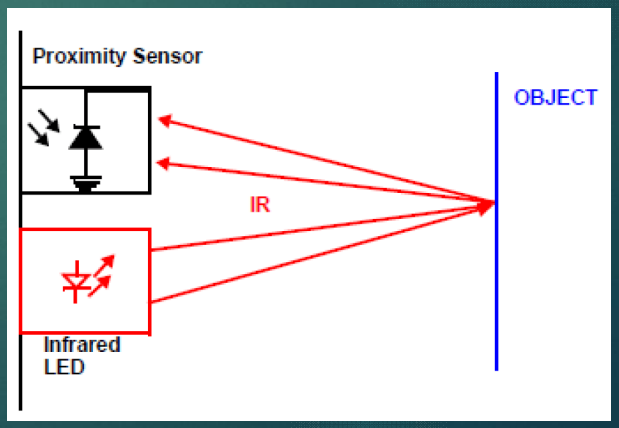


Figure 17: infrared sensor-object present [26]

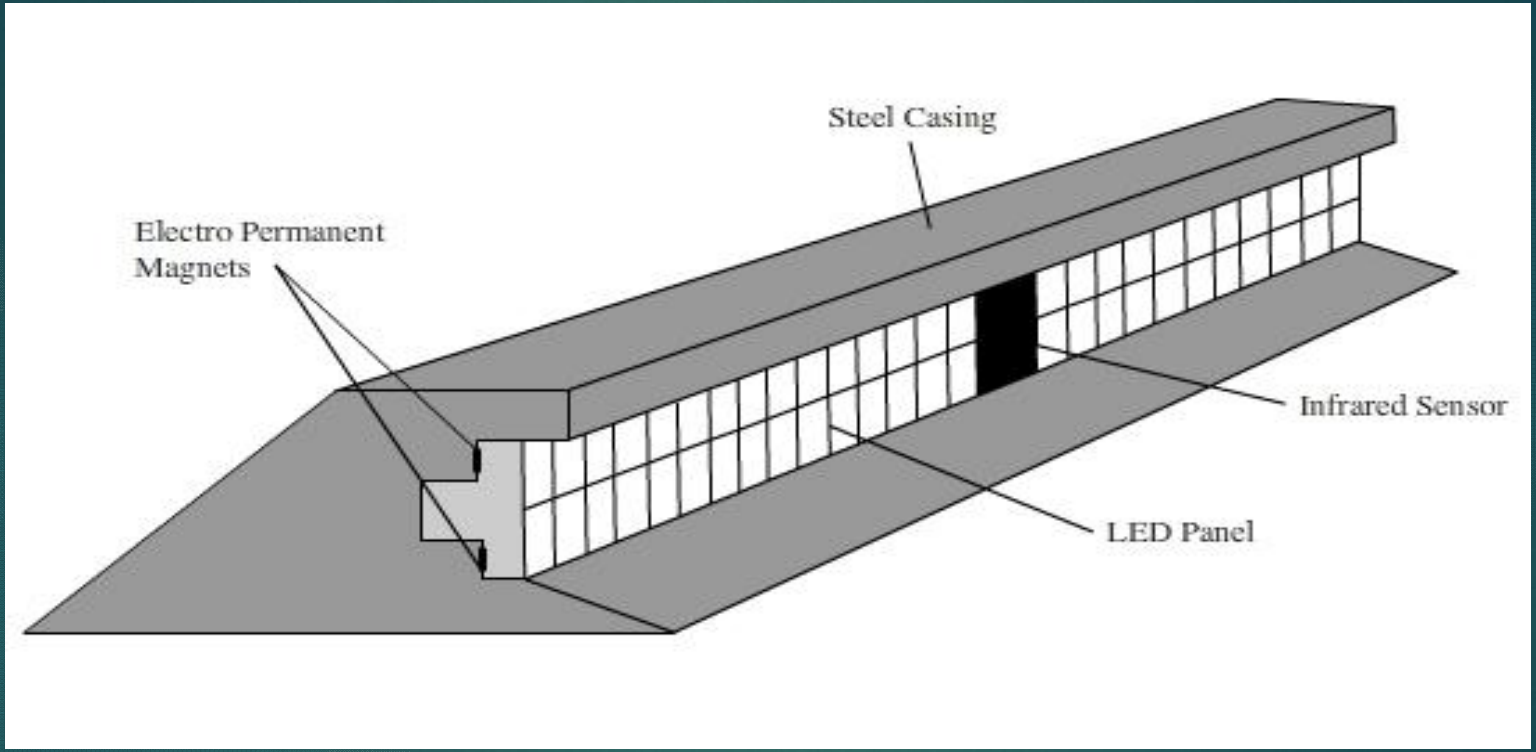
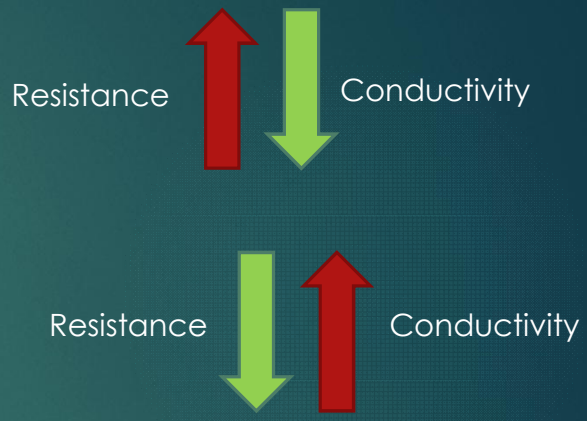


Figure 18: Labelled system diagram.

Conductivity

- **Electrical conductance**
  How easily electricity flows through an object.
- Formula:

$$G = \frac{1}{Resistance}$$



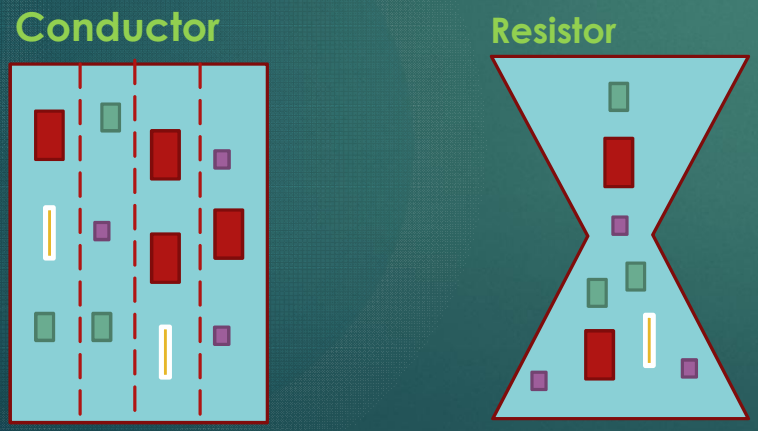


Figure 19: Resistor vs. conductor

Figure 20: symbol for LED

Figure 21: colored LEDs [28]

Conductivity

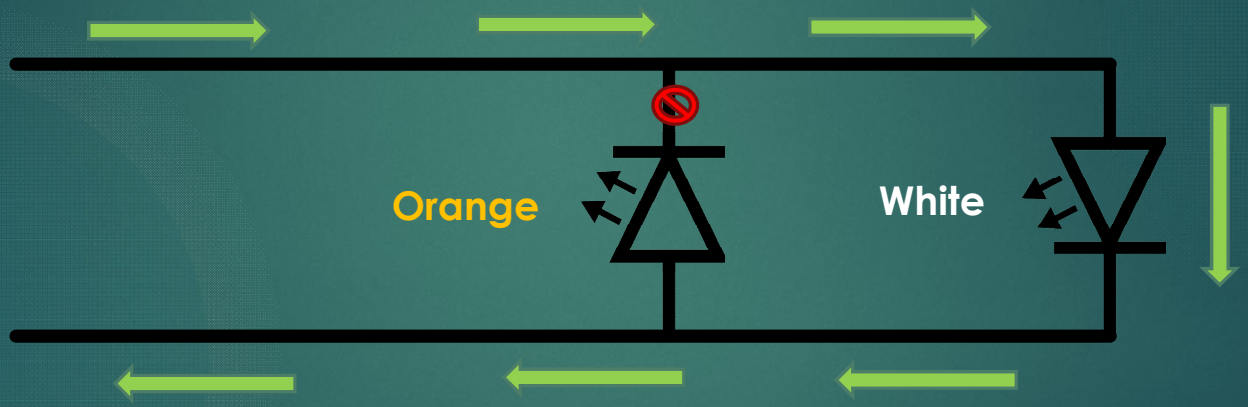


Figure 22: Lighting the white LED

Conductivity

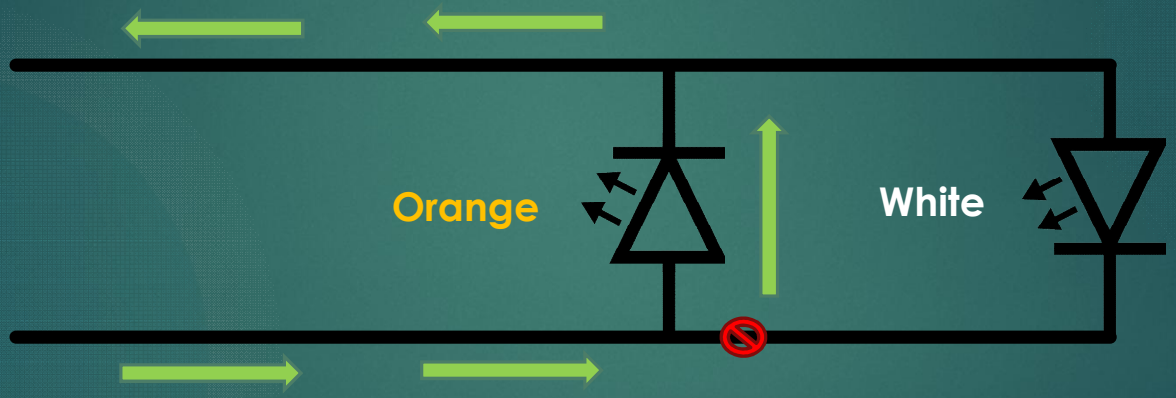


Figure 23: Lighting the orange LED

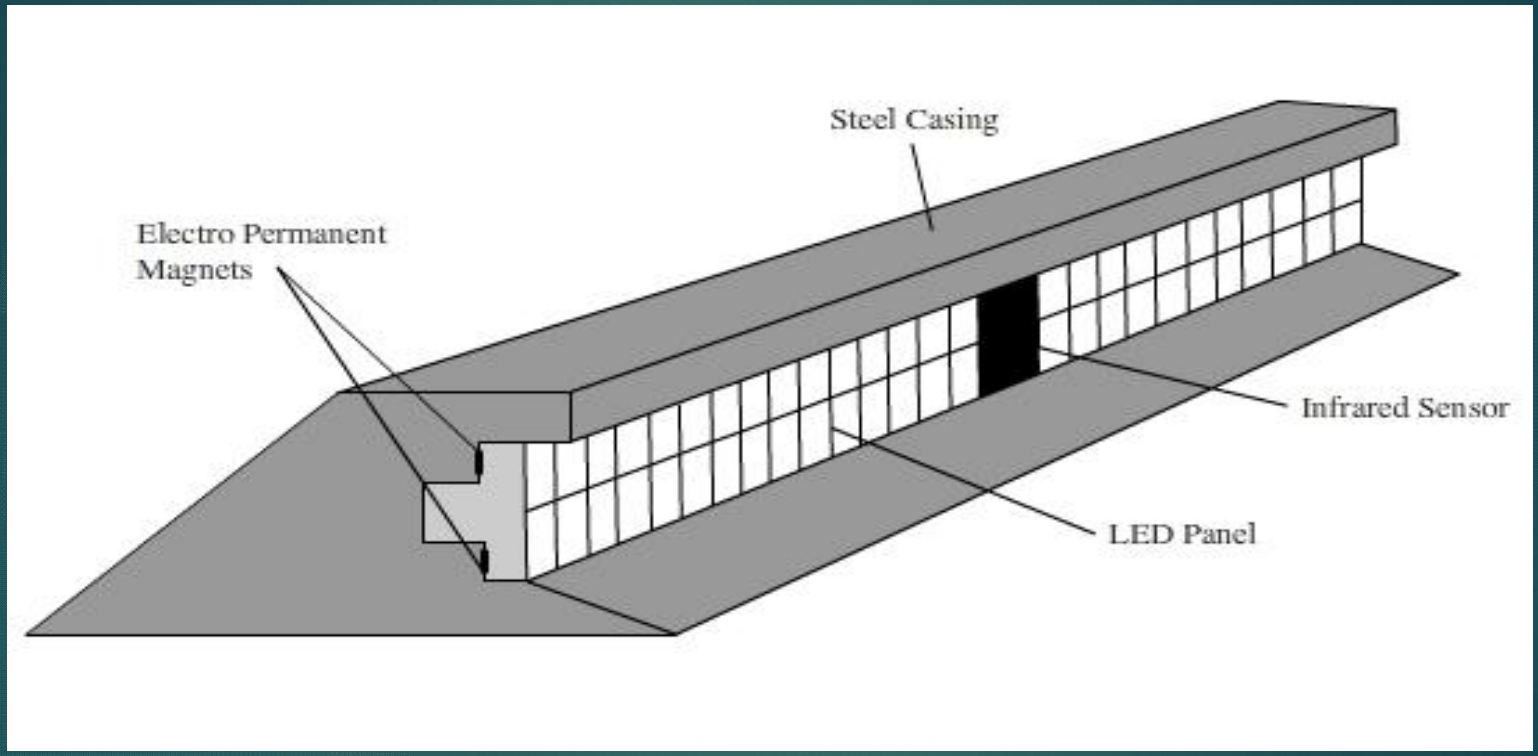


Figure 24: Labelled system diagram.

Newton's 2nd Law of Motion

- Commonly recognized by formula : F=m*a
- Example of principle:
  - Gravitational force (gravity)
  - Gravitational acceleration (g) is 9.81 m/s^2

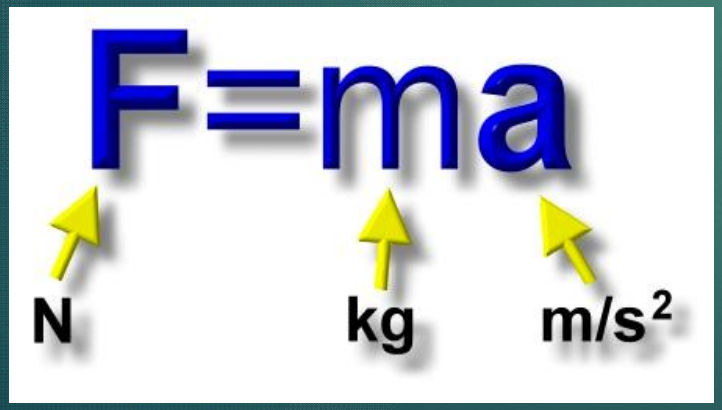


Figure 25: Equation for Newton's second law [10]

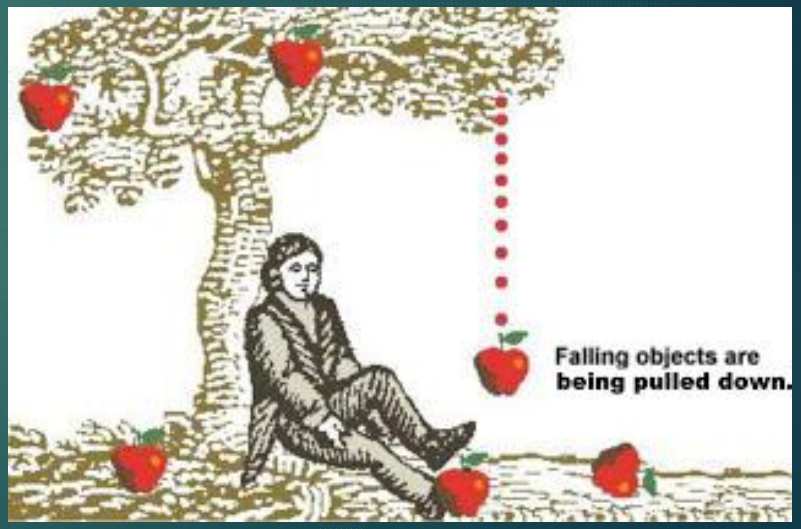


Figure 26: Apple falling down due to gravitational force [11]

Application of Newton's 2nd Law

- Used in the structural design of steel casing.
- Feature: slopped bottom lip.
  - Clears unwanted dirt or water away from LED panels

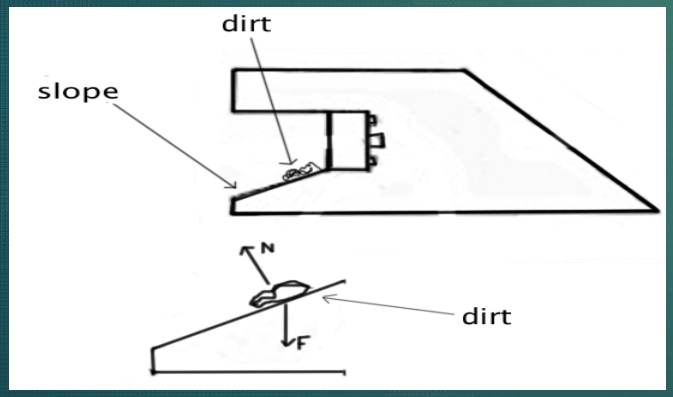


Figure 27: Slopped bottom lip of the steel casing.

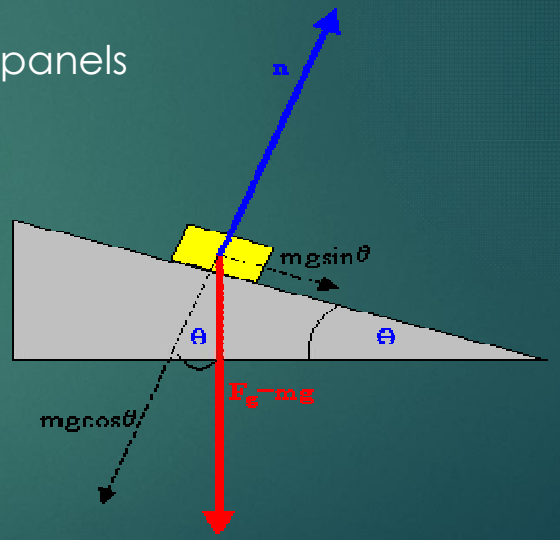


Figure 28: Gravitational force on an inclined surface. [12]

Snell's Law

- Refraction/deflection of light.
- Caused when light travels through different mediums.
- Example: Looking in water

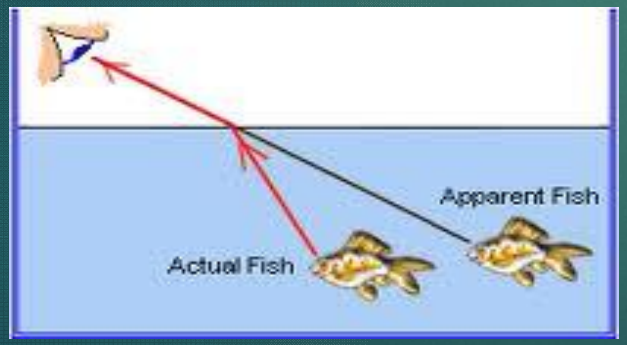


Figure 29: Light refraction in water. [13]

$$n_1 \sin\theta_1 = n_2 \sin\theta_r$$

Where:

n_1 = refractive index medium 1

n_2 = refractive index medium 2

θ_1 = angle of incidence

θ_r = angle of refraction

Figure 30: Snell's equation. [14]

Application of Snell's Law

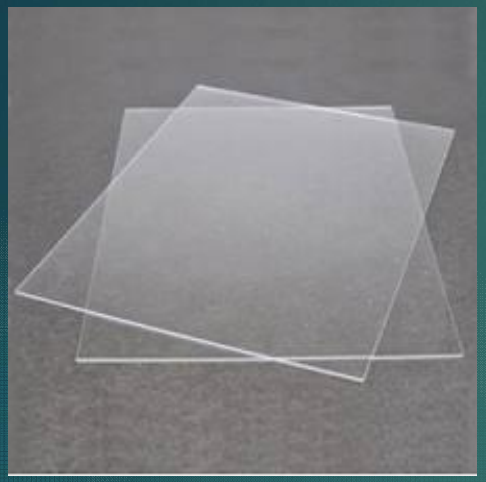


Figure #: Plexiglas sheet. [15]

- Plexiglas used to protect LED panel.
- Light emitted by LED's travel through Plexiglas and air
- Plexiglas must be parallel to the LED's to prevent fraction.

Figure 31: LED panel with infrared sensor.

Stress (Tensile Strength)

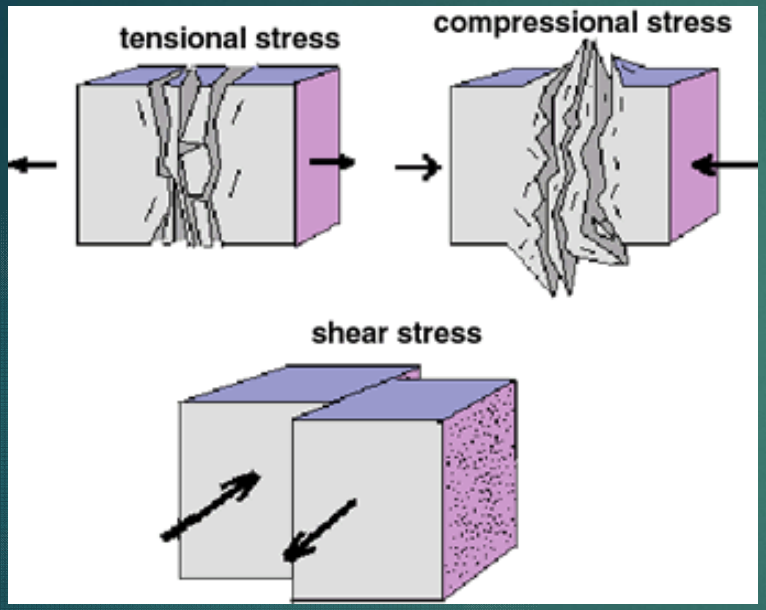


Figure 32: Comparison of LED light vs. High Pressure Sodium Lamps [16]

- Stress changes shapes
- Tensile strength → max stress before breaking
- Tool steels have the highest tensile strength(640 Mpa-2000 MPa) [16]

Light Dispersion

- Light dispersion → light takes different paths

High Pressure Sodium lamps:

- 70-81% downward luminaire [17]

LED:

- **100%** luminaire [17]

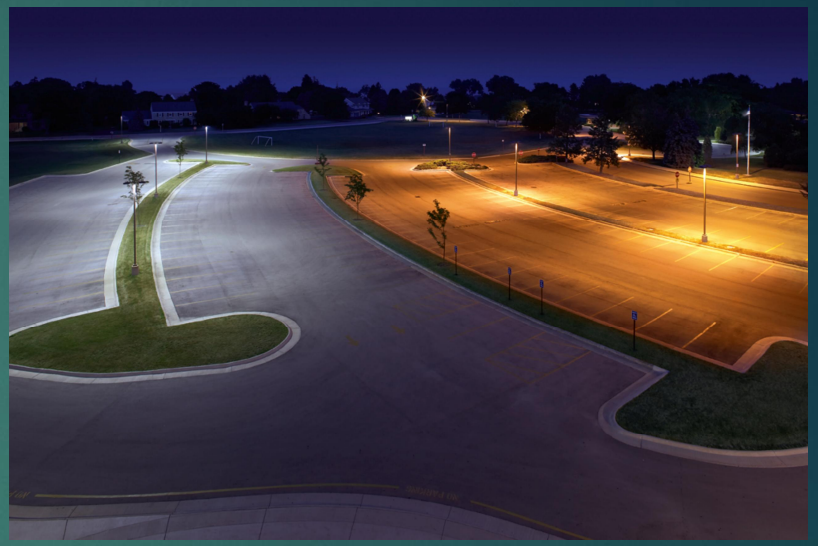


Figure 33: Pollution of LED light vs. High Pressure Sodium Lamps [17]

Electro Permanent Magnetism

- Two states- On and off
- Doesn't need constant electricity
- Extremely strong
- Uses both electro and permanent magnets

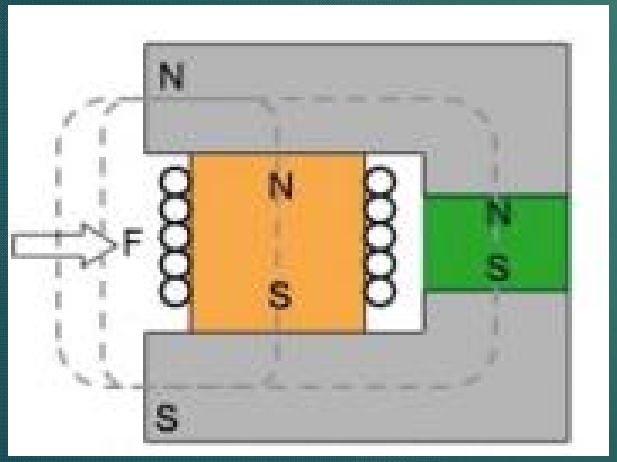


Figure 34: Electro permanent magnet [18]

Figure 35: Industrial crane using electro permanent magnets [19]

Applications

- Coupling system for LED Panel
- Allows easy replacement
- Energy efficient
- No mechanical parts

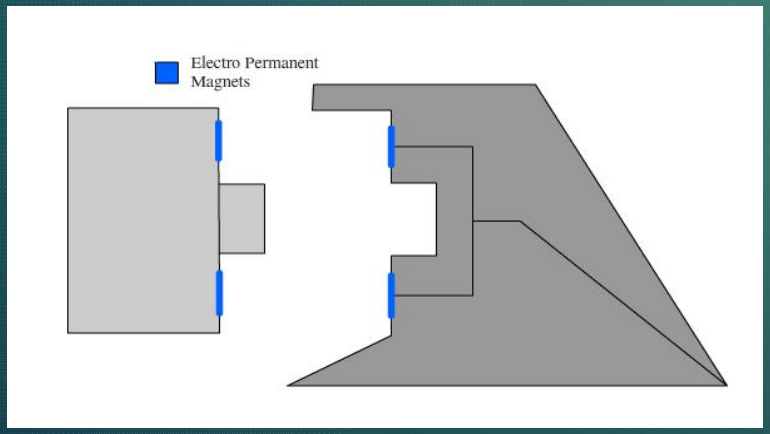


Figure 36: ILSLS Coupling system

Figure 37: Consumer phone using electro permanent magnet attachments. [23]

Kirchhoff's Laws

Voltage Law:

- Sum of voltage drops/gains in a circuit loop = 0

Current Law:

- Sum of all current in a circuit loops is always zero.
  - Charge conserved

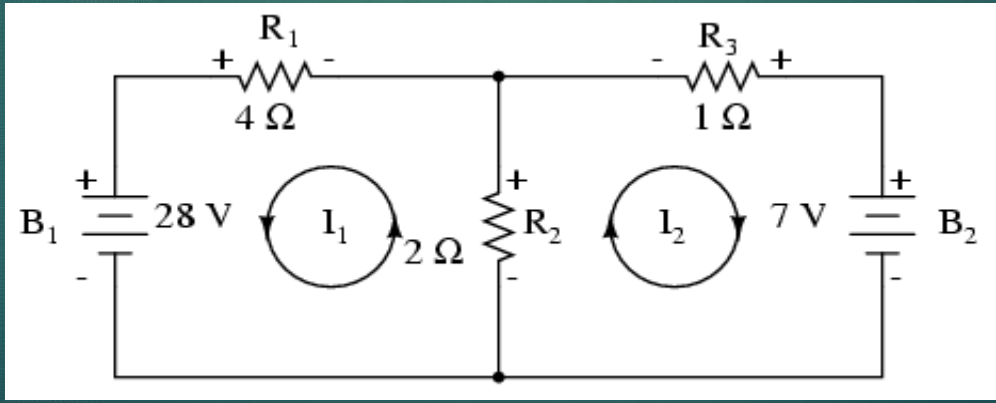


Figure 38: Circuit Diagram, parallel system [21]

Applications

- LED panels wired in parallel
- All panels work independently
- Ensures Safety

Figure 39: ILSLS Coupling system [22]

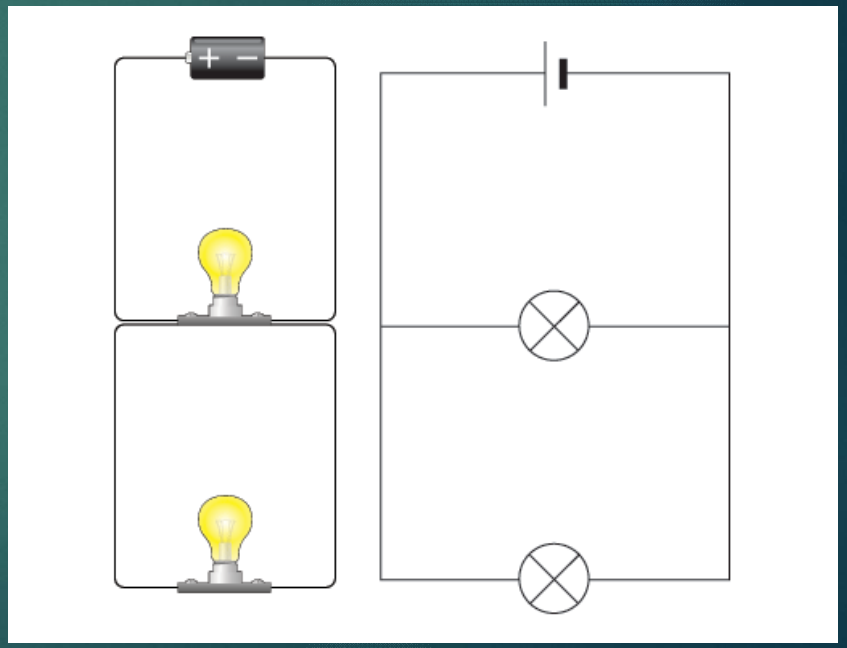


Figure 40: ILSLS Coupling system [21]

Conclusion

- The future is here
- Dynamic
- Safer
- More efficient

Figure 41: Inspiration for the futur [8]

The Interactive LED Street Lighting System will light our way to a greener, safer and brighter future.

References

[1]	M. G. Richard, "Treehugger," 9 March 2010. [Online]. Available: http://www.treehugger.com/interior-design/led-street-lights-are-greenest- choice-life-cycle-study-shows.html. [Accessed 24 July 2014].
[2]	J. Laumer, "Tree Hugger," 14 November 2009. [Online]. Available: http://www.treehugger.com/sustainable-product-design/nightlife-made-sustainable-street-lights-that-match-evening-sensitivities-save-considerable-energy.html. [Accessed 22 July 2014].
[3]	L. R. Fang, "LED Street Light". China Patent 8057074, 21 July 2009.
[4]	G. Manaugh, "Gizmodo," 3 Fedbruary 2014. [Online]. Available: http://gizmodo.com/led-streetlights-will-change-hollywood-and-make-every-c-1514840416. [Accessed 25 July 2014].
[5]	J. Gerdes, "Forbes," 31 July 2013. [Online]. Available: http://www.forbes.com/sites/justingerdes/2013/07/31/los-angeles-completes-worlds-largest-led-street-light-retrofit/. [Accessed 25 July 2014].
[6]	J. Gerdes, "Forbes," 30 June 2012. [Online]. Available: http://www.forbes.com/sites/justingerdes/2012/06/30/global-trial-shows-led-street-lighting-delivers-up-to-85-energy-savings/. [Accessed 26 July 2014].

References

[7]	M. Pearson, "Ottawa Citizen," 20 April 2014. [Online]. Available: http://www.ottawacitizen.com/technology/City+looks+save+year+with+switch+street+lights/9760798/story.html. [Accessed 22 July 2014].
[8]	"Nexus Robot," 2010. [Online]. Available: http://www.nexusrobot.com/product.php?id_product=43. [Accessed 22 July 2014].
[9]	"Sarda Magnets," 2013. [Online]. Available: http://www.sardamagnets.com/application.asp?prodid=147. [Accessed 2014 5 July].
[10]	"Zoolander Education," 24 March 2009. [Online]. Available: http://zonalandeducation.com/mstm/physics/mechanics/forces/newton/mightyFEqMA/mightyFEqMA.html. [Accessed 24 July 2014].
[11]	M. Pelton, "Fundamental Creation Physics," 19 Septmeber 2012. [Online]. Available: http://milestone26.blogspot.ca/2012/09/gravity-and-gravitational-agttraction.html. [Accessed 24 July 2014].
[12]	

References

[13]	Williamson Labs," 13 July 2001. [Online]. Available: http://www.williamson-labs.com/480_opt.htm . [Accessed 20 July 2014].
[14]	"Prof Desk," 9 October 2010. [Online]. Available: www.prof-desk.com/materials/physics-i-48. [Accessed 23 July 2014].
[15]	"Gemiz," 15 April 2012. [Online]. Available: http://www.homeideas.pics/tag/make-plexiglass-furniture/ . [Accessed 22 July 2014].
[16]	R. B. C. e. al, "Residual stress analysis of structural stainless steel sections," *Journal of Constructional Steel Research,* vol. 4, no. 2, 2008.
[17]	"Government Energy," 4 August 2013. [Online]. Available: http://apps1.eere.energy.gov/.../outdoor_area_lighting.pdf. [Accessed 18 July 2014].
[18]	[Online]. Available: http://images.tutorvista.com/cms/. [Accessed 23 July 2014].
[19]	"Walker Magnetic," 12 Septemeber 2013. [Online]. Available: http://www.walkermagnet.com/Collateral/Images/English-US/material-handling/rail.jpg. [Accessed 22 July 2014].
[20]	" Dante Storage," 14 May 2011. [Online]. Available: http://dantestorage.blob.core.windows.net/engismo/wpcontent/uploads/2014/06/3-google-projects-cant-wait-for-ara.png. [Accessed 22 July 2014].

References

[21]	R. Desmond, 12 August 2004. [Online]. Available: http://www.ibiblio.org/kuphaldt/electricCircuits/DC/00216.png. [Accessed 12 July 2014].
[22]	"Digi Gallery," [Online]. Available: http://gallery.digi.com/wp-content/uploads/2013/10/christmas-lights.jpg. [Accessed 12 July 2014].
[23]	Dante Storage[Online]. Available: http://dantestorage.blob.core.windows.net/engismo/wpcontent/uploads/2014/06/3-google-projects-cant-wait-for-ara.png [Accessed 14 July 2014].
[24]	5 February 2014. Electromagnetic Spectrum [online]. Available: http://www.sun.org/encyclopedia/electromagnetic-spectrum [Accessed 8 July 2014].
[25]	EETimes[Online]. Available: http://www.eetimes.com/document.asp?doc_id=1272536 [Accessed 8 July 2014].
[27]	Unite Under Freedom [Online]. Available: http://uniteunderfreedom.com/?p=1003 [Accessed 26 July 2014].
[28]	S. Gajendran, "Creativentechno," 7 January 2012. [Online]. Available: http://creativentechno.wordpress.com/2012/01/07/how-led-works/. [Accessed 20 July 2014].