INTRODUCTION TO TELEVISION ENGINEERING

EEEN 462 – ANALOGUE COMMUNICATION

Friday, 21 November 2025

DEFINITIONS

- **Television** is the transmission of visual images of moving and stationary objects, generally with accompanying sound, as electromagnetics waves and the reconversion of the received waves into audio and visual signals.

- **Broadcast engineering** is the field of electrical engineering, and now to some extent computer engineering and information technology, which deals with radio and television broadcasting. Broadcast engineering involves both the studio and transmission aspects (the entire air-chain), as well as receivers.

DEFINITION TWO

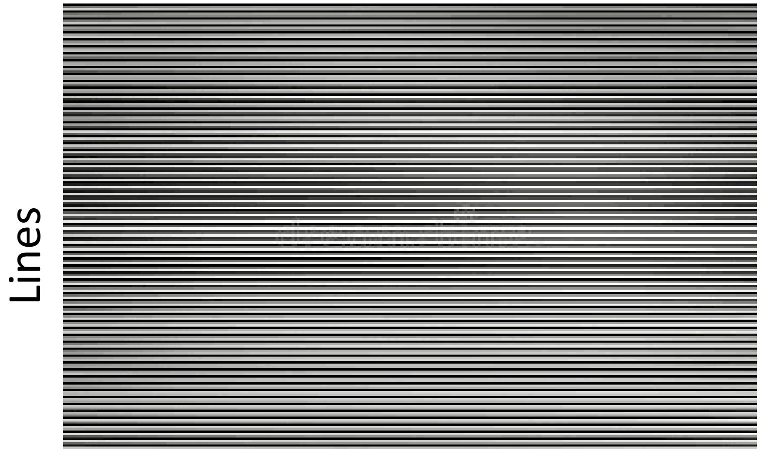
1. **Television** is an electromagnetic apparatus that receives electromagnetic waves and displays the reconverted signals

2. **Television** is the integrated audio and visual content of electromagnetic waves received and converted by such apparatus.

HISTORY OF TELEVISION

- 1925 - First demonstration of electronic TV by J.L Baird (UK) and C.F Jenkins (USA)
- 1930 – Development of camera and picture tubes
- 1933 – First TV broadcasts

BASICS - TYPES OF TV SYSTEMS



Monochrome

1. 525 lines – NTSC, American
2. 625 lines – PAL, European
3. 819 lines – SECAM, French

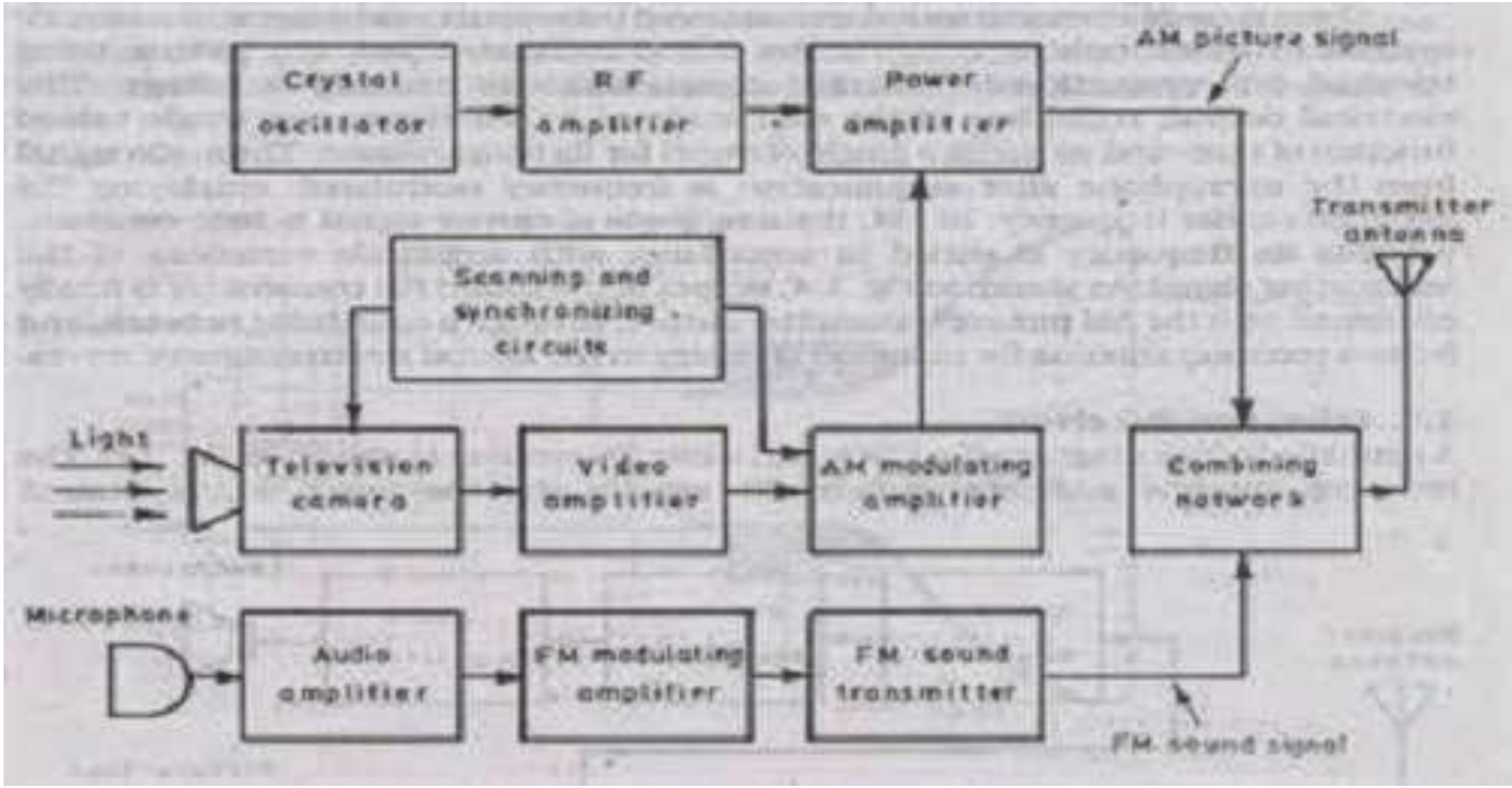
Colour Systems

1. **N**ational **T**elevision **S**ystem **C**ommittee (NTSC) used in America since 1953
2. **P**hase **A**lternation by **L**ines (PAL) developed in Germany in 1967
3. **S**equential **C**oulerus **A** **M**emoir (SECAM) – French for French for "Sequential colour with memory"

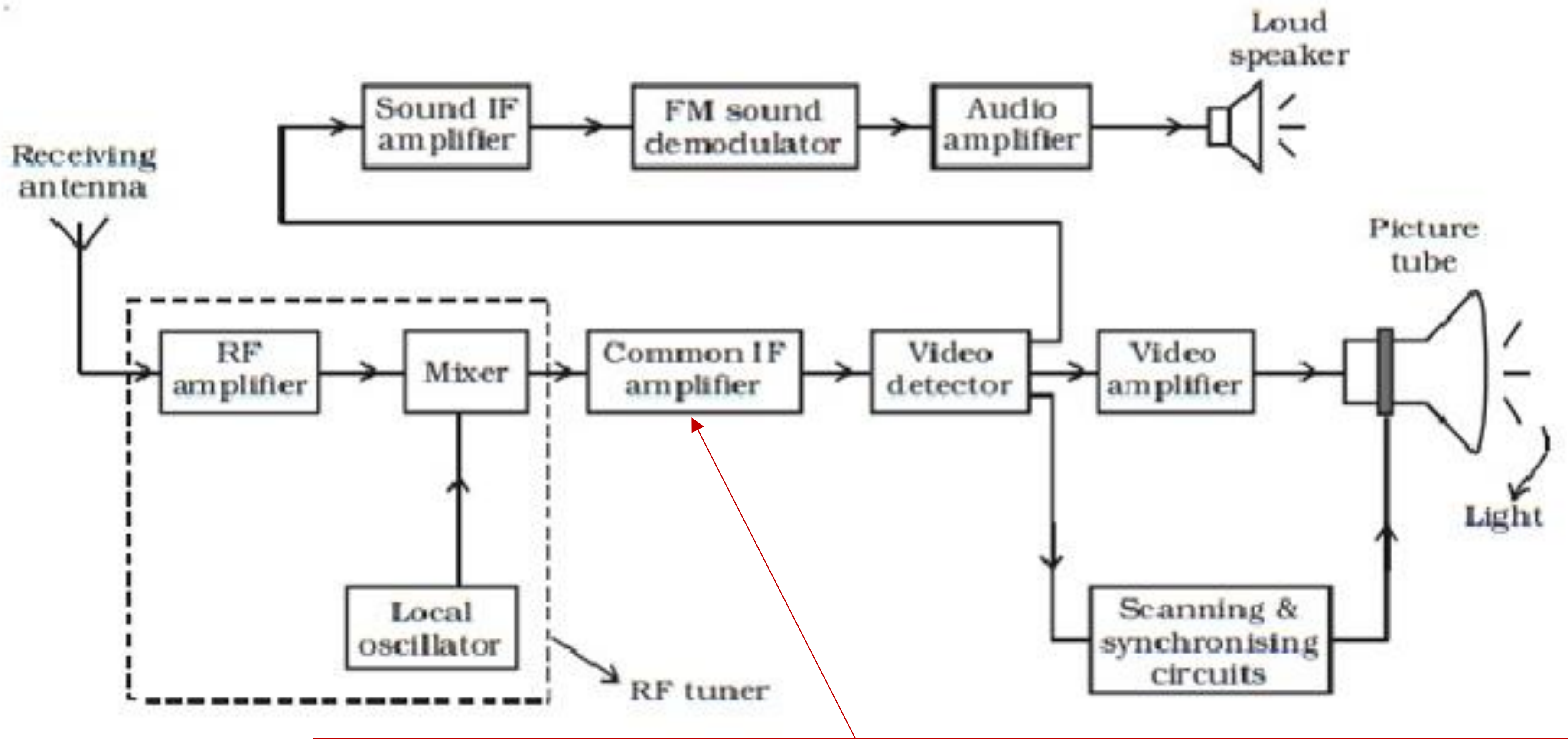
Frequency Bands

1. VHF Band – 41 to 68 MHz and 174 to 230 MHz
2. UHF Band – 470 MHz – 840 MHz

BASICS - BLOCK DIAGRAM OF MONOCHROME TV TRANSMITTER



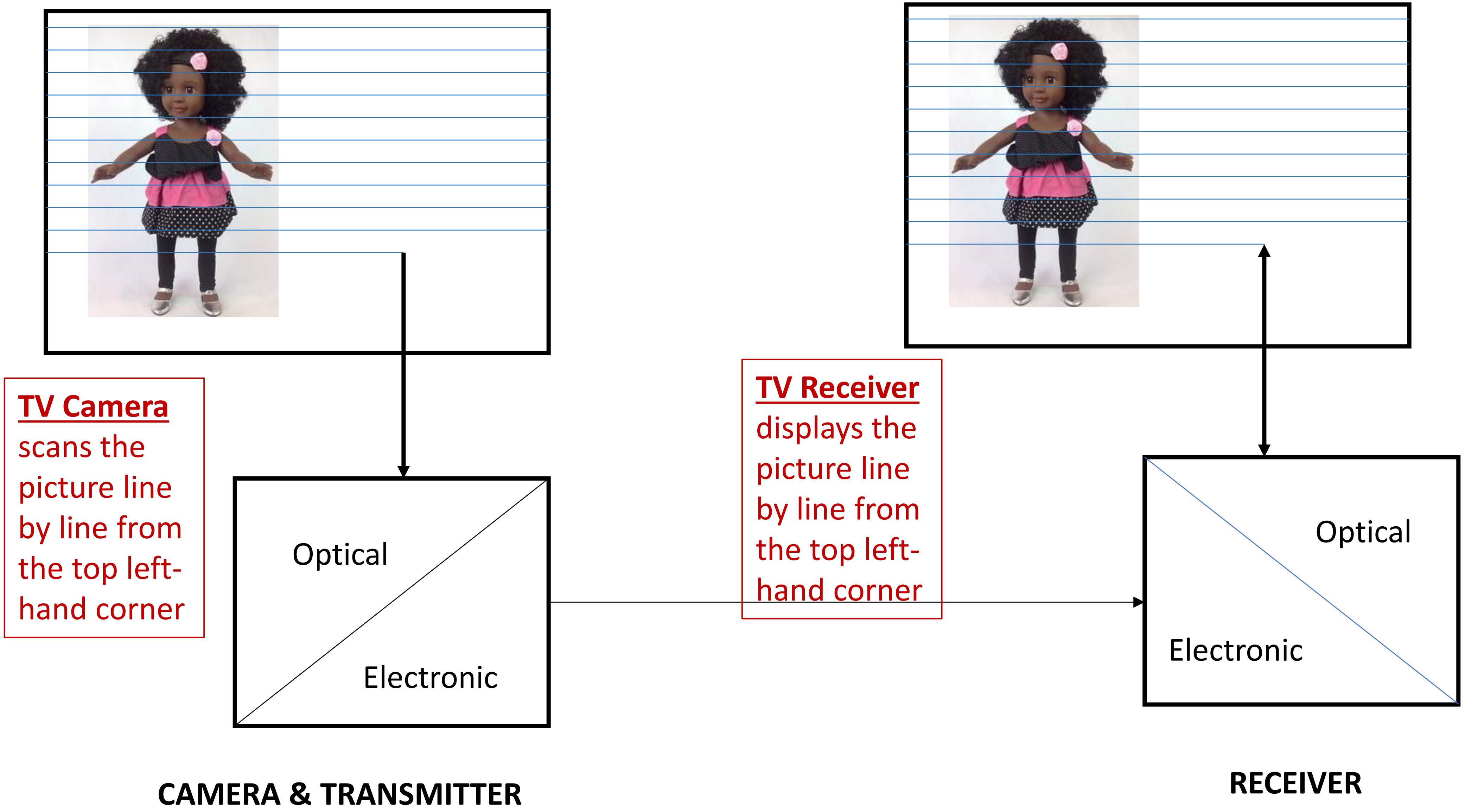
BASICS - BLOCK DIAGRAM OF MONOCHROME TV RECEIVER



Reasons why intermediate Frequency is used

1. To improve frequency selectivity by filtering at IF
2. At high frequencies, signal processing circuitry performs poorly
3. To convert the various tunable frequencies of the stations to a common frequency for processing.

BASICS – VIDEO TRANSMISSION & RECEPTION



GROSS STRUCTURE OF TELEVISION

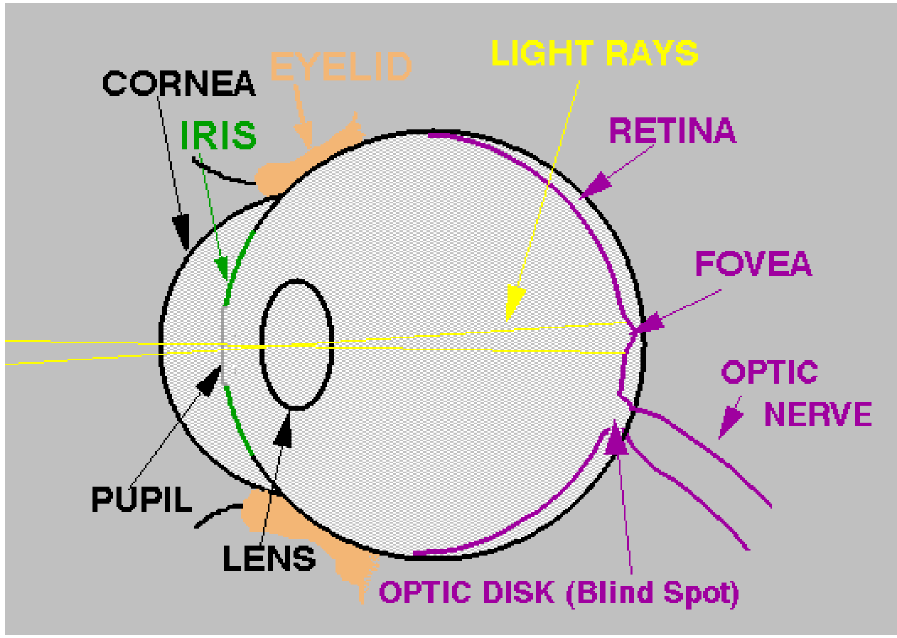
Television frame standard is a rectangle with a width-to-height ratio of a picture frame referred to as aspect ratio of 4:3.

Reasons for adopting 4:3 aspect ratio are:

1. Eyes can move with more ease in the horizontal direction than in the vertical direction.

2. The fovea, surface with maximum sensitivity and resolution at the centre of the retina has greater width than height.

3. Aspect ratio of 4:3 was found to be most pleasing to cinema viewers and was also found to create less fatigue.



BASICS - ASPECT RATIO OF VARIOUS VISUAL DISPLAYS

RESOLUTION OF TV/COMPUTER SCREENS

1. 1280 x 1024 **S**uper-e**X**tended **G**raphics **A**rray **(SXGA)**
2. 1366 x 768 **High** **D**efinition **(HD)**
3. 1600 x 900 **High** **D**efinition Plus **(HD+)**
4. 1920 x 1080 **F**ull **H**igh **D**efinition **(FHD)**
5. 1920 x 1200 **W**ide **U**ltra **E**xtended **G**raphics **A**rray **(WUXGA)**
6. 2560 x 1440 **Q**uad **H**igh **D**efinition **(QHD)**
7. 3440 x 1440 **W**ide **Q**uad **H**igh **D**efinition **(WQHD)**
8. 3840 x 2160 **4K** or **U**ltra **H**igh **D**efinition **(UHD)**

WORKED EXAMPLE 1: DIMENSIONS OF A TV SCREEN

Dimensions of a TV screen are usually specified by the diagonal length of the screen.

Example 1

For an aspect ratio of 4:3, determine the height and width of a 100cm screen size.

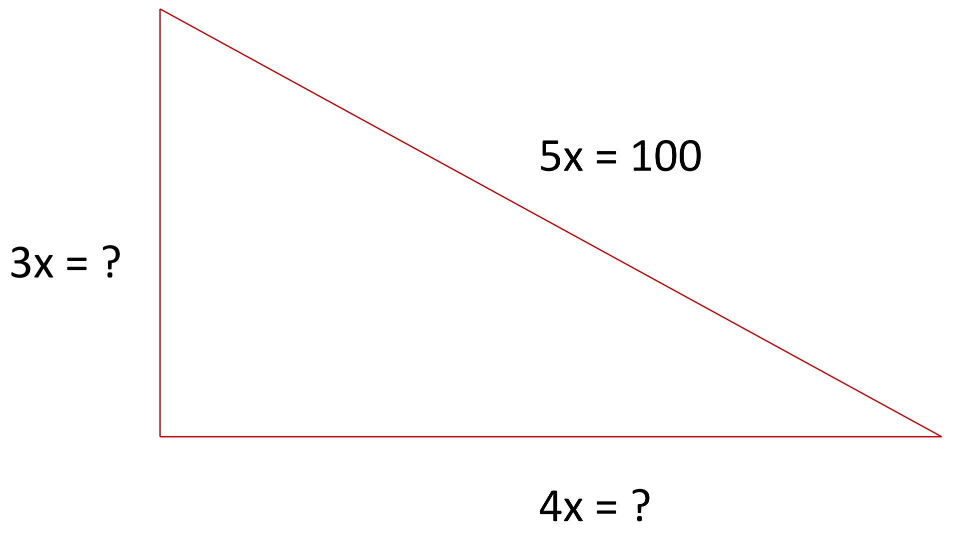
Solution

5x = 100 cm

x = 20

Hence height, = 3x =20x3 = 60 cm

Width = 4x =20X4 = 80 cm



WORKED EXAMPLE 2 : DIMENSIONS OF A COMPUTER SCREEN

Dimensions of a TV screen are usually specified by the diagonal length of the screen.

Example 1

For an aspect ratio of 16:9, determine the height and width of a 100cm screen size.

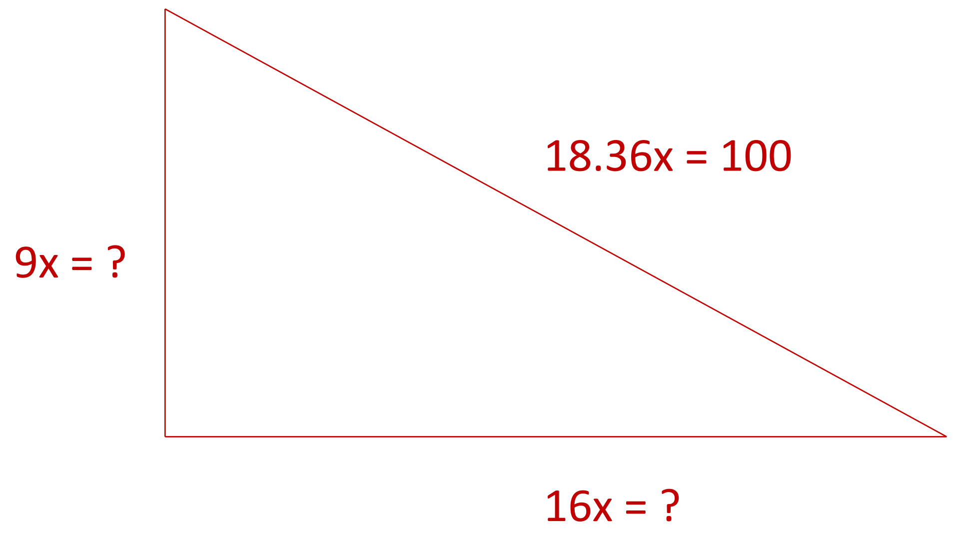
Solution

18.36x = 100 cm

x = 5.4

Hence height, = 9x =9x5.4 = 49 cm

Width = 16x =16X5.4 = 86.4 cm



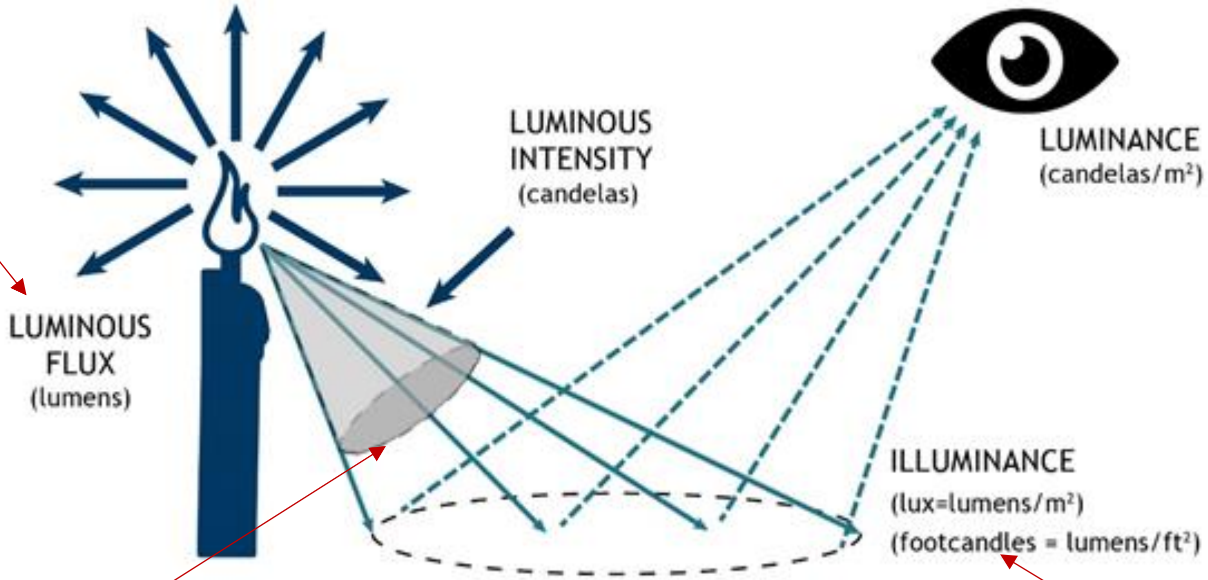
SCIENTIFIC BACKGROUND TO TELEVISION

ECE 516E – ANTENNA & RADIOWAVE PROPAGATION

Monday, November 10, 2025

MEASURING LIGHT BRIGHTNESS /01

Luminous Flux : Total amount of visible light emitted by a source per second, in all directions. It measures the total "output" of a light source



Luminous Intensity: Power of light emitted by a source in a particular direction. It describes how "concentrated" the light is in a specific beam.

Illuminance: Amount of luminous flux falling on a given surface area. It measures how much a surface is illuminated.
Formula: 1 Lux = 1 Lumen per square meter (lm/m^2).

MEASURING LIGHT BRIGHTNESS /02

UNIT IN LIGHT SYSTEM	PROPERTY NAME	UNIT NAME (SYMBOL)	MEASURAND
Light Source	Luminous Flux	Lumen (lm)	Total amount of visible light emitted.
Light Source	Luminous Intensity	Candela (cd)	Power of light emitted in a specific direction.
Illuminated Surface (Book or Screen)	Illuminance	Lux (lx)	How much light falls on a surface. (lm/m^2)
Illuminated Surface (Book or Screen)	**Luminance**	**Nit (cd/m^2)**	How much light is reflected/emitted by a surface. **This is "brightness."**

Notes:
The word "nit" comes from the Latin word "nitere," which means "to shine" or "to glitter."
Nit was adopted as a non-SI (International System of Units) name for the standard unit of luminance, the candela per square meter (cd/m^2), to provide a shorter, more convenient term for industries like display technology and lighting.

PHOTOMETRIC Vs RADIOMETRIC UNITS

Photometric Units:

- Photometric Units measure light energy with regard for human perception. They are weighted by the sensitivity of the human eye.
- Photometric Units are: Lumens, Candelas, Lux and Nits.

Radiometric Units:

- Radiometric Units measure raw light energy without regard for human perception as follows:
  - **Radiant Flux (instead of Luminous Flux)** is measured in Watts (W).
  - **Irradiance (instead of Illuminance)** is measured in Watts per square meter (W/m^2).

Applications:

- **Radiometric units** are used in solar power, radar, terrestrial radio transmitters, and designing lasers.
- **Photometric units** are used for anything related to human vision, like lighting and video displays.

REVIEW QUESTION -

1. Mention the various factors which are necessary for the successful transmission and reception of motion pictures.

ANS:

1. Geometric form and Aspect ratio
2. Number of Scanning lines and frames per second
3. Synchronization
4. Picture Resolution
5. Brightness Gradation and colour characteristics

REVIEW QUESTION – ASPECT RATIO

QUESTION

Justify the reason of having rectangular frame with width-to-height ratio 4:3 in TV system.

ANS

a) Our eye see the movement of objects comfortably only in horizontal direction than in the vertical direction.

b) The frame size of the motion picture which already exists is having the aspect ratio 4:3. So by using the same ratio for TV frame, we can telecast motion pictures in TV screen without wasting any portion (backward compatibility).

c) In real life, most objects move in the horizontal plane.

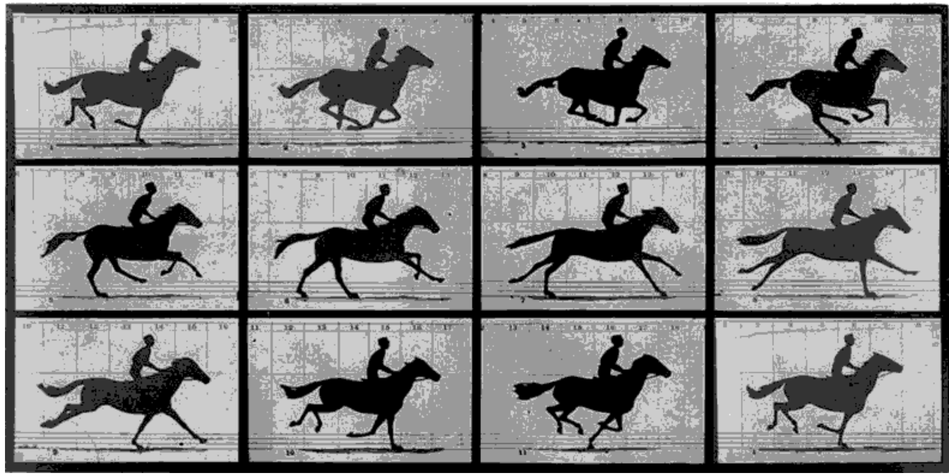
REVIEW QUESTION – PERSISTENCE OF VISION

QUESTION:

What is meant by persistence of vision?

ANS:

Persistence of vision refers to the storage characteristics of the eye. When the nerves of the retina are stimulated by the incident light, the sensation produced will not cease immediately after the light is removed but persists for about 1/16th of a second.



When images are shown in rapid succession, the brain blends them together to create the illusion of smooth, continuous motion. This phenomenon is the basis for how movies, animations, and other visual media work.

REVIEW QUESTION – CHARACTERISTICS OF HUMAN EYE

QUESTION:

Mention some important characteristics of human eye that relate to Television?

ANSWER:

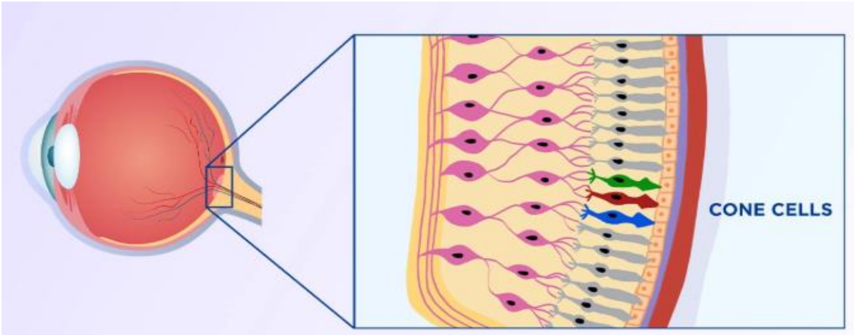
The important characteristics of human eye are:

1. **Visual acuity** - the ability of human eye to resolve finer details in a picture. Acuity defines the maximum pixel density you can perceive at a given viewing distance, which in turn determines the necessary resolution and pixel pitch for an ideal television display.
2. **Persistence of vision** - the perceptual phenomenon where your brain retains an image for a fraction of a second after it's gone, which television exploits by displaying a rapid sequence of still frames to create the illusion of smooth, continuous motion.
3. **Brightness** - the perceived intensity of light emitted from the screen, quantified as luminance and measured in nits (cd/m^2), which is the key metric for calibrating and specifying display performance.
4. **Colour sensation -** Our eye's three cone cells, sensitive to Red, Green, and Blue wavelengths, are the biological blueprint for the RGB subpixels in a television, which are engineered to stimulate these cones in precise combinations to recreate the entire spectrum of color sensation.

REVIEW QUESTION – HUMAN EYE & VISION

QUESTION:

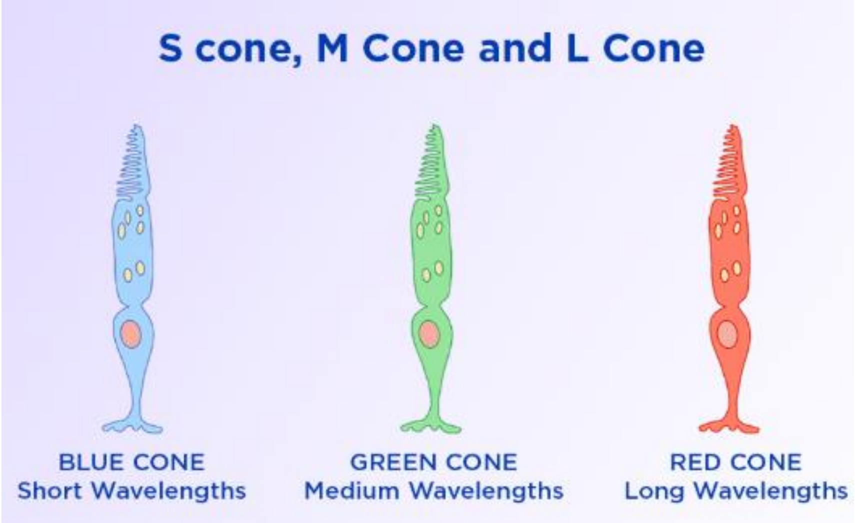
State the names of cells responsible for vision in the human eye



ANSWER:

Rods and Cones are the primary light-sensitive cells that capture the image.

Three types of cones (S, M, L) which are sensitive to Short, Medium, and Long wavelengths (roughly Blue, Green, and Red) are the direct biological inspiration for the RGB subpixels in a television display.



PHOTOCONDUCTIVITY

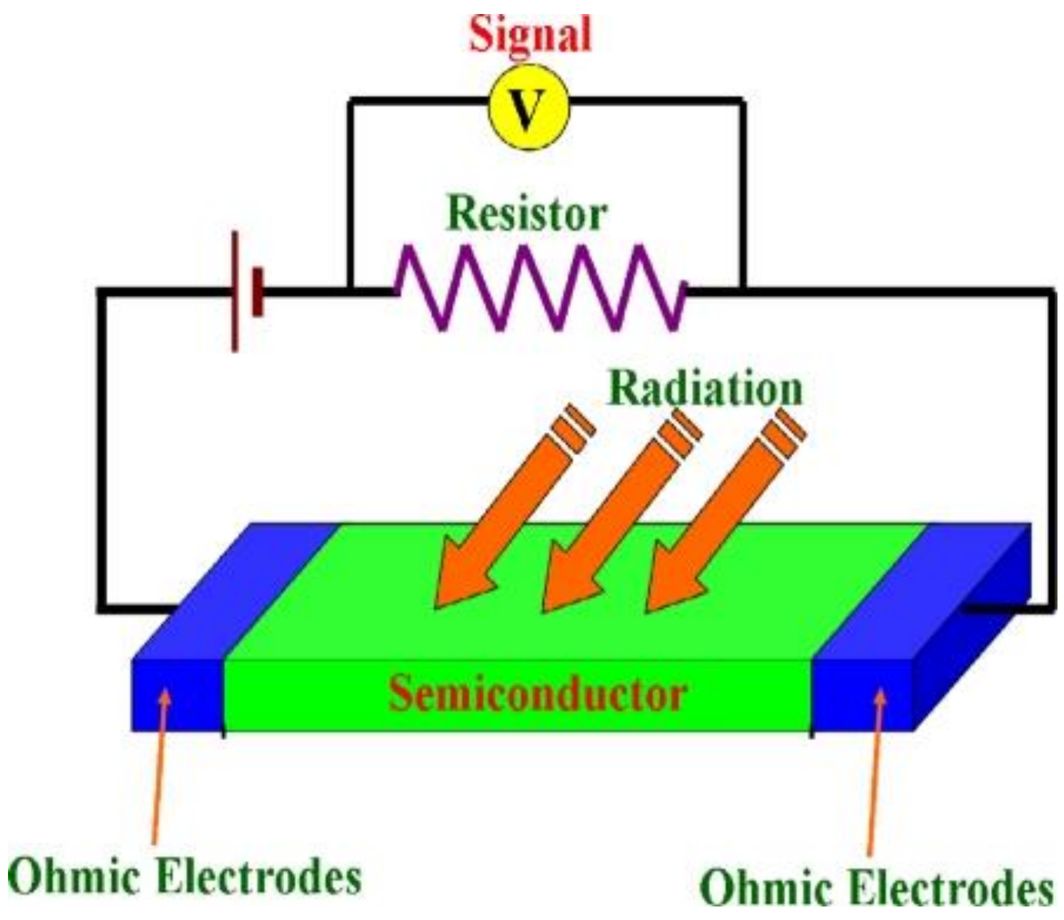
Applications in Television Engineering

ECE 516E – ANTENNAS & RADIOWAVE PROPAGATION

Monday, November 10, 2025

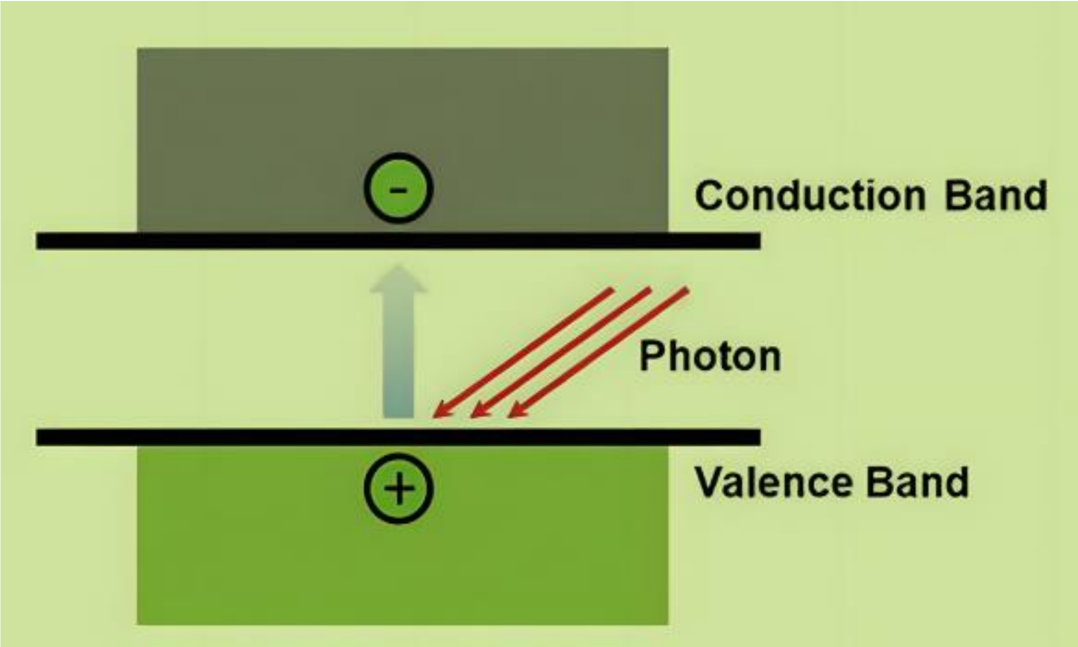
WHAT IS PHOTOCONDUCTIVITY?

1. **Photoconductivity was discovered by Willoughby Smith in 1873, photoconductivity** is the phenomenon where certain materials become more electrically conductive when exposed to light.
   a) **Dark State:** Material has low conductivity (high resistance).
   b) **Illuminated State:** Material has high conductivity (low resistance).
2. **Change in conductivity** is often reversible when the light is removed.



THE PHOTOCONDUCTIVE PROCESS

1. A photon with energy greater than or equal to the band gap (E_g) strikes the material.
2. It transfers its energy to a valence band electron.
3. The electron is excited across the band gap into the conduction band.
4. This creates two charge carriers:
   a) A free electron in the conduction band.
   b) A positively charged hole in the valence band.



Further Reading:
https://inc42.com/glossary/photoconductivity/

THE CORE CHALLENGE OF TELEVISION:
TURNING LIGHT INTO AN ELECTRONIC SIGNAL

1. **The Goal:** Transmit a moving image electronically.
2. **The Problem:** How to "see" a scene and convert its varying brightness levels (light) into a corresponding varying electrical signal.
3. **Early Mechanical Solutions (Nipkow Disk):**
   1. Used spinning disks with holes to scan a scene.
   2. Limited resolution, bulky, and prone to wear.
4. **The Need for an All-Electronic Solution:**
   1. Required a device that could change its electrical properties based on light intensity.

MECHANICAL TV IMAGE FORMATION - NIPKOW DISK

1. **Nipkow disk** consisted of a spinning disk with a spiral pattern of holes that, by precisely timing a light source and a photo-sensor, scans an image line by line.
2. **Nipkow disk** was a crucial component of early mechanical televisions, invented by Paul Nipkow in 1884.
3. **Nipkow disk was used in the first televisions of the 1920s and 1930s** until electronic television systems became the standard.

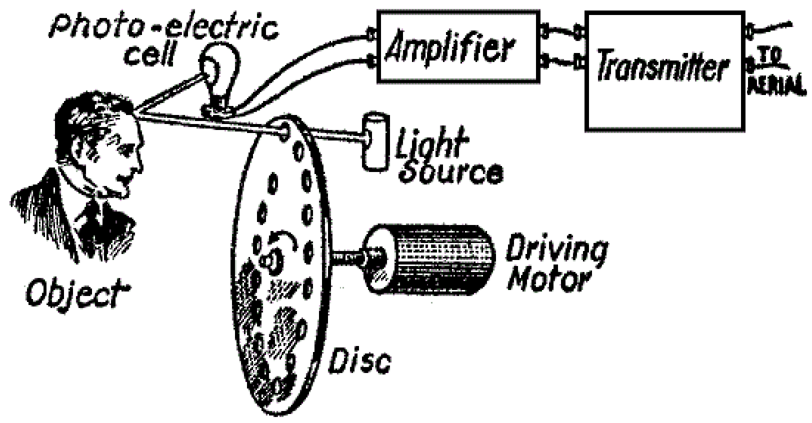


FIG. 1.—Nipkow Disc Scanning at Televisor or Transmitter.
www.hawestv.com

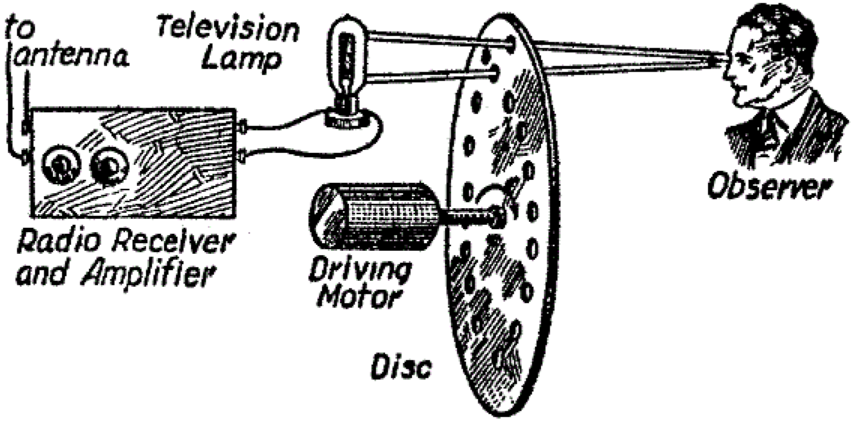
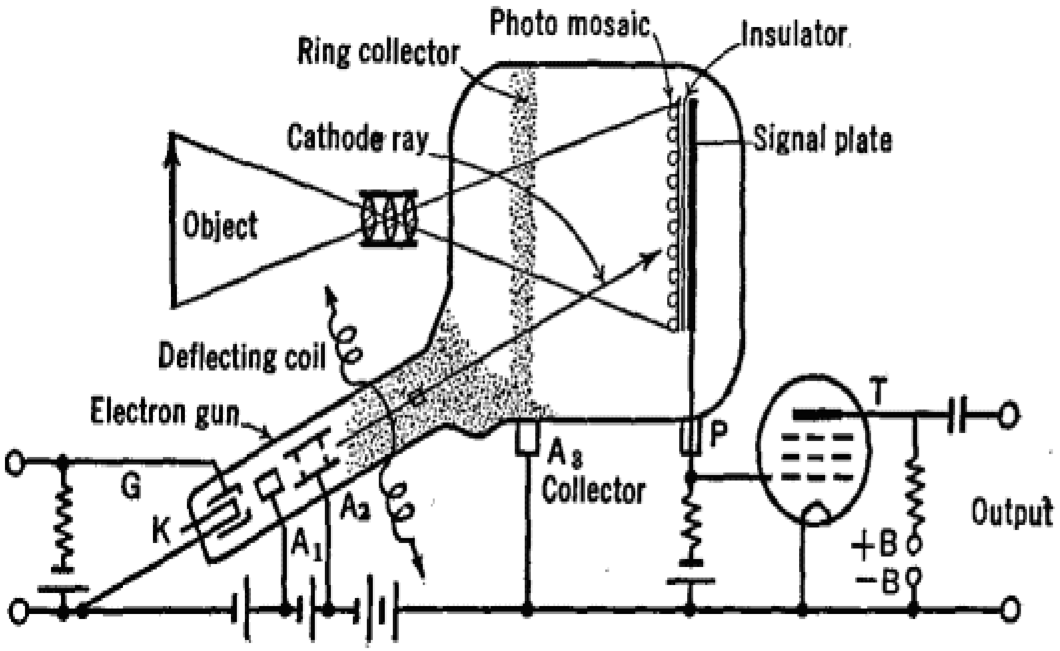


FIG. 2.—Nipkow Disc Reproduction at Television Receiver.
www.hawestv.com

<u>**Further Reading:**</u>
http://www.hawestv.com/mtv_howMTVwks/howMTVwks.htm

TV IMAGE FORMATION - ICONOSCOPE

1. **The Inventor:** Vladimir K. Zworykin, often called the "father of television."
2. **The Device:** The **Iconoscope** was the first practical video camera tube based on photoconductivity.
3. **Core Components:**
   a) **Photoconductive Mosaic:** A screen coated with millions of tiny, isolated droplets of a photoconductive material (like silver coated with cesium-silver oxide).
   b) **Electron Gun:** Fires a beam of electrons to scan the mosaic.
   c) **Collector Ring:** Captures the resulting signal current.
4. **Iconoscope replaced mechanical spinning parts with a fast, electronic scanning beam.**



Further Reading:
http://www.vias.org/basicradio/basic_radio_22_06.html

LEGACY & IMPACT OF THE ICONOSCOPE

1. **A Major Breakthrough:** The Iconoscope made high-definition, all-electronic television possible.
2. **Widespread Adoption:** It was the primary camera tube used by RCA and NBC for broadcasting in the 1930s and 1940s.
3. **Evolution:** Iconoscope to improved tubes like the **Orthicon** and **Vidicon**, which used the same core photoconductive principle but were more sensitive.
4. **Lasting Legacy:**
    1. Proved the viability of electronic image capture.
    2. The principle of using a material's property to convert light to a signal is fundamental to modern **CCD and CMOS sensors** in digital cameras and phones.