
بسم الله الرحمن الرحيم

Fluoroscopy

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Objectives

1. Discuss the development of fluoroscopy
2. Explain visual physiology and its relationship to fluoroscopy
3. Describe the components of an image intensifier
4. Calculate brightness gain and identify its units
5. Discuss the role of the television monitor and television image in forming the fluoroscopic image

OUTLINE

Overview of Fluoroscopy
Special Demands of Fluoroscopy
Illumination
Human Vision
Fluoroscopic Technique
Fluoroscopic Image Intensification
Image-Intensifier Tube
Multifield Image Intensification
Fluoroscopic Image Monitoring
Fluoroscopic Image Recording

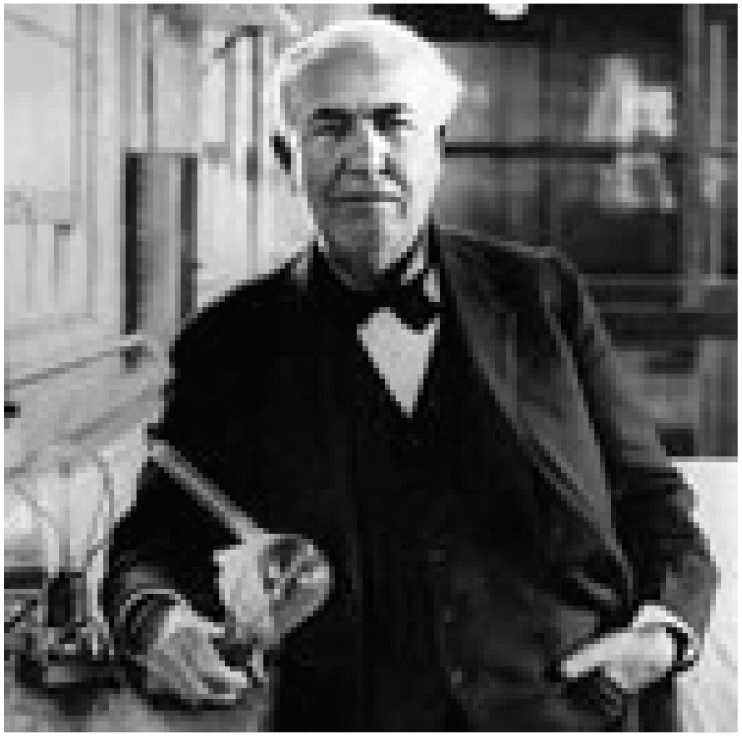
Overview of Fluoroscopy

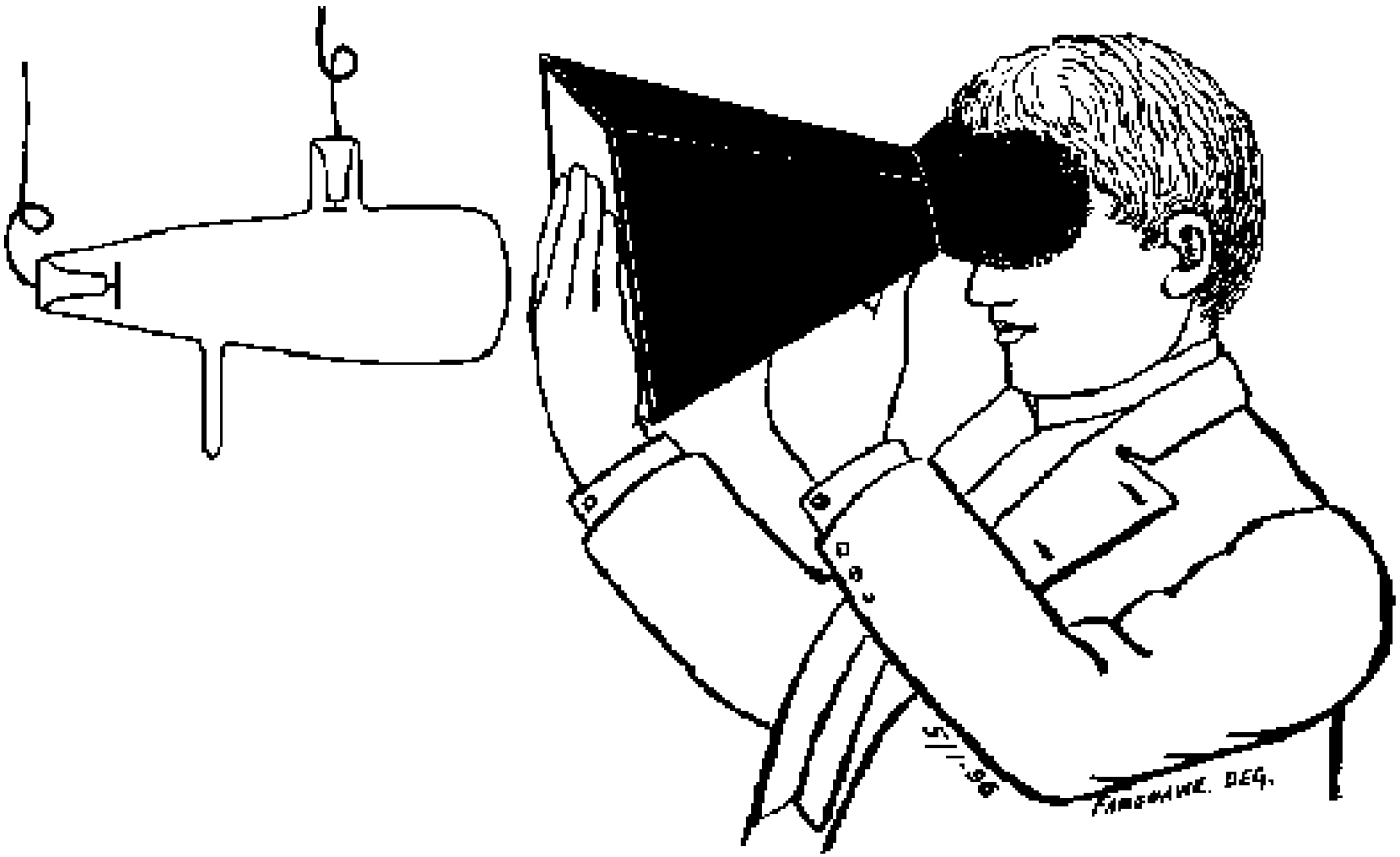
- **Fluoroscopy was invented by Thomas Edison in 1896.**
- **The fluoroscope is used for the examination of moving internal structures and fluids.**
- **The images in the earliest fiuoroscopic systems were of very poor quality for a number of reasons:**

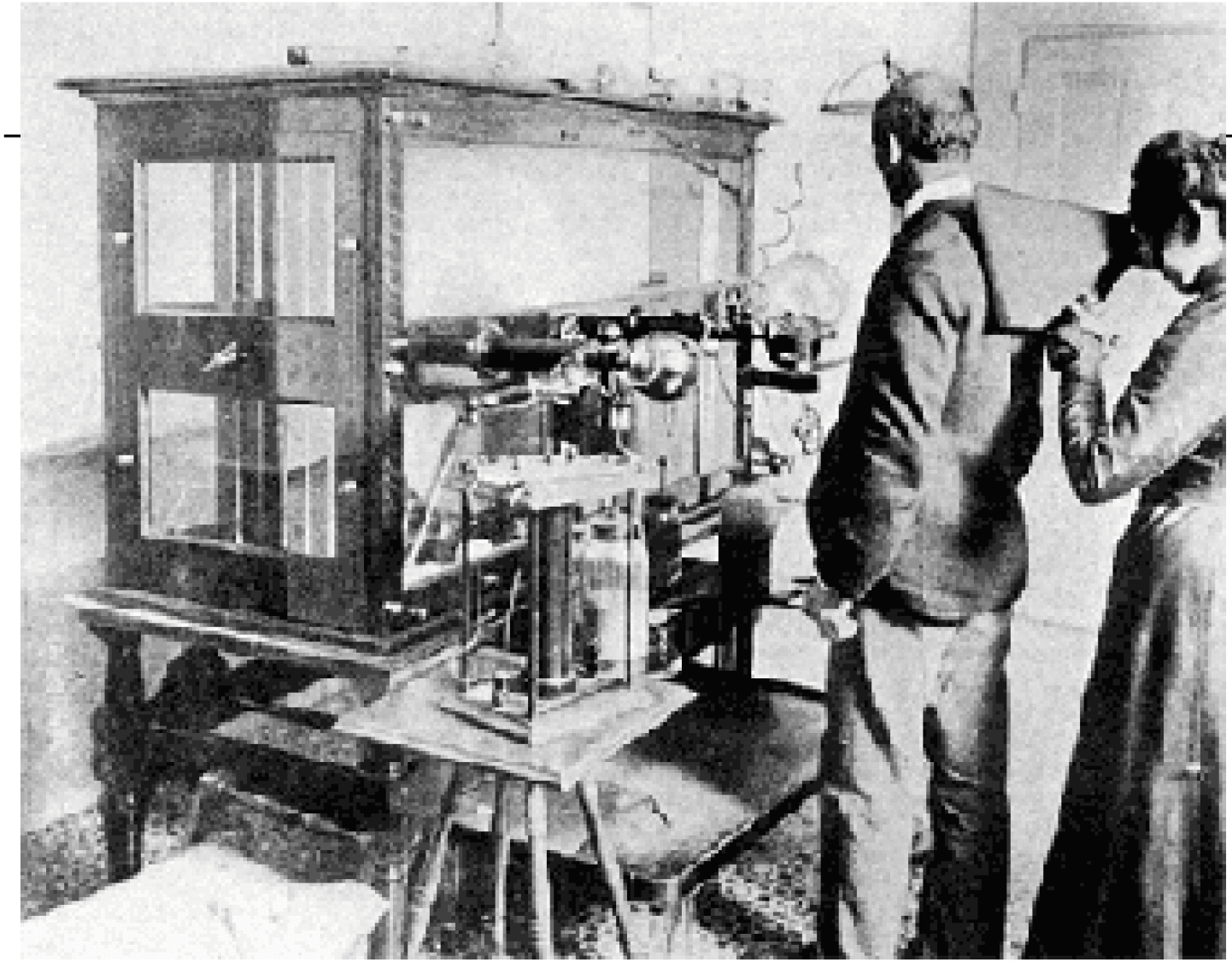
1- Poor light output by the fluorescent screen for safe exposure rates.

2-Low efficiency of the light conversion of the screen.

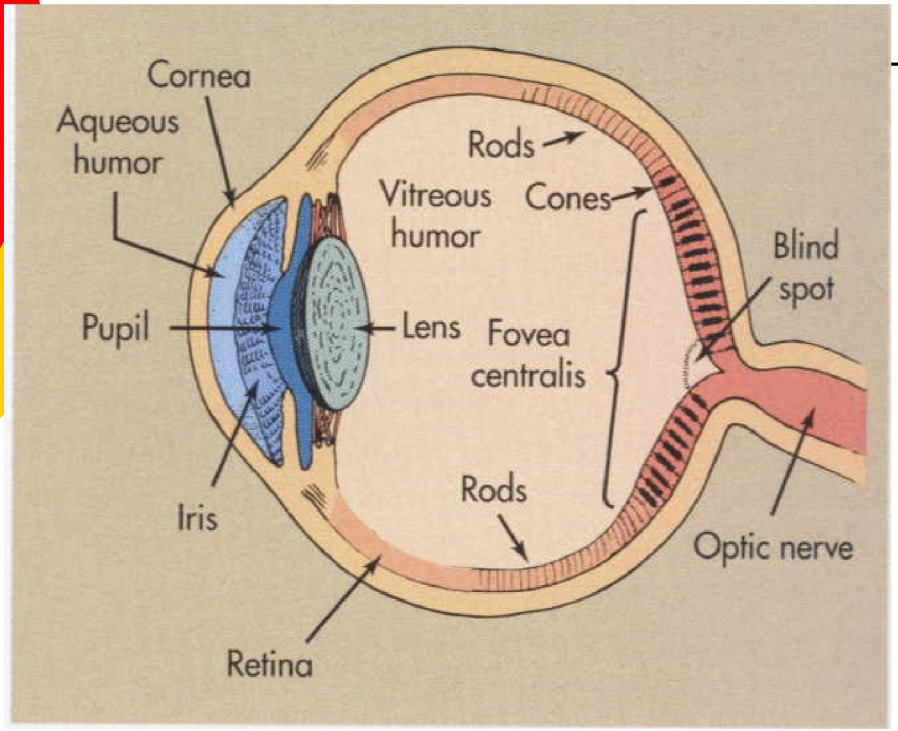
3-poor spatial resolution.

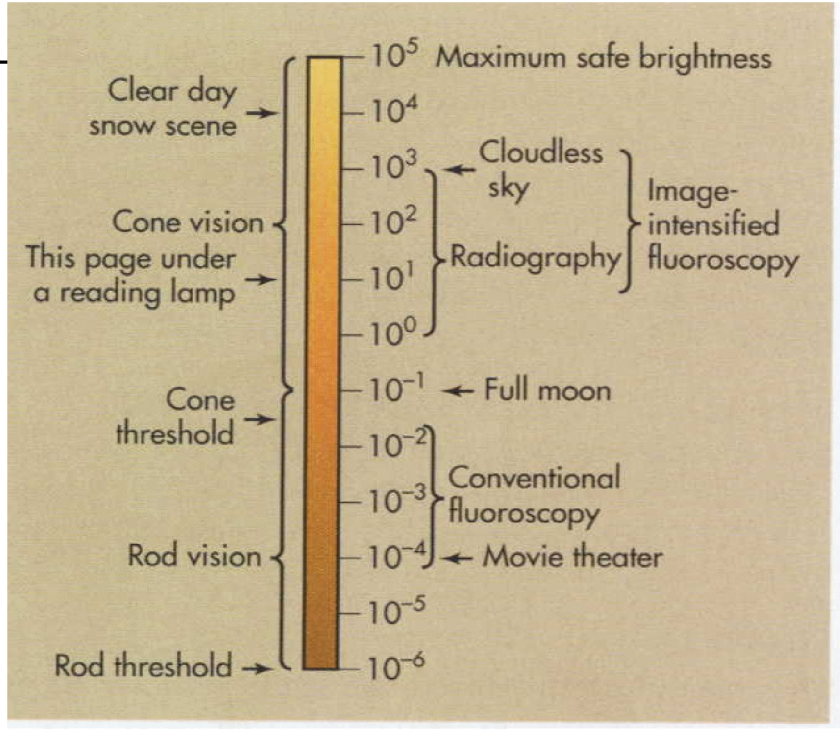






Human vision

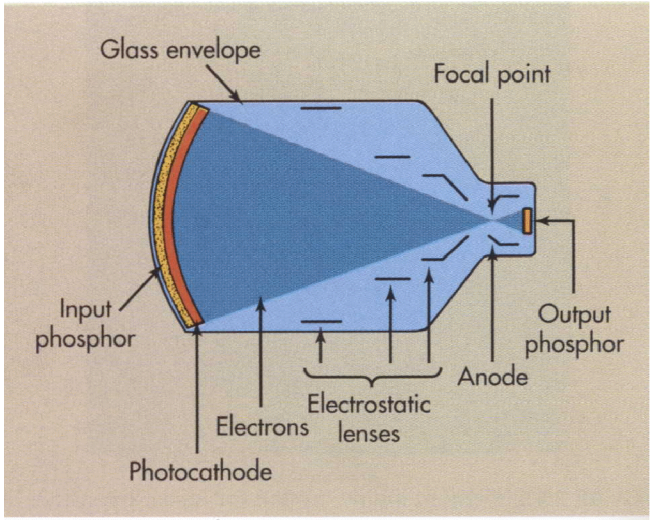


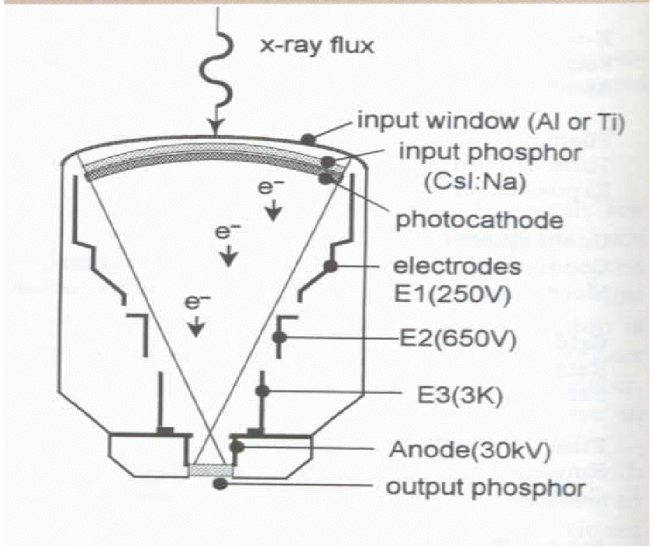


- There are more than 100000 of rods and cones per square millimeter of retina.
- The rods are sensitive to low light levels (scotopic vision) , but the cones are less sensitive to light (photopic vision).
- The visual acuity of cones is much better than that of rods.
- The cones perceive color, but rods are essentially colorblind.

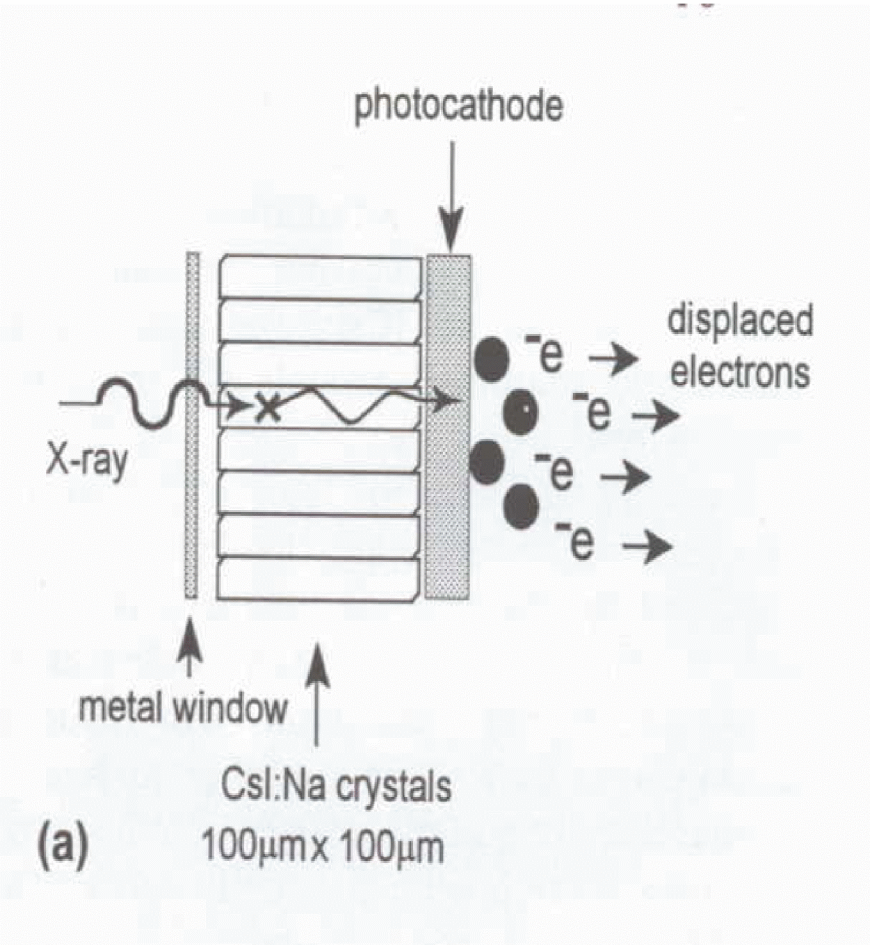
Image Intensifier tube

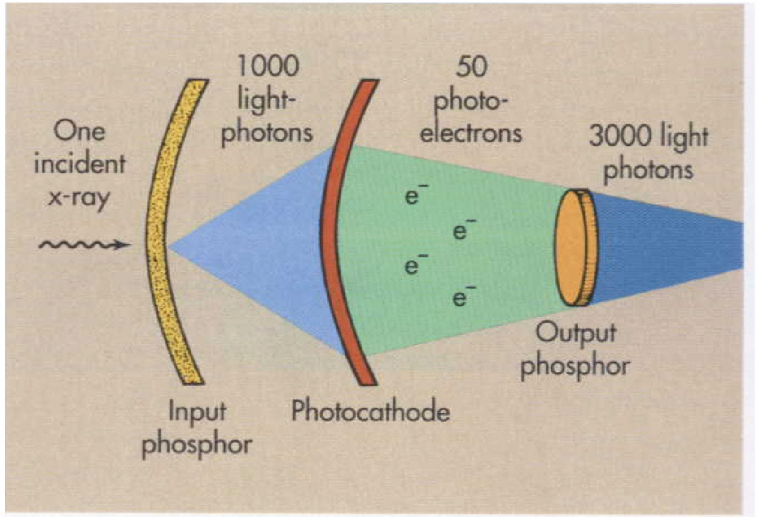
- A thin glass or metal (aluminum or titanium) input window,
- An input fluorescent screen (CsI:Na).
- A photocathode.
- high voltage focusing electrodes E1, E2 and E3 electrodes leading to the anode.
- output fluorescent screen coupled to a video camera and/or film cameras

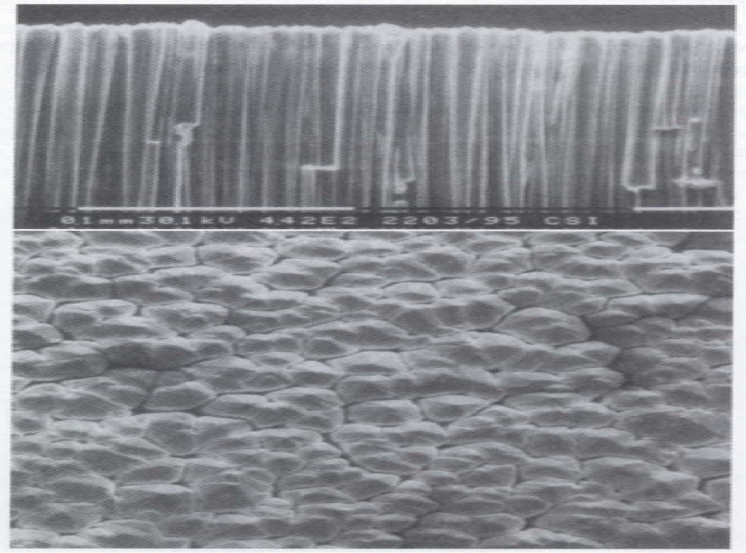




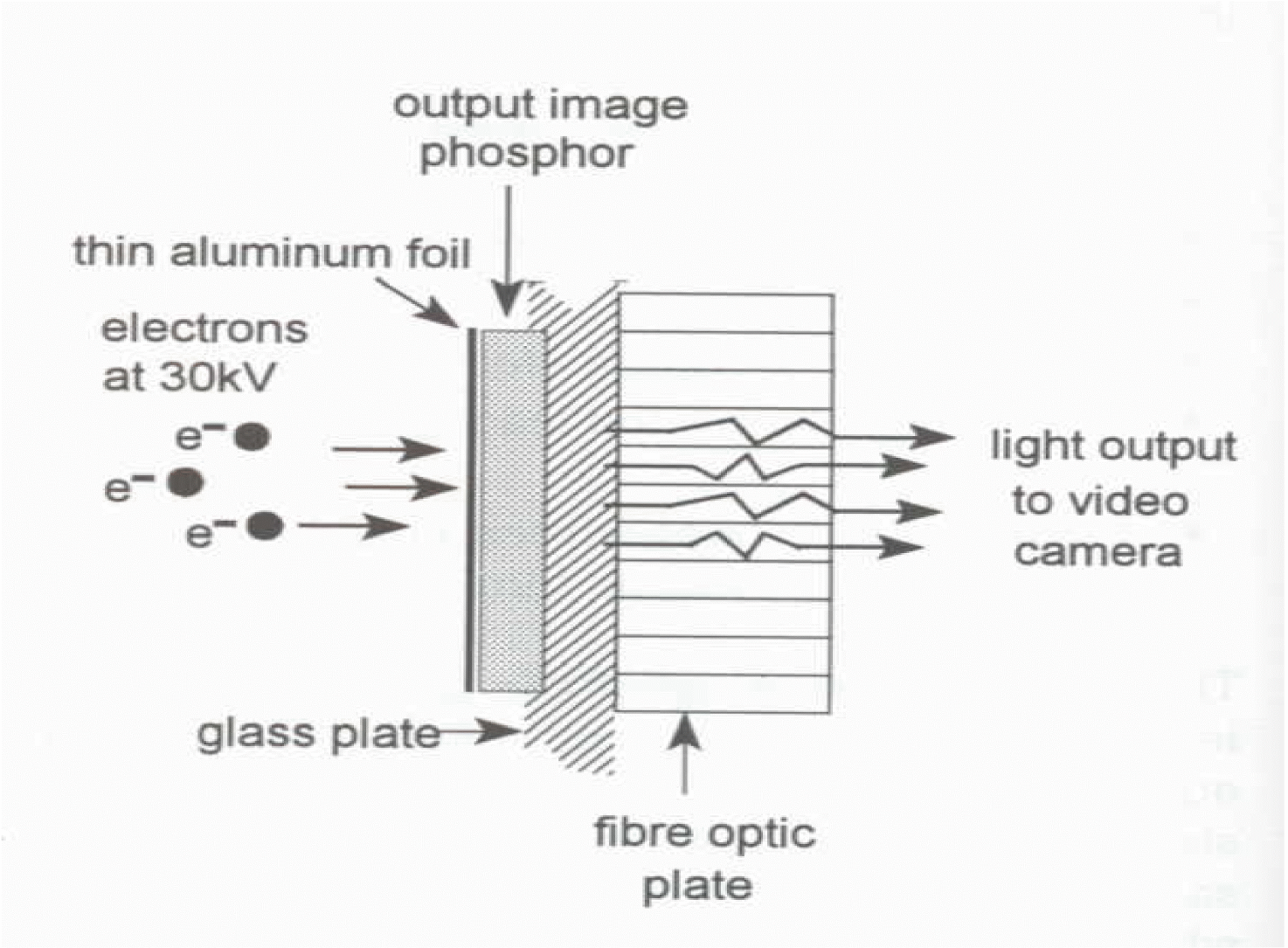
Input Phosphor







Output phosphor



Brightness Gain

$$\text{Flux Gain} = \frac{\textit{Light photons from output phosphor}}{\textit{light photons at photocathode}}$$

Minification Gain

$$\text{Minification Gain} = \left(\frac{d_i}{d_o}\right)^2$$

where d_i is the diameter of the input phosphor and d_o is the diameter of the output phosphor.

Brightness Gain

Brightness gain = Minification gain × Flux gain

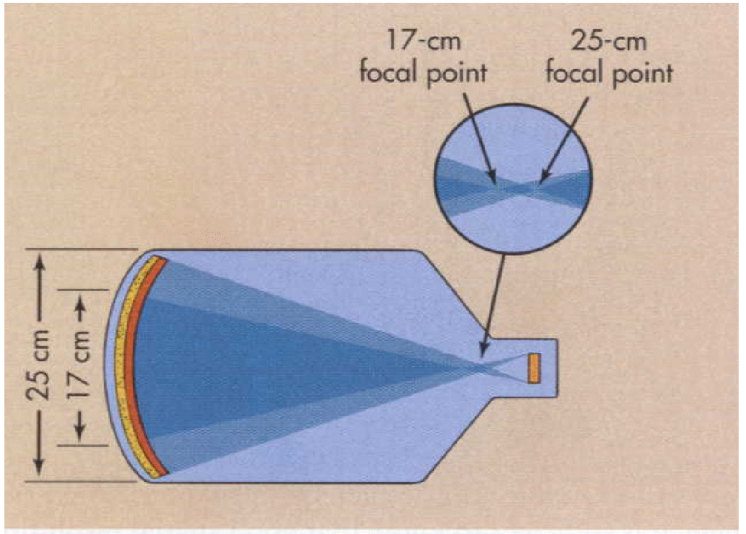
Conversion Factor

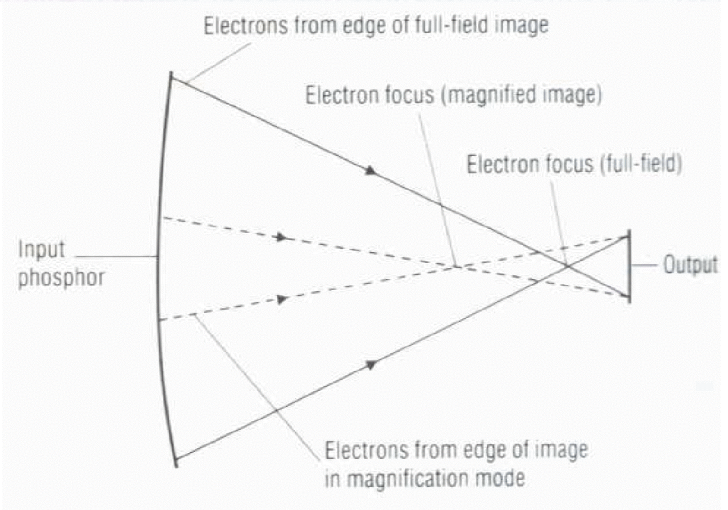
$$\text{Conversion Factor} = \frac{\text{Output-phosphor illumination (cd/m}^2\text{)}}{\text{Input exposure rate (mR/s)}}$$

Multifield Image Intensification

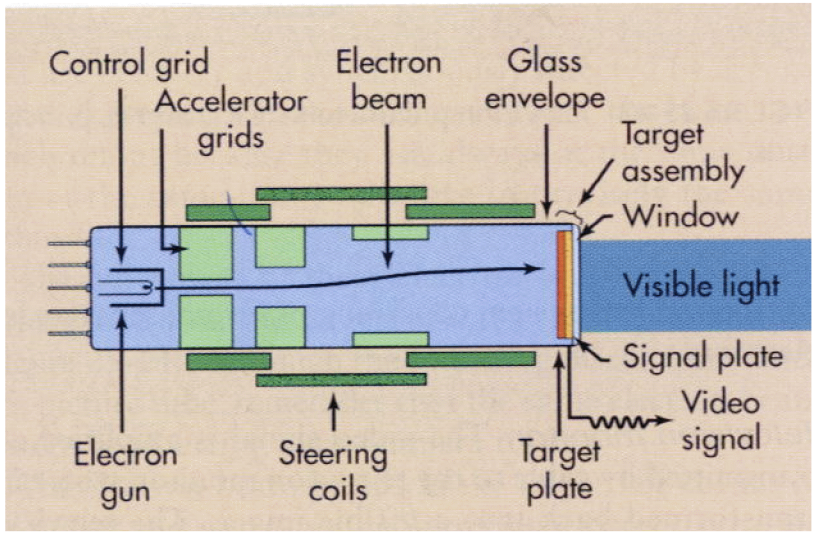
$$MF = \frac{d_1}{d_2}$$

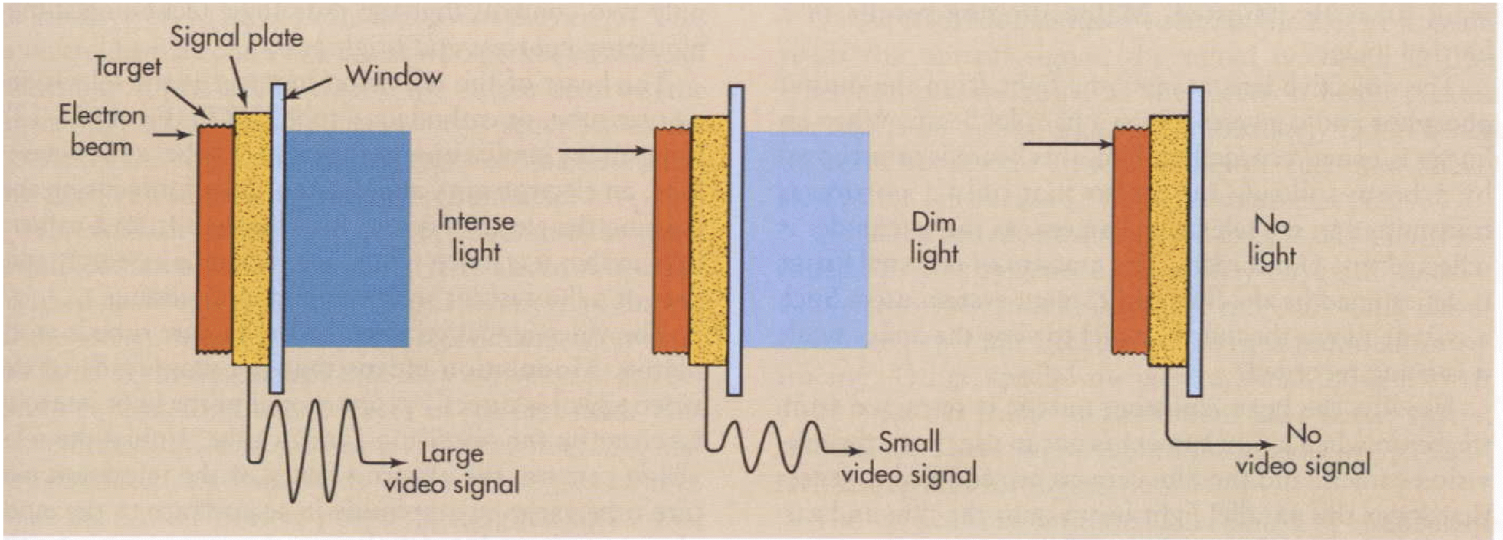
$$\text{patient dose} = \frac{d_1^{\,2}}{d_2^{\,2}}$$



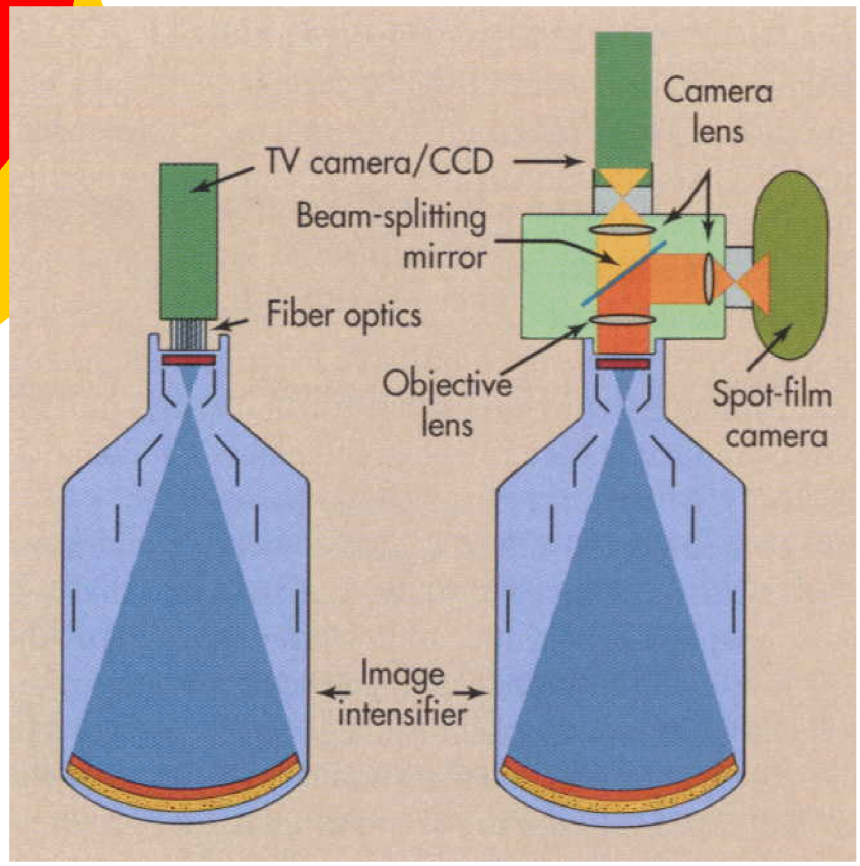


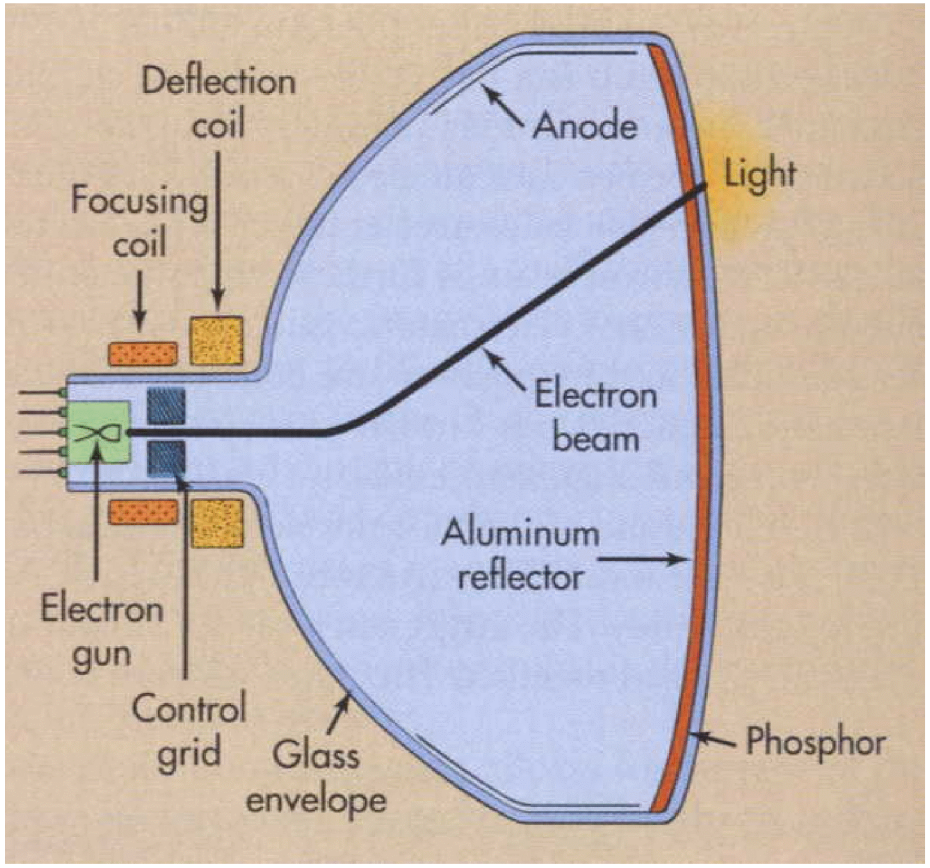
Vidicon television camera Tube



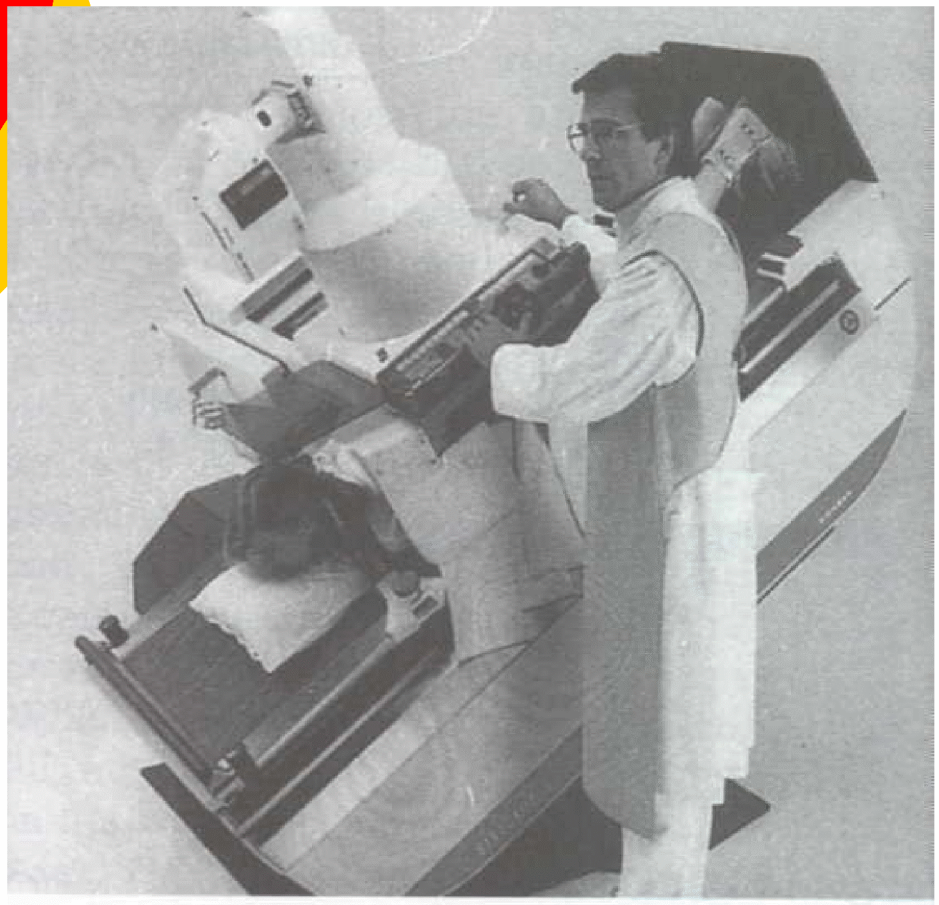


Television picture Tube (CRT)





Fluoroscope and associated parts



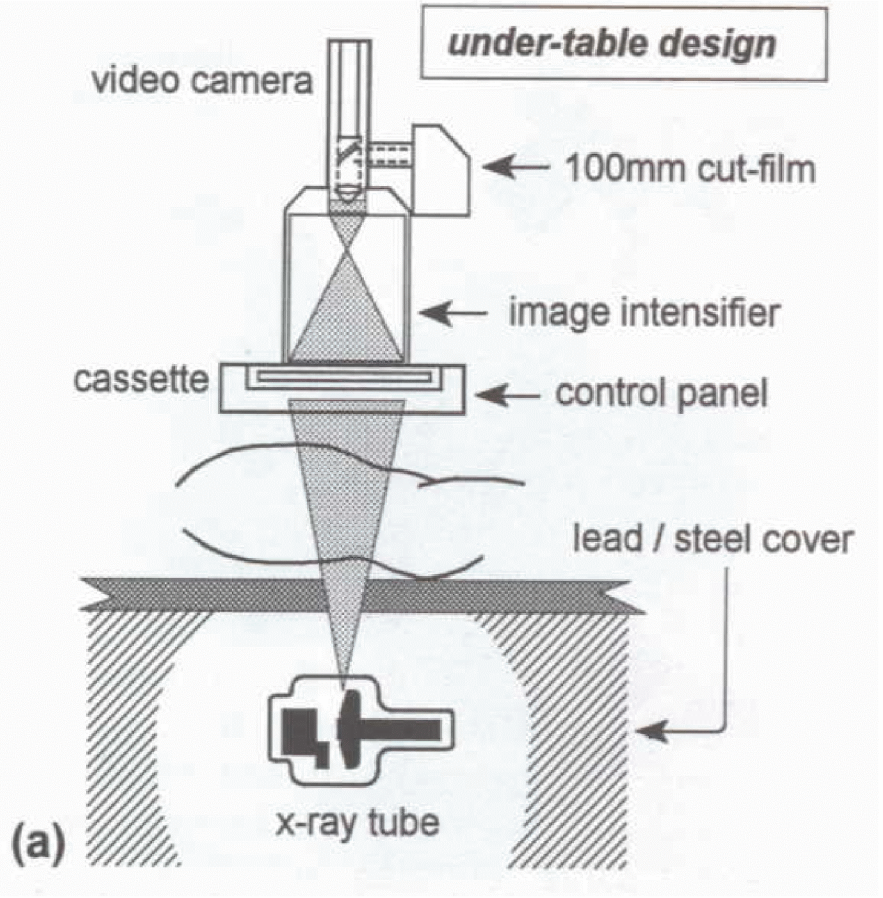
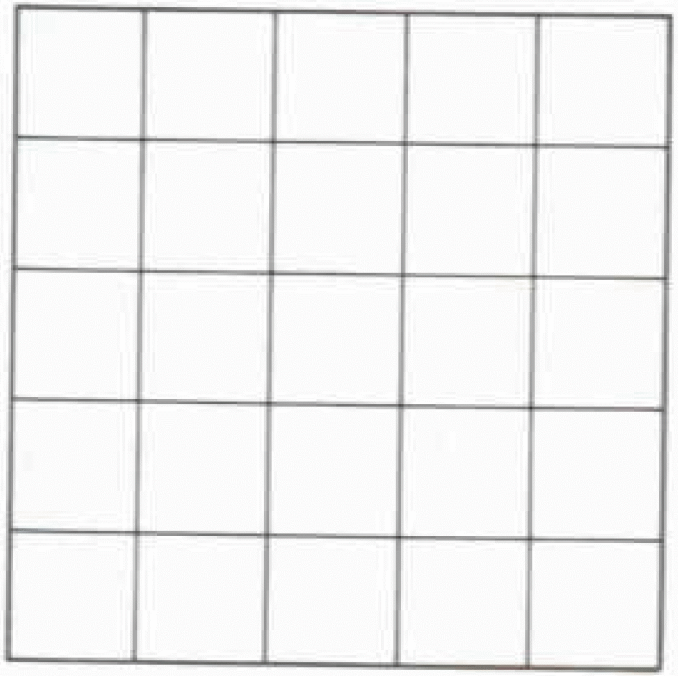


Image Distortion



Test object

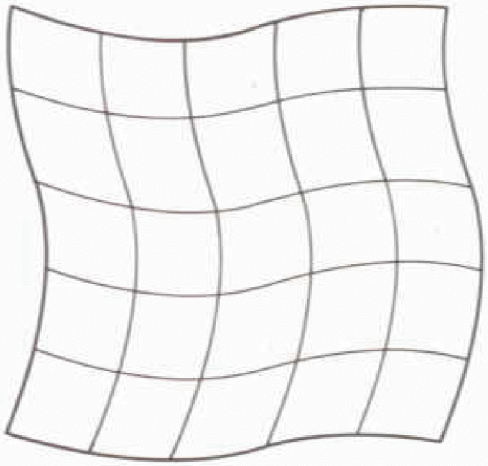


Image displaying 'S' distortion

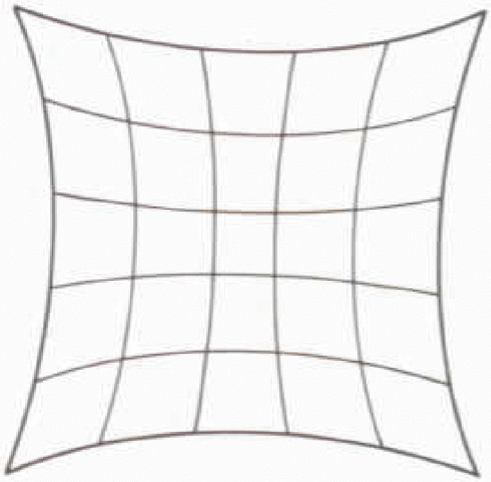


Image displaying 'pin-cushion' distortion

Contrast ratio

- X-ray scattering at the input window.
- X-ray scattering at the input phosphor.
- Light scattering within the phosphor itself.
- Visible light not absorbed the photocathode.
- Back-scattering of light from the output phosphor toward the photocathode.
- Scattering of light at the output window (reduced by fiber optic plate).

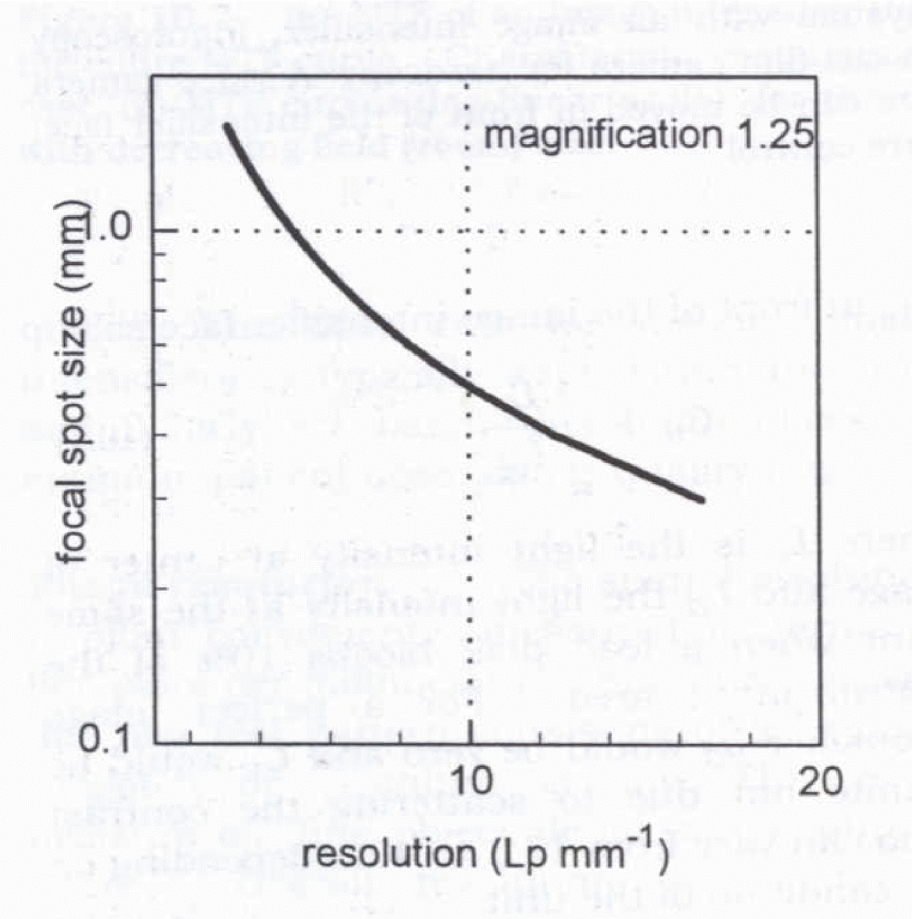
Resolution

- Patient separation from the image intensifier face usually gives a magnification of about 1.25 .

$$R = \frac{m}{F(m-1)}$$

- Conversion factor and image pincushion **increase** with **increasing field size**.

- Resolution and contrast ratio both improve with **decrease** in field size and relative patient dose also **increase**.



References

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2. *Jerrold T. Bushberg, Anthony Seibert. "The Essential Physics of Medical Imaging"*

3. *William R. Hendee, Russell Ritenour, "Medical Imaging Physics"4st edition,2002*

4. *Stewart C. Bushong "Radiologic Science for Technologists " 8st edition , 2004 .*

5. *Thomas S. Curry, James E. Dowdey, Robert C. Murry "Christensens Physics of Diagnostic Radiology" 4st edition, 1990 .*