



Dark Room 6

The Grid & BEAM RESTRICTING DEVICES

By

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- Certain devices are designed for **restricting of the undesirable radiation** i.e. scattered radiation

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1- Kilo voltage :

- Increase of **kilovolt age** → increase X ray energy → more beams undergo **Compton reaction** & scattered .
- SO , all radiographs should be taken at **LOWEST reasonable** **Kv** to minimize scattered radiation .
- To increase required x ray dose with out increase energy ,
INCREASING OF **mAs** is the solution .

2- Field size :

- Increase field size → increase scattering .
 - So Collimate Field

3- Patient thickness :

- The more thick part radio graphed → more scattering .
- *Unfortunately , this factor is not under control .*

HOW TO CONTROL SCATTERED RADIATION ?

- **2 devices** are designed specifically to this aim : ***Beam restrictors & * Grids**
- ***TYPES OF BEAM RESTRICTORS :***
 1. Aperture diaphragm .
 2. Cones or cylinders .
 3. Collimators .

- **Scattered Radiation** is a great problem disturbing the quality of radiographic image .

- **THE GRID**

- IS a great solution for this problem .
- SO What is the grid ... & how it work ?

Introduction :

- Scattered X ray produced from the patient by **Compton effect**
- it is a **harmful** factor to the process of imaging .
- The intensity of **scattered radiation** is relatively ralledated to : such as
 - * **Kv**
 - * **Beam size**
 - * **Patient thickness**

Steps of solutions of this problem:

- Using of **intensifying screens** → improving of image quality , BUT not due to the previous cause .

- **Selective filter** passing **1 ry beam** , was not effective
- The **extremely effective** device for elimination of scattered X ray was **THE GRID** .

Structure of the grid :

- In 1913 it is invented by

Dr. Gustave Bucky

- It is a board like device , composed of **alternating strips of :**

*** Radiopaque material (Grid material)**

& * Radio translucent material

(interspace material)



Inter-space STRIP



GRID STRIP



- This structures are **encased in an Aluminium** case , for :

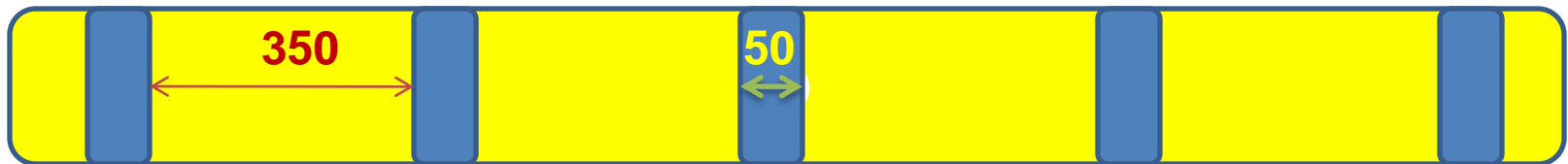
- * **Rigidity**

- * **Protection from moisture .**

- **In Typical grid :**

- grid strips thickness **50 um** , interspace strips **350 um**

- Up to **12.5%** of **all photons** falling on grid absorbed .

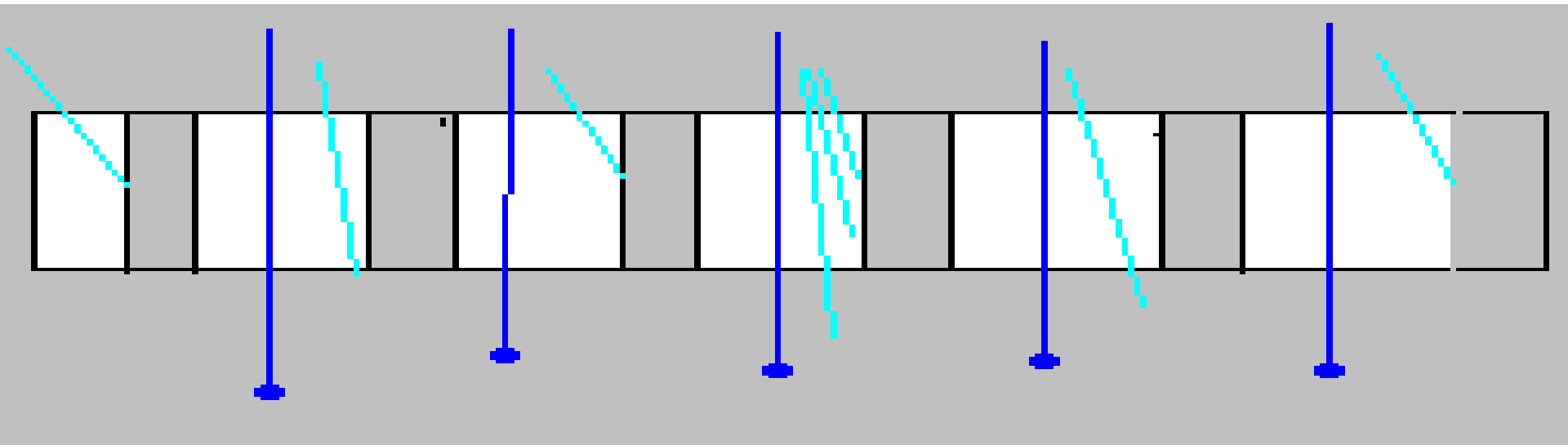


HOW A GRID WORK :

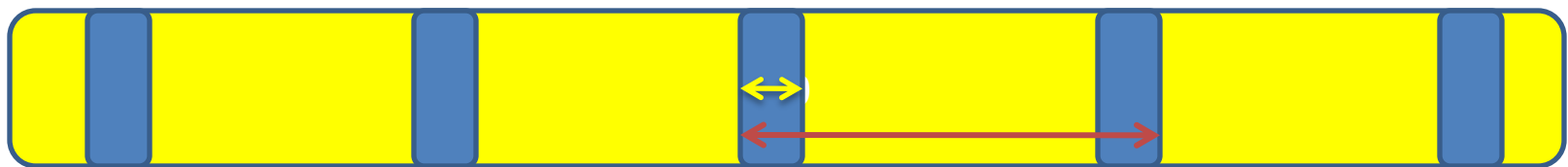
- All primary beam photons are passing when falling on **interspace strips** .
- Scattered beams **may** or **may not** pass according there angle ,
- if a beam falling **by an angle** . It will strike grid strip by side → absorbed & **not passing** to the film .

***1ry beam**

***Scattered**



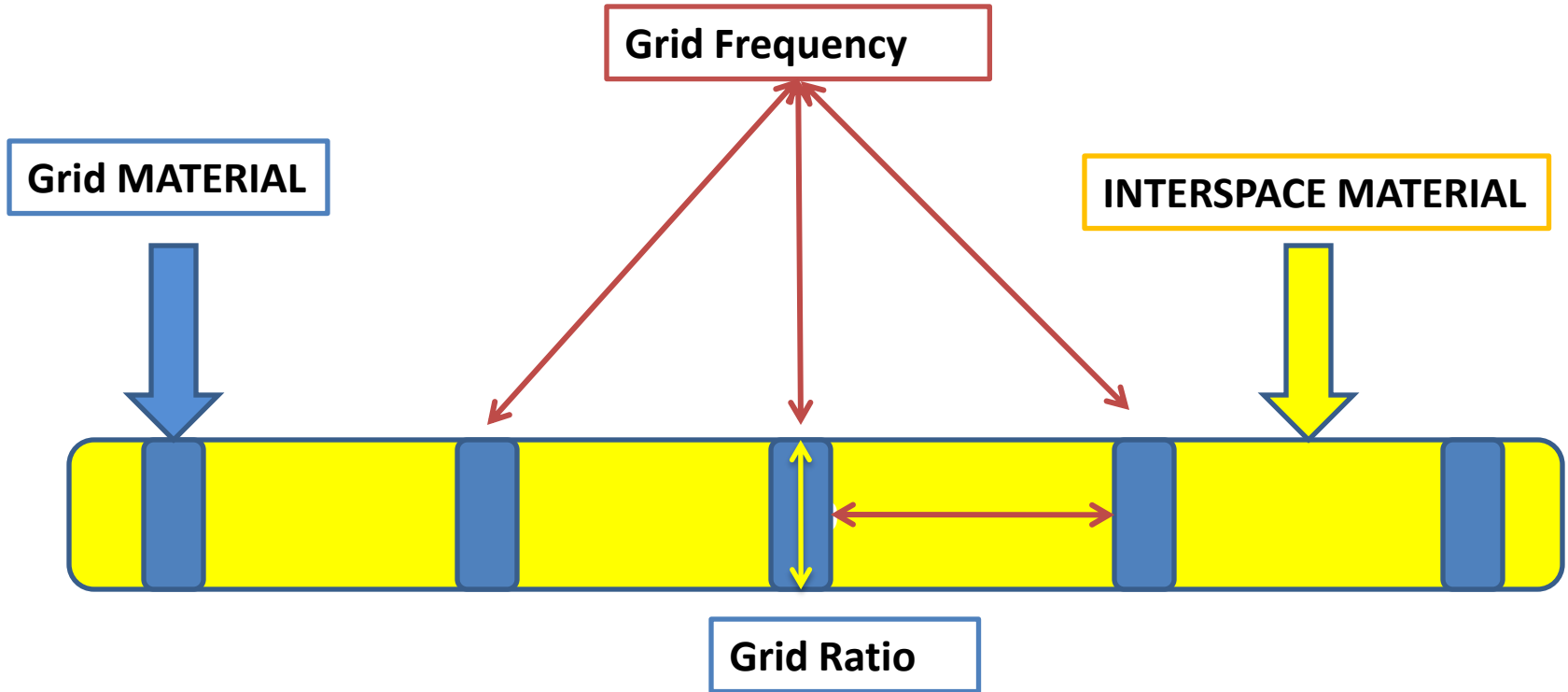
- If a grid is remove about **80 : 90 %** of scattered radiation = it has **good clean up** .
- The **percentage of absorbed radiation =**
width of grid strips / width of (grid + iterspace)
strips



percentage of absorbed radiation

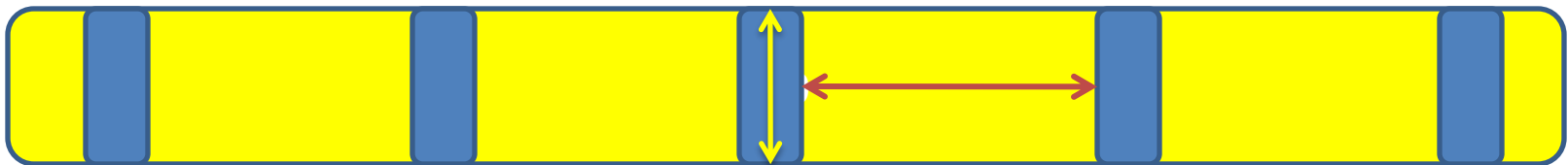
Characteristics of grid construction:

- **1- GRID RATIO**
- **2- GRID FREQUENCY**
- **3- GRID MATERIAL**
- **4- INTERSPACE MATERIAL**

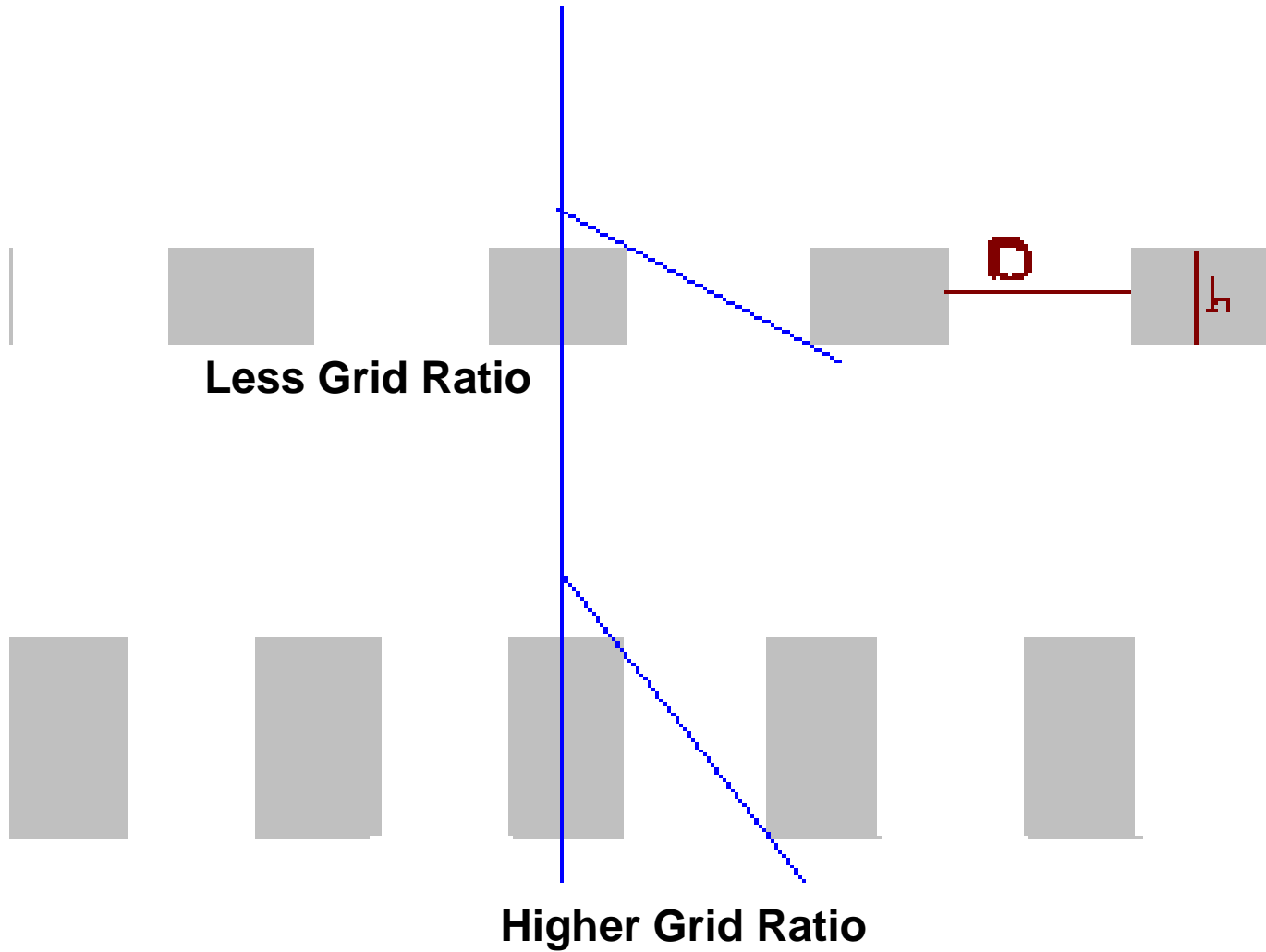


1- GRID RATIO :

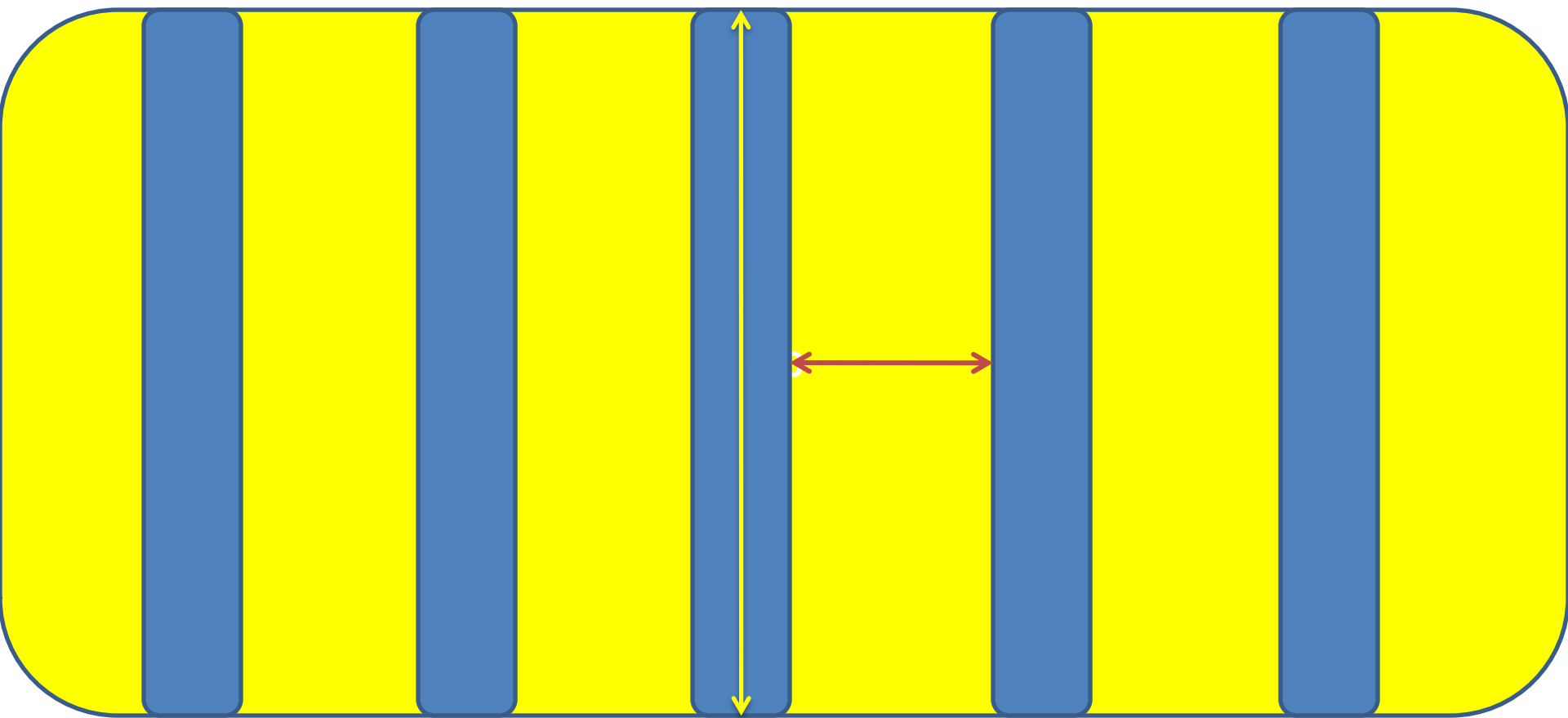
- = $\frac{H}{D}$ or Height of grid strips .
D Thickness of interspace
- **High ratio** → less angle of deviation is allowed → **more effective clean up** .



Grid Ratio



- Increase of **Grid ratio** is made by :
 - 1- Increase **grid height**
 - 2- Reduce width of **inter space** or both
- Grid ratio generally **5 : 1** to **16 : 1**
- **Disadvantages of high ratio :**
 - 1- Difficult to be manufactured
 - 2- Need **higher exposure** to get satisfied image



2- GRID FREQUENCY

- It is **number of grid strips / inch or cm** .
- * Grids with **high frequency** → less distinct grid lines in film .
- Most grids have frequency **60:110/inch** i.e.
24: 42 / cm



Frequency : Grid Strips / Inch

Disadvantage :

- Increase frequency → more dose needed ,
- this can be **overcomed by decrease thickness** of grid strip .

(but this will decrease its clean up)



Less Frequency Grid



Higher Frequency Grid

3- GRID MATERIAL :

- The grid strip should be **thin** & **highly absorber** to x ray .
- **Lead** Is the *most widely used material*
- **Why ?** due to : * High atomic number
 - * Easy to be shaped
 - * Relatively inexpensive
- Other substances : **tungsten** , **platinum** , **gold** & **uranium** .
- **Non** of these materials is **better** than lead .

4- Interspace material :

- **Aluminum** or **plastic fibers** , are the *main substances*
- **Advantages of aluminum :**
 - 1- High atomic number → **some selective filtration** of scattered rays .
 - 2- Give less visible grid lines
 - 3- It doesn't absorb moisture .
- **Disadvantages :** More dose is need with it .

☆ *MEASURING GRID* ☆ *PERFORMANCE*

- The principle **function of grid** is : eliminating of scattered radiation → **improve contrast** .
- Thus to measure grid performance = **measure of contrast improvement** .
- Grid performance = ***CONTRAST IMPROVEMENT FACTOR***
(k)

Contrast improvement factor (**k**) : •

it is the ratio between contrast with & without using a grid .

$$k = \frac{\text{Radiographic contrast with grid}}{\text{Radiographic contrast without grid}}$$

Most grids has (k) **1.5 : 2.5** •

- Factors affecting K :
 1. **High ratio** → high k
 2. **Heavy grids** → high k
 3. High frequency → low k

K is generally measuring at 100 kv •

SELECTIVITY (LEAD CONTENT)

- In an ideal grid , all 1ry beams transmitted , & **all scattered absorbed** .

SELECTIVITY (Σ) : is the ratio of

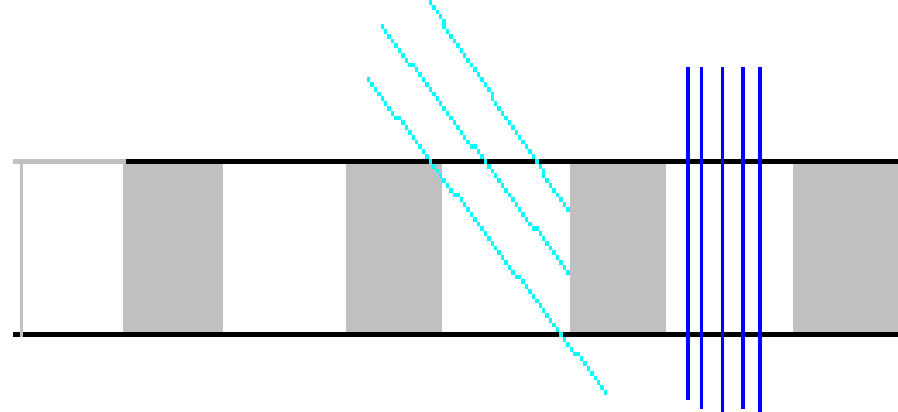
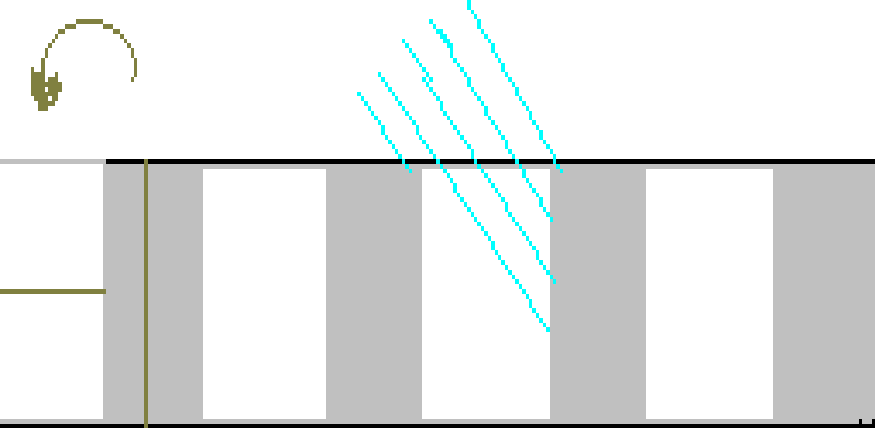
- Transmitted 1ry radiation to scattered radiation .

$$\text{Sigma (} \Sigma \text{)} = \frac{\text{1ry radiation transmitted}}{\text{scattered rad transmitted}}$$

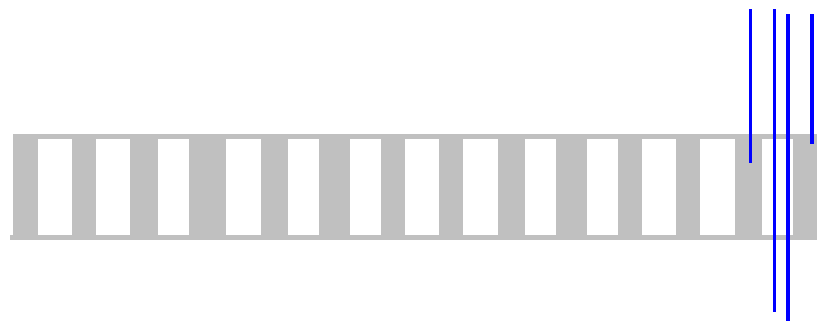
- Total mass of lead is the main factor affecting selectivity .

MORE LEAD → HIGHER SELETIVITY

But proper arrangement is an important factor ,
if lead strips are adherent to each other → no
image will be formed



HIGHER RATIO = HIGHER CONTRAST



HIGH FREQUENCY = LOW CONTRAST

**** TYPES OF GRIDS ****

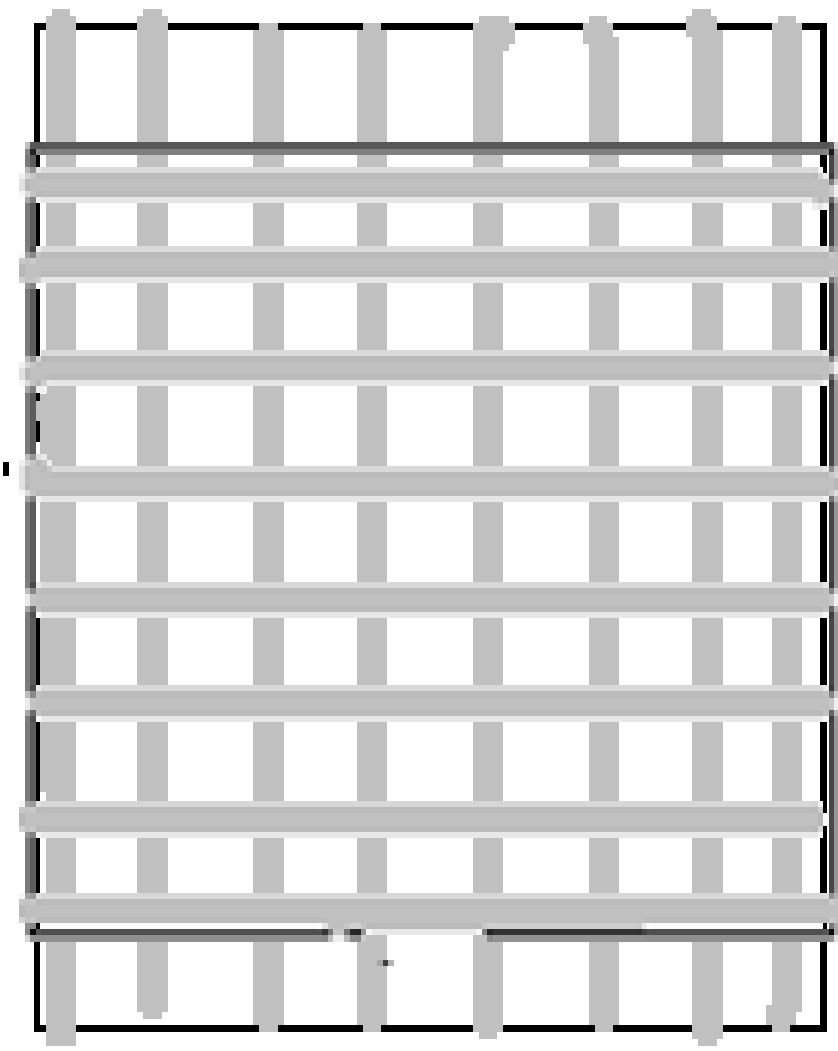
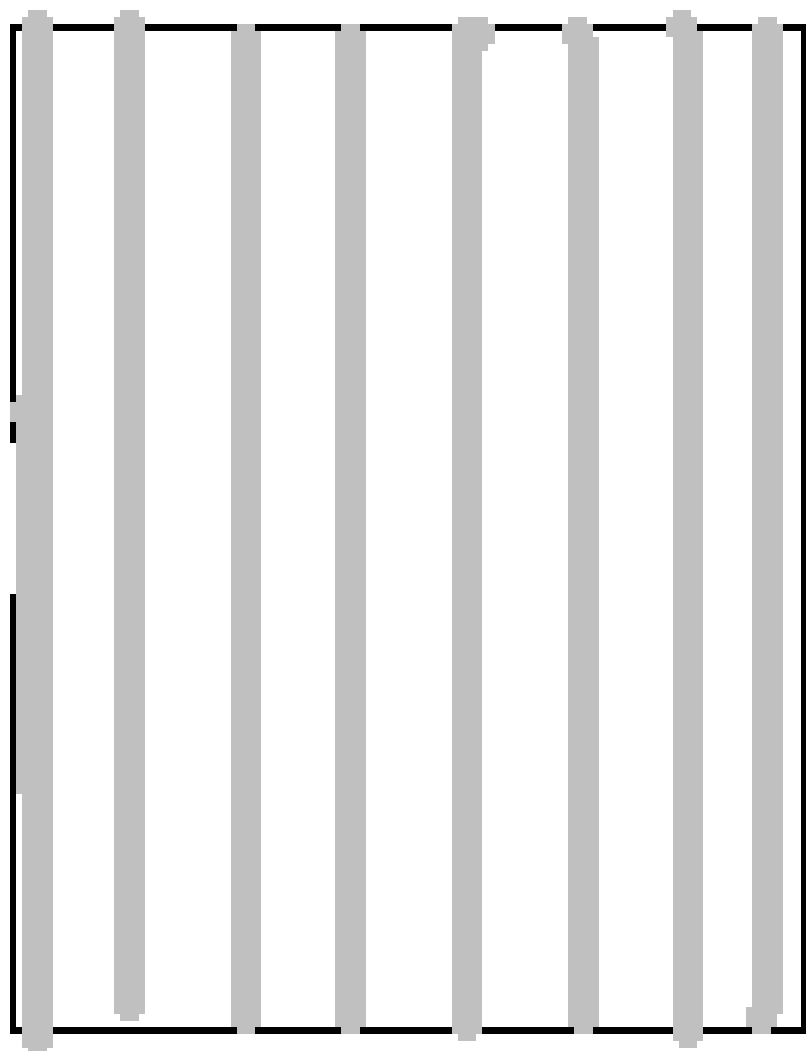
- 1. Linear grids**
- 2. Crossed grids**
- 3. Focused grids**
- 4. Moving grids**



Linear grids

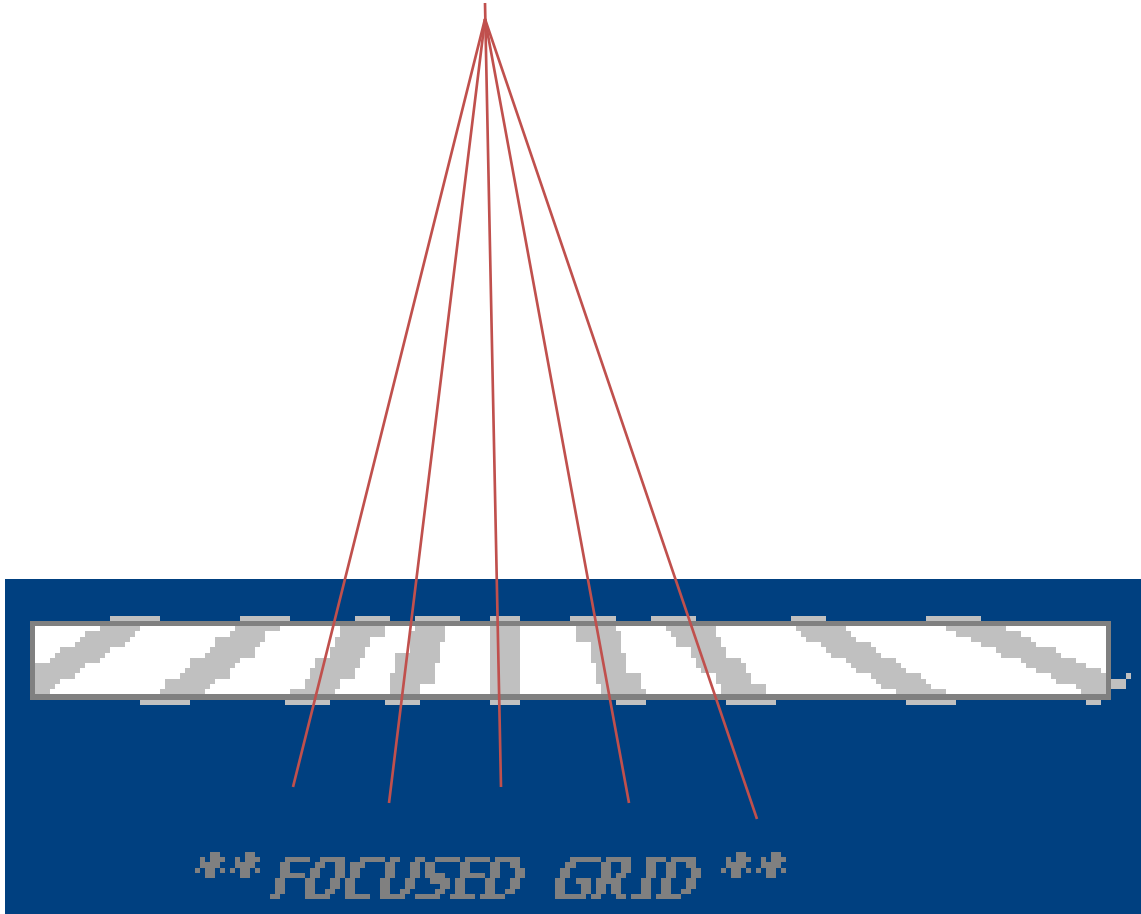


Crossed grids





**** FOCUSED GRID ****



**** FOCUSED GRID ****

Moving grids :

- ***Grid lines :***

Are the shadow lines of the grid strips appearing in the radiograph .

It occur due to **absorbption of some 1ry beams** by grid strips .

- The **more wide grid strips** → more obvious lines.
- More frequency → Less obvious lines .

- **At 1920** , Dr. Hollies potter suggesting to make the grid moving during radio graphing the film, thus a moving grid invented .
- By adding **moving mechanism** to a linear grid , it will become MOVING GRID .

Types of moving grid mechanisms:

1. **Single stroke grid .**
2. **Reciprocating grid**
3. **Oscillating grid**

Disadvantages of moving grids :

1. It require **bulky mechanism** , which able to be failed .
2. More distance is need between Film & patient , this give false magnification in the film .
3. **Increase of exposure time** .
4. The movement of the grid , may **vibrate the film** → blurred image .
5. Stroboscopic effect .

AIR-GAP Technique

- *It is a technique used for **reducing the scattering radiation** .*
- *The film is present at **4 : 6 inches** distance from the radio graphed part → **scattered beams (which has low energy not reaching the film)***
- *Some degree of magnification occur with this technique , which can be considered & accepted .*

BEAM-RESTRICTING DEVICES

- ***TYPES OF BEAM RESTRICTORS :***

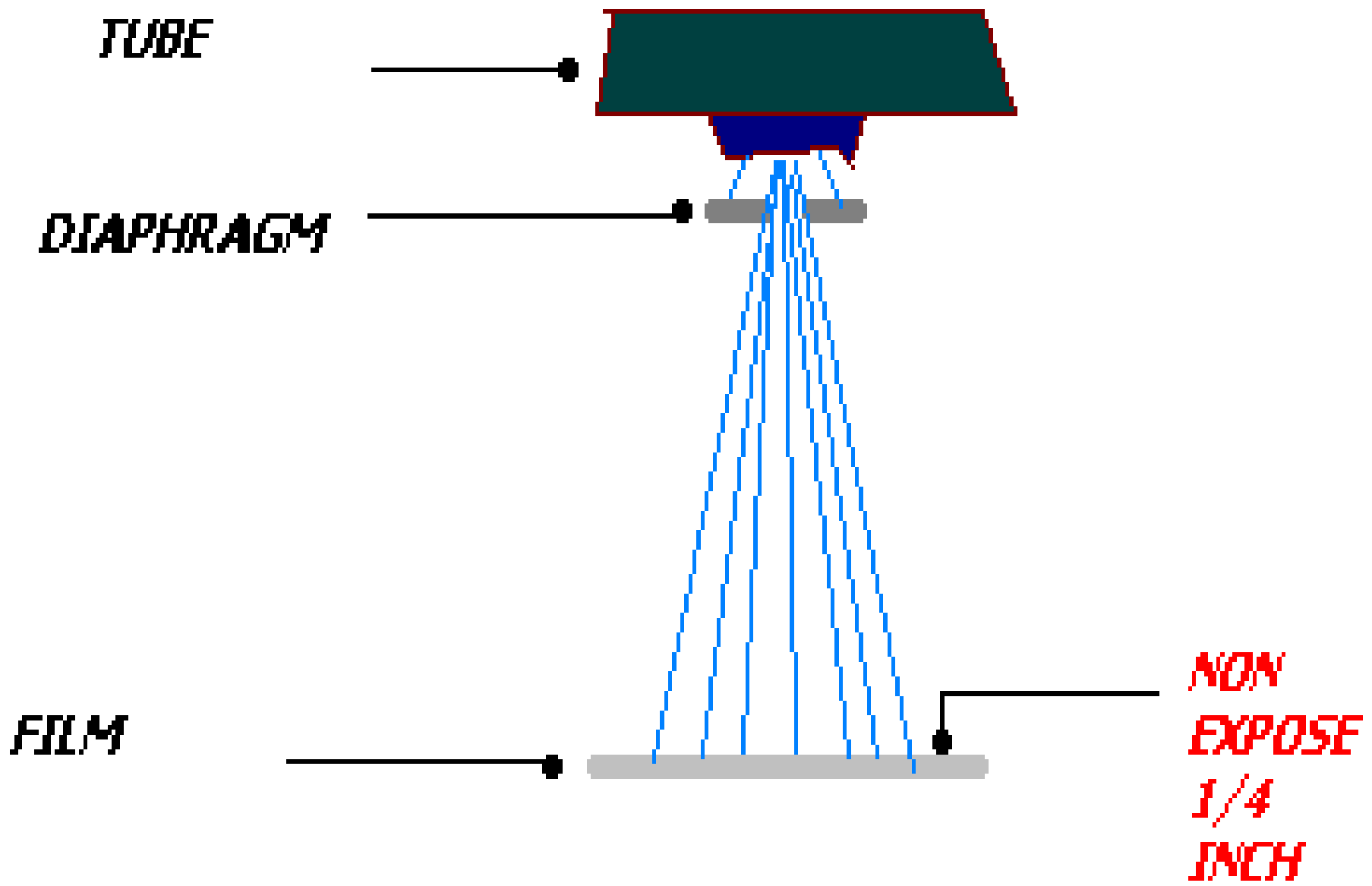
1. Aperture diaphragm .

2. Cones or cylinders .

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1- Aperture diaphragm :

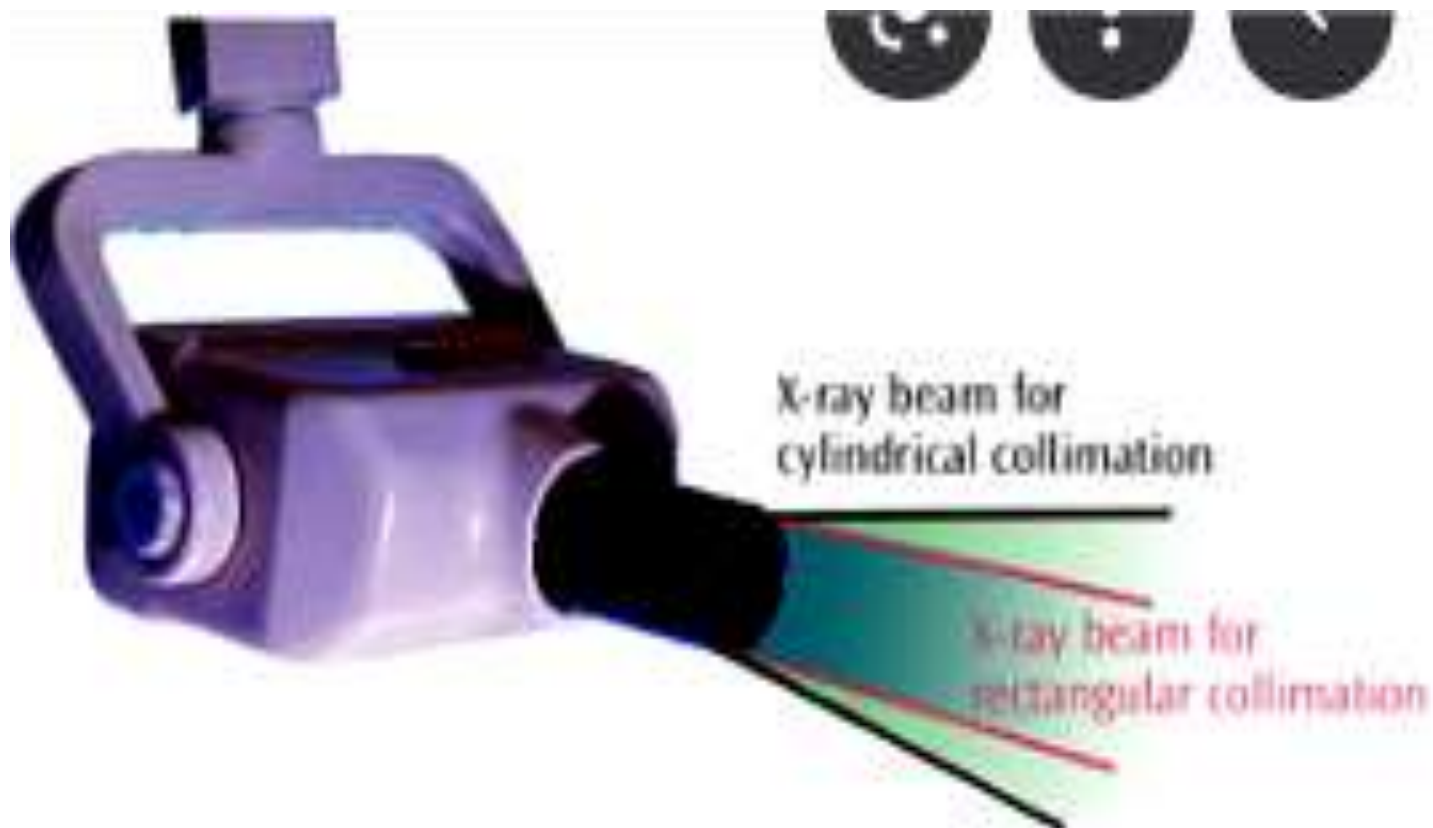
- It is the **simplest** of all devices .
- It is simply a **lead diaphragm** attached to the head of X ray tube .
- Well designed diaphragm should be giving an **image < film size with 0.25 inch in each side**
→ thus unexposed parts are visualized .



2-CONES & CYLINDERS :

- It considered a **modification of diaphragm** .
- It is an extended metal device restricting beam to the required size .
- Beam acquired by it is cylindrical .



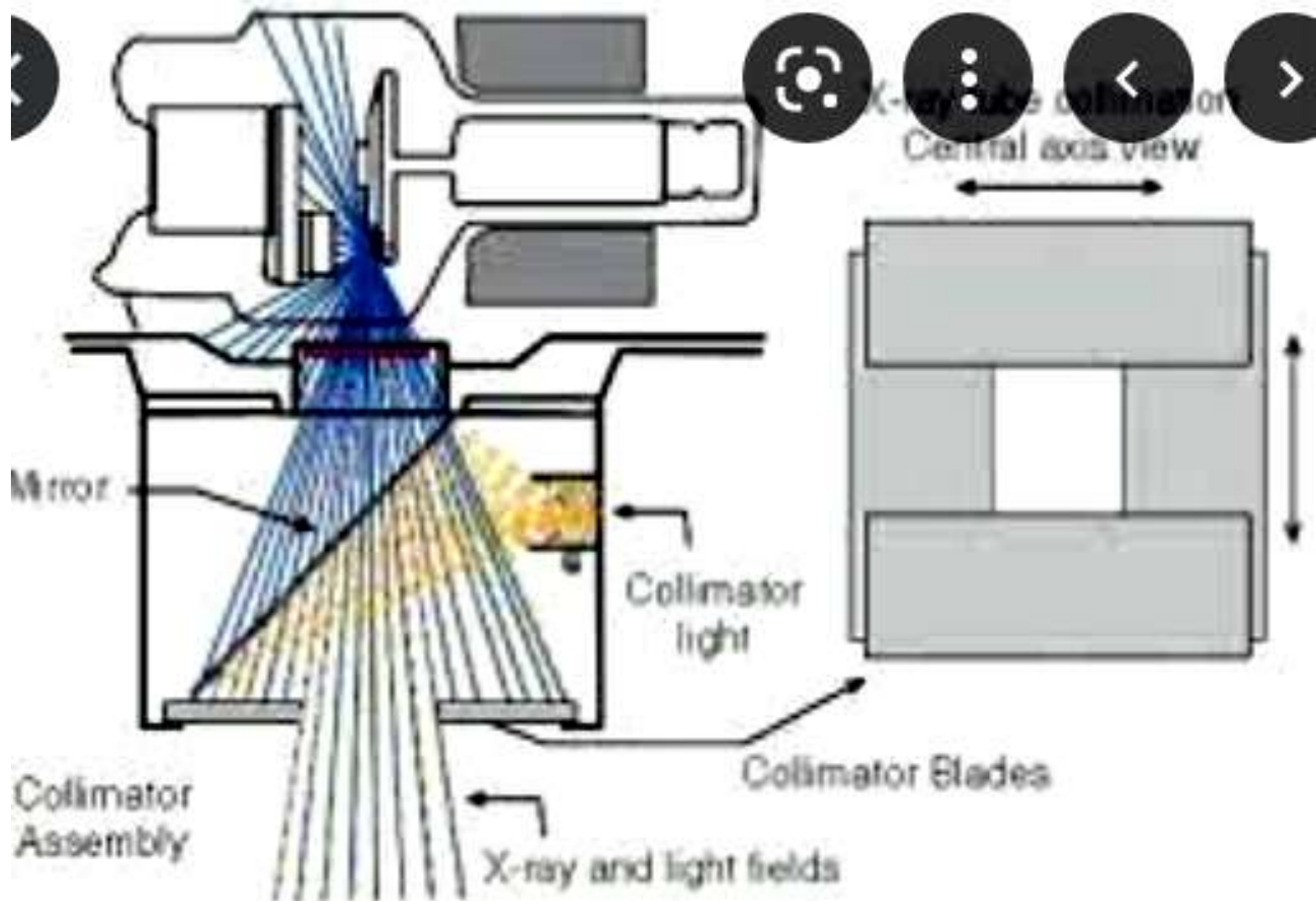


- Opening of them are fixed → for **specific types** of examination .
- **CONE CUTTING** : if cone & film are not on a line
→ *side of cone interfere with beam* →
unexposing of side of the film .
- Cones are used mainly in **dental radiology**.



Dental X-ray instruments for dental ...
castellini.com

3- Collimator :





Collimation

Sources & Further reading :

- ▶ **Dark Room** – Prof Dr. Nabeel Khattar
- ▶ **Dark Room** – MOH Institute –

PROFF. DR. AHMED FARID YOUSIF

- https://staffsites.sohag-univ.edu.eg/ahmed_abodahab

An open book with white pages is placed on a rustic wooden surface. The background is a soft-focus bokeh of warm, golden light filtering through trees, creating a peaceful and scholarly atmosphere.

Thank You

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