Intensifying Screens & Grids

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Introduction

- Extraoral films are those that are placed outside the mouth during X-ray exposure.
- These films are of two types: **Non- Screen Films and Screen Films.**
- Both are available in various sizes

1. 4 ¾’’× 6 ½’’
2. 5’’ × 7’’
3. 6 ½’’ × 8 ½’’
4. 8’’ × 10’’
5. 10’’ × 12’’

Non-screen films:

- These are used without the intensifying screens.
- The emulsion is sensitive to direct X-ray exposure rather than fluorescent light.
- These films are much slower and therefore require a longer exposure time but the detail of the image obtained on using these films are much sharper.
- These films are not recommended for dental use.

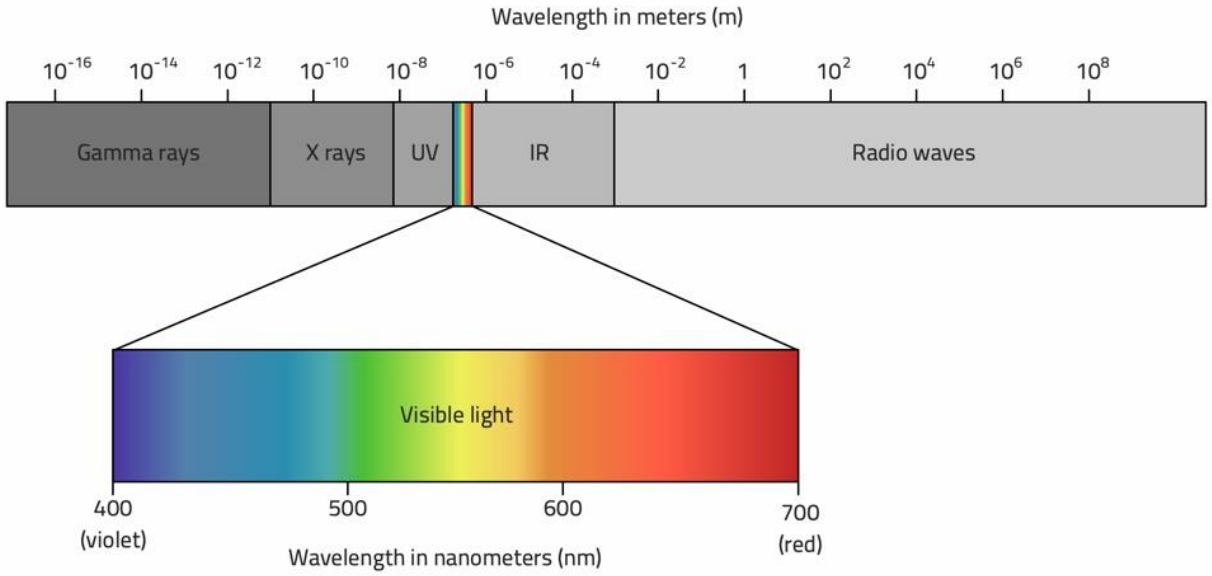
Screen films:

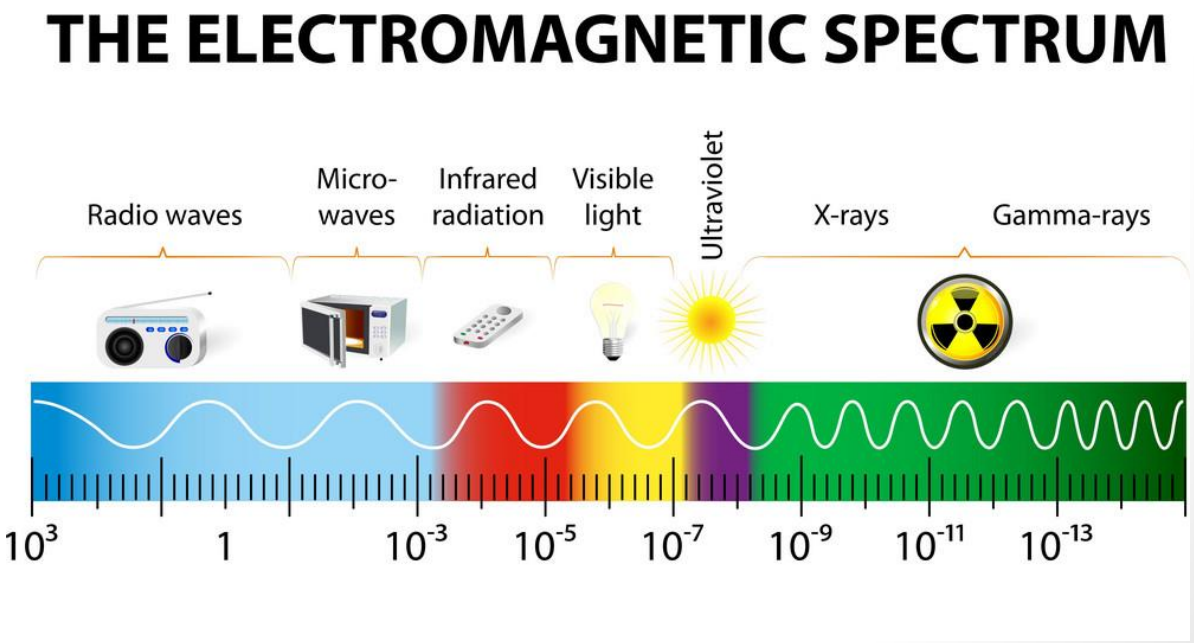
- These films are used in combination with intensifying screens, that emit visible light.
- These screens are placed in the film cassette, on either side of the film and are held under pressure in a rigid manner, so that the fluorescent layers of the screen and the emulsion of the film are pressed together closely.
- Screen film is sensitive to fluorescent light rather than direct x-radiation.

- Screen films are of two types,

1. **Blue light sensitive** (Kodak X-Omat and Ektamat films), and the other being
2. **Green light sensitive** (Kodak Ortho and T-Mat films).

- These films are used in combination with cassettes and intensifying screens (where applicable).


Wavelength in meters (m)
10^{-16} 10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 1 10^{2} 10^{4} 10^{6} 10^{8}
Gamma rays
X rays
UV
IR
Radio waves
Visible light
400
(violet)
500
600
700
(red)
Wavelength in nanometers (nm)


THE ELECTROMAGNETIC SPECTRUM
Radio waves
Micro-waves
Infrared radiation
Visible light
Ultraviolet
X-rays
Gamma-rays
10^{3}
1
10^{-3}
10^{-5}
10^{-7}
10^{-9}
10^{-11}
10^{-13}

- The **Green light sensitive films** are those used with the rare earth intensifying screens, and these are two or more times faster and provide sufficient clarity for most diagnostic tasks.

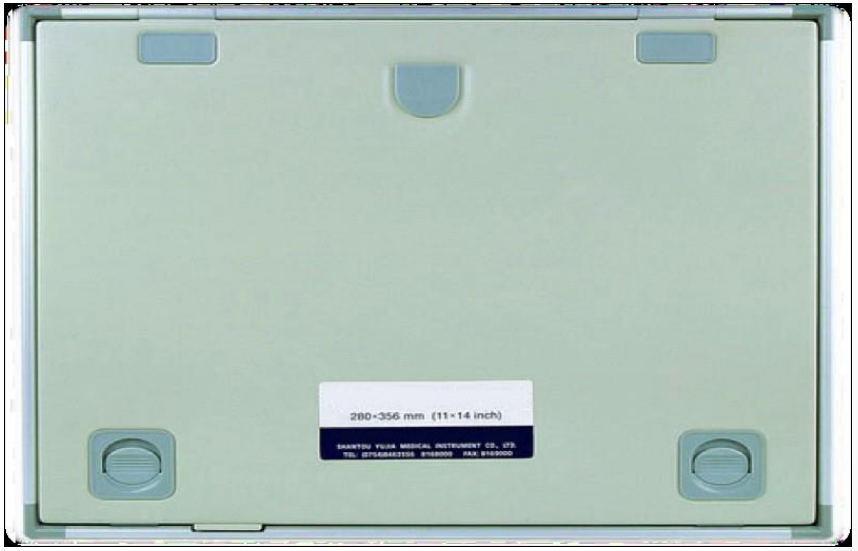
- These films (T-Mat) have tubular shaped silver halide grains which are oriented with their flat faces to the radiation source, thus providing a larger cross-section and resulting in increased speed without loss of sharpness.
- These are used for skull, cephalometric and panoramic radiography.

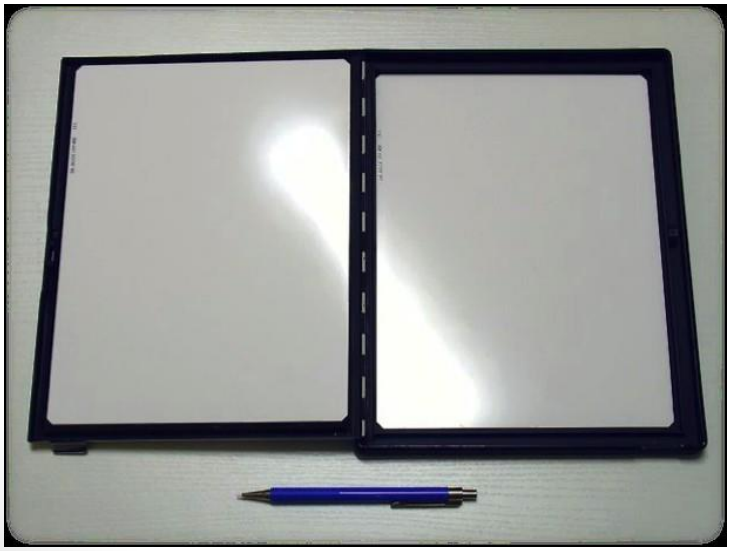
TABLE 4-2
Rare Earth Elements Used in Intensifying Screens

COMPANY	NAME	PHOSPHOR	EMISSION
Kodak	Lanex	Gadolinium oxysulfide, terbium activated	Green
Imation	Trimax	Gadolinium oxysulfide, terbium activated	Green
Sterling	Quanta	Yttrium tantalate, niobium activated	Blue and UV

***It is important to use the right screen film combination so that the emission and absorption characteristics of the screen and film are matched.**

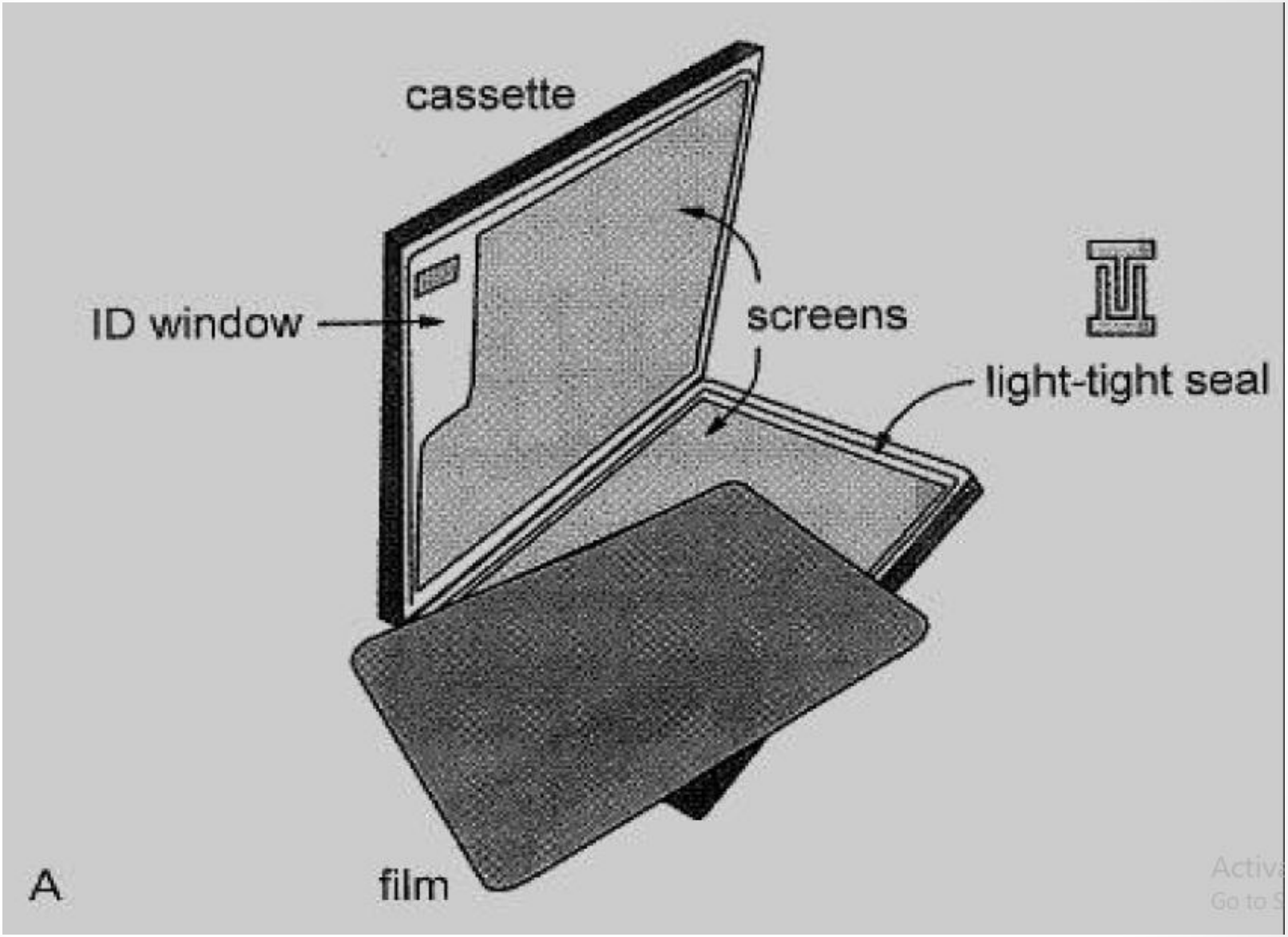
Cassette





- Extra oral films are boxed in quantities of 50 or 100 films.
- The films are usually placed in a film cassette, with or without intensifying screens.

- This is a special device that is used to hold the extraoral film and the intensifying screens.
- A cassette may be **flexible or rigid**, most cassettes are rigid except for the panoramic cassette, which may be flexible.
- A rigid cassette is like a book like container consisting of two aluminum or bakelite leaves which open and close on hinges.
- The front cover lid is placed so that it faces the tube head and is usually constructed of plastic or of low density metal and offers little resistance to the passage of the ray.


cassette
ID window
screens
light-tight seal
A
film

- The back plate is constructed of heavy metal and lined with lead to absorb X-rays which pass through the enclosed film and reduce scatter radiation.
- The intensifying screens are installed inside the front and back covers of the cassette. The film is positioned between the two intensifying screens.
- Each screen exposes one side of the film. The cassette is loaded and unloaded in the dark room.
- The cassette must be marked to orient the finished radiograph, a metal letter ‘L’ or ‘R’ is attached to the front cover of the cassette to indicate the patient’s left or right side respectively.

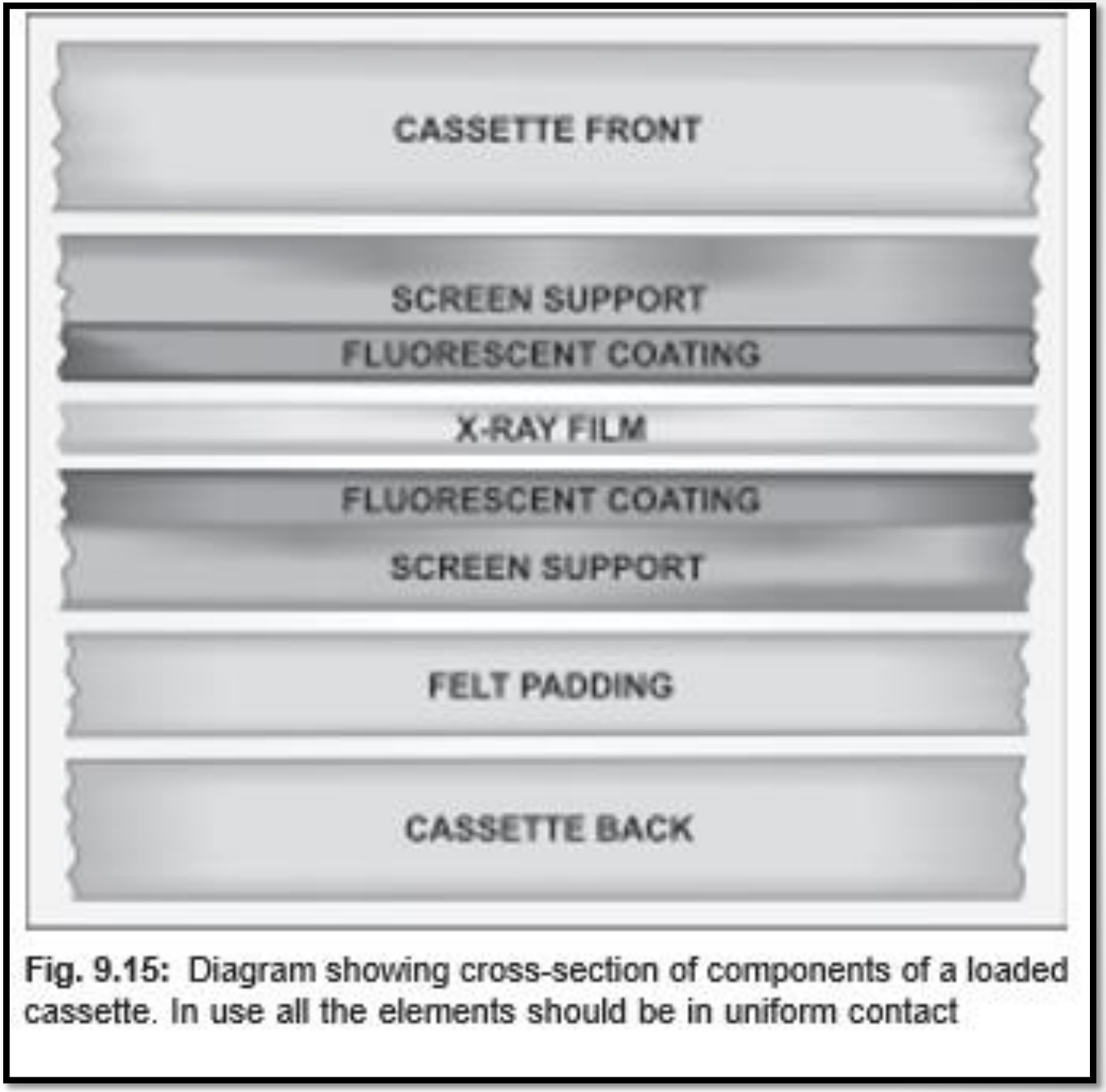


Fig. 9.15: Diagram showing cross-section of components of a loaded cassette. In use all the elements should be in uniform contact

Intensifying screen

- Intensifying screen is a device that transfers X-ray energy into visible light; the visible light, in turn exposes the screen film.

- These screens intensify the effect of X-rays on the film, thus less radiation is required to expose a screen film, and thus the patient is exposed to less radiation.

PRINCIPLE BEHIND INTENSIFYING SCREENS?

LUMINISCENCE : *Emission Of Light By A Substance*

- **LUMINISCENCE**
  - **FLOURESCENCE**
    - Light is emitted instantaneously($<10^{-8}$ sec)
    - Stops after the stimulus is removed
    - Conventional
  - **PHOSPHORESENCE**
    - Emission of light is delayed beyond 10^{-8} sec.
    - Continues to emit light (after glow).
    - Digital radiography.

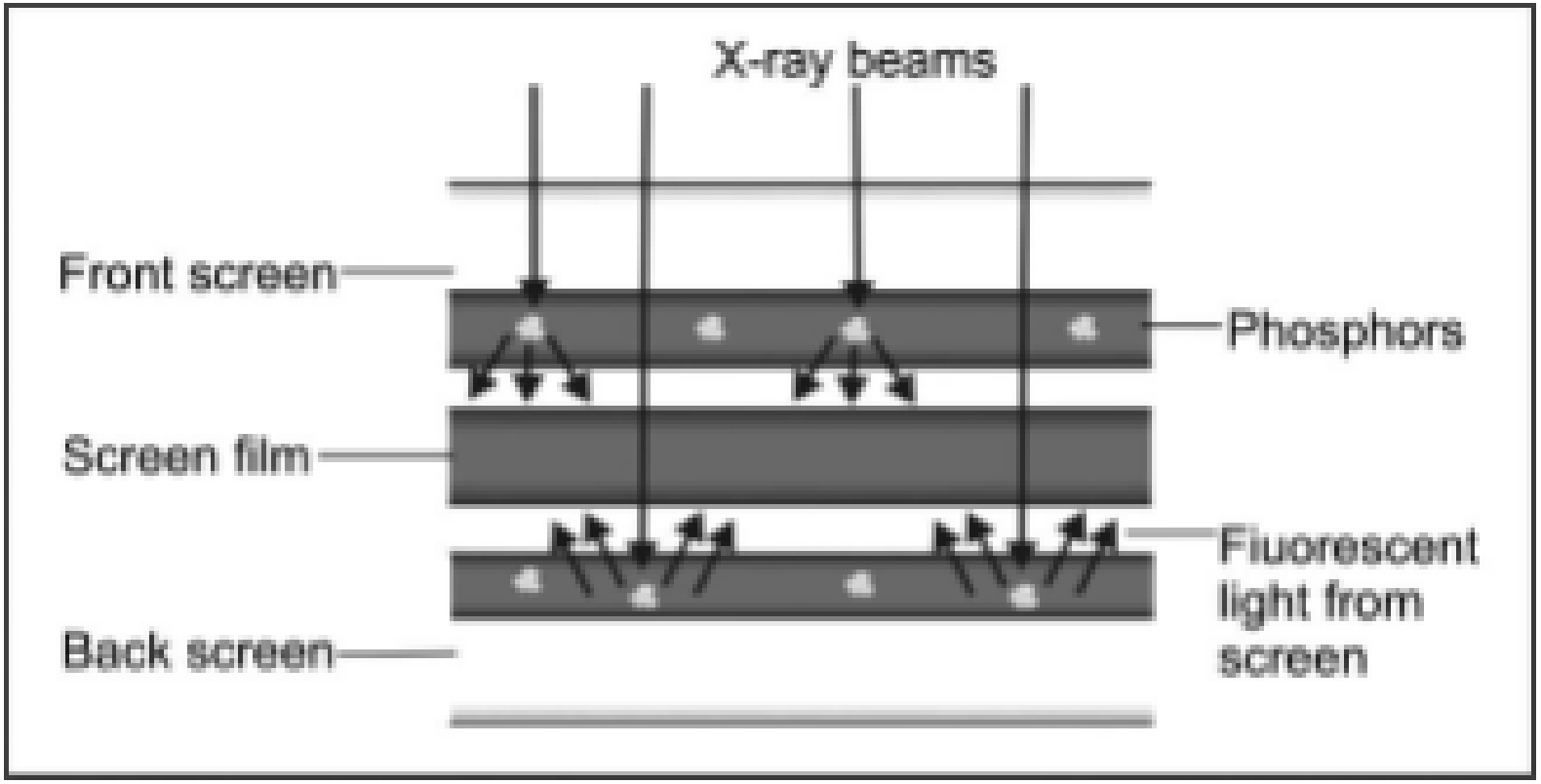
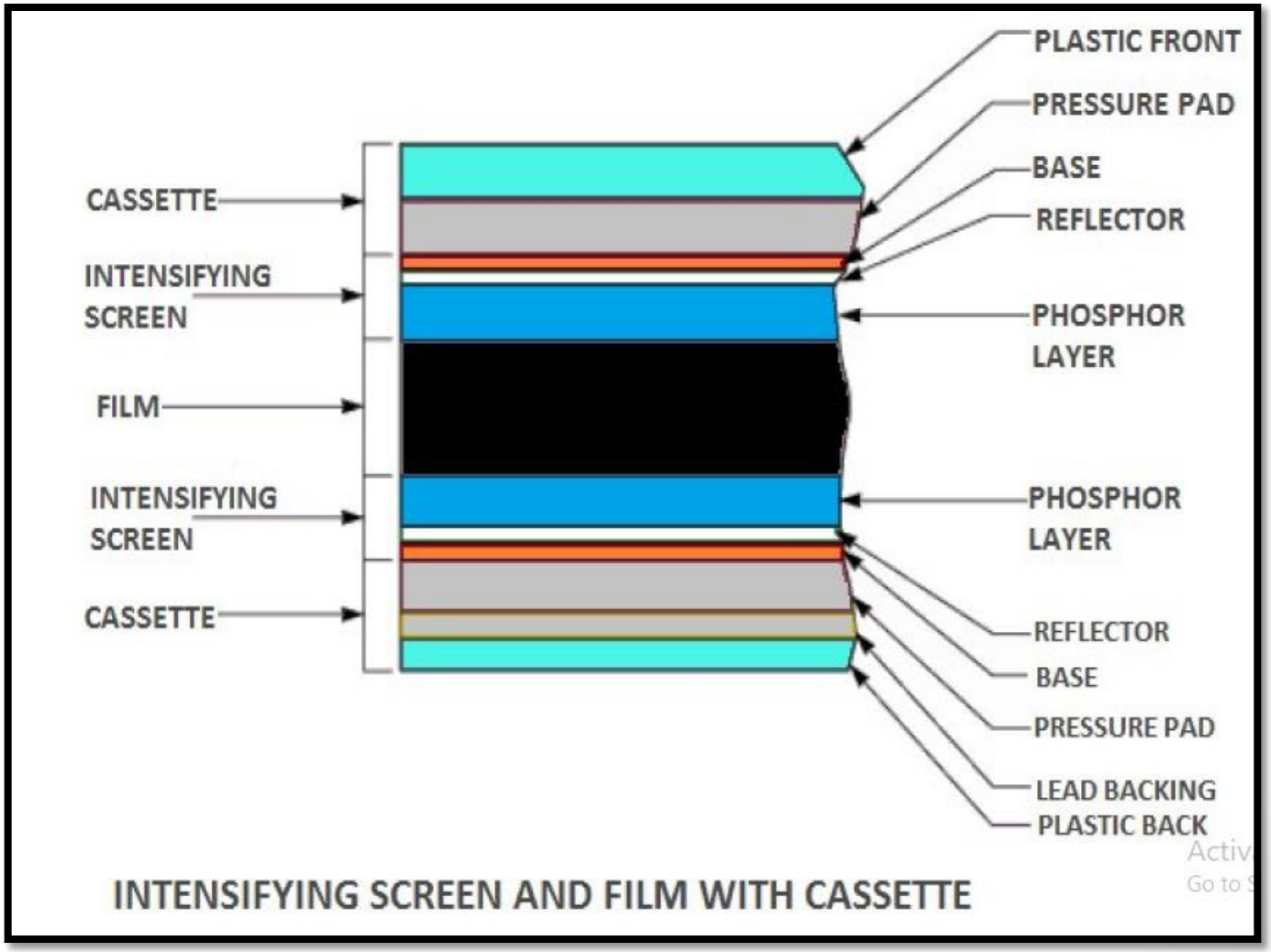


Fig. 9.16: Phosphors in the intensifying screen emit visible light when hit by X-ray photons. Multiple visible light photons then strike and expose the film

- In Extraoral radiography, a screen film is sandwiched between the two intensifying screens of matching size and secured in a cassette.
- An intensifying screen is a smooth plastic sheet coated with minute fluorescent crystals known as phosphors.
- When exposed to X-rays, the phosphors fluoresce and emit visible light in the blue or green spectrum, the emitted light then exposes the film.

Composition



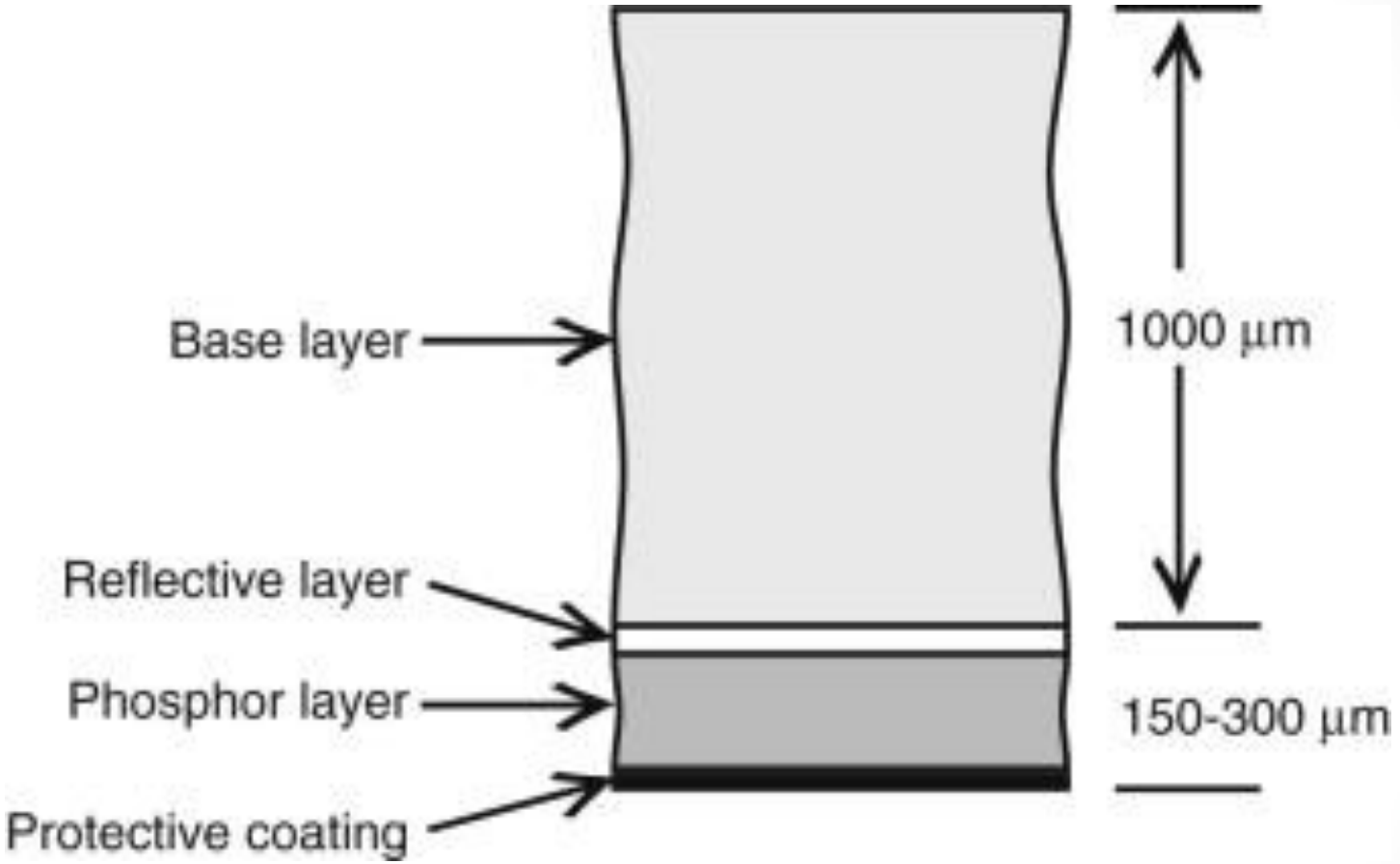
Composition

1. Base: Made of either a stiff sheet of cardboard or polyester plastic material (like the one used for the base of the radiographic film).

- It is about 0.25 mm thick.
- supporting component of the screen.

2. Reflecting layer: This is a thin layer of white material (i.e. magnesium oxide or titanium dioxide) between the base and the luminiscent layer.

- The light from the phosphors is emitted isotropically.
- Without a reflective layer, only half of the light would interact with the film.
- The reflective layer redirects the light to the film.

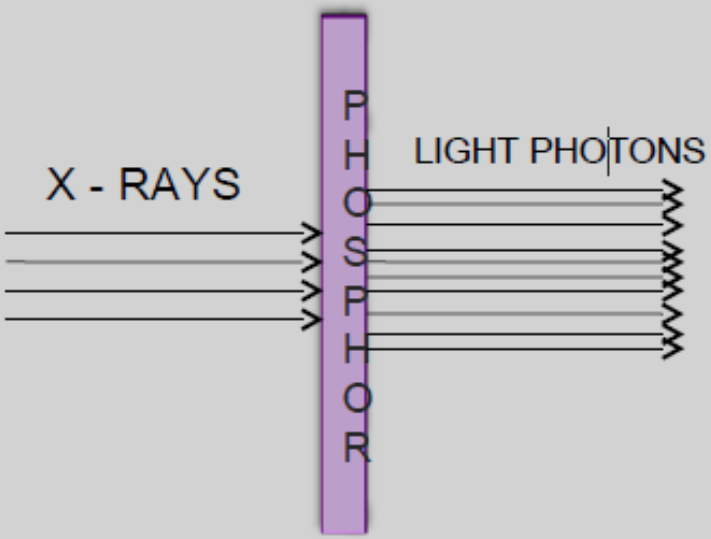

Base layer
Reflective layer
Phosphor layer
Protective coating
1000 µm
150-300 µm

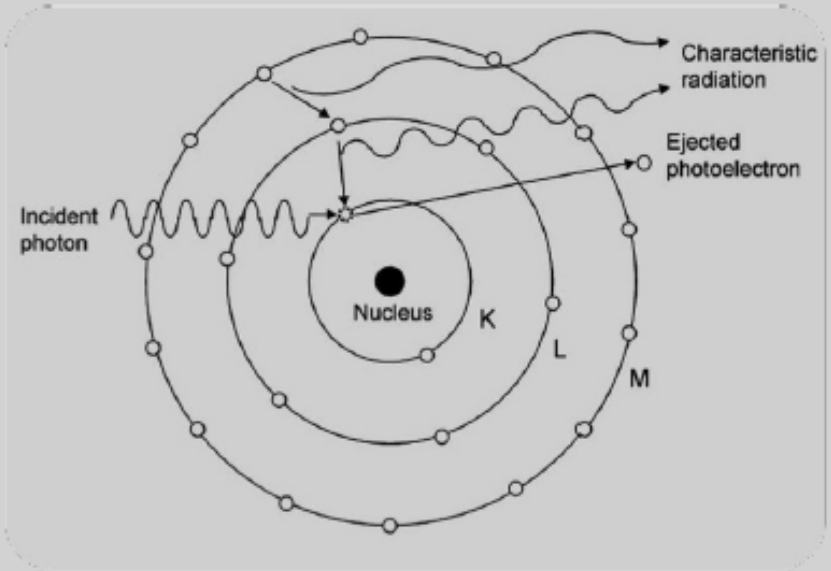
3. Phosphor layer: This layer consists of a light sensitive phosphor crystals suspended in a plastic material.

- When these crystals are struck by photons they fluoresce, that is, they emit visible light photons that expose the X-ray film.

PHOSPHOR LAYER :

FUNCTION OF THIS LAYER IS TO CONVERT *FEW ABSORBED X RAY PHOTONS INTO MANY LIGHT PHOTONS BY PHOTOELECTRIC EFFECT.*





PHOSPHOR CRYSTALS
-SUSPENDED IN PLASTIC

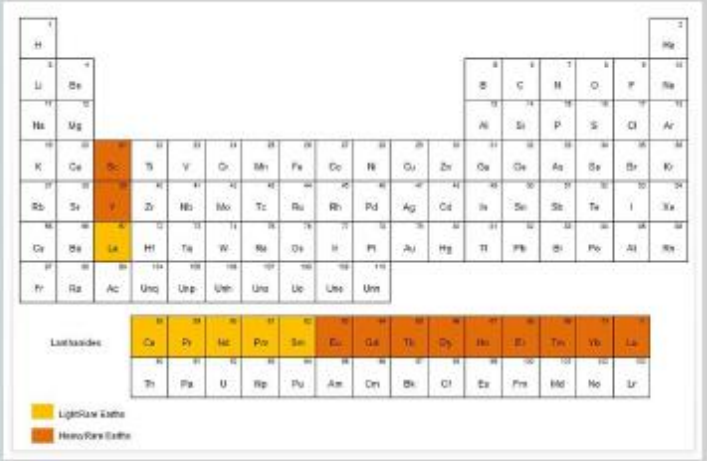
Most frequently used:

- *Calcium Tungstate($CaWO_4$)*
- *Superseded by various Rare earths:*

Lanthanum oxybromide.
Lanthanum oxysulfide.
Gadolinium oxysulfide.
Yttrium oxysulfide.
Barium lead sulfate.
Barium fluorochloride.

RARE EARTH PHOSPHORS:

- THE TERM IS USED NOT BECOS THEY ARE RARE
  BUT BECOS THEY ARE DIFFICULT TO SEPARATE
  FROM THE EARTH.
- 97% OF THE RARE EARTHS ARE FROM CHINA.



DESIRABLE FEATURES OF PHOSPHORS:

- *High X-Ray absorption efficiency*
- *High X-Ray to light efficiency*
- **Emission spectre matched to film sensitivity**
- *Fast light emission*
- *Absence of afterglow*
- *Uniform light output i.e. uniform dispersion in suspension media.*

- Types of phosphor used in dental screens are:
  - i. Crystalline Calcium Tungstate, that fluoresces in the blue portion of the spectrum. Conventional screens (Kodak X-Omatic Regular screens) are used with blue sensitive films.
  - ii. Rare earth intensifying screens using terbiumactivated gadolinium oxysulphide and theliumactivated lanthanum oxybromide, which fluoresce in the green portion of the spectrum.

4. Coat: This layer protects the phosphor layer from mechanical insult such as abrasion, scratching, etc.

- It is important to keep the intensifying screens clean, because any debris, spots which are opaque to visible light or scratches will result in light (under exposed) spots on the resultant radiograph.

Care and Use of Screen

1. There should be no gap between the screen and the film, so as to avoid excessive blurring of the image because of greater area of the film over which light can spread.
2. The cassette after use may become buckled or bent, and then it is difficult even for the felt lining in the cassette to help maintain close contact between the screen and the film.
3. Scratches, dust or grease will also prevent light photons passing from the screen to the film and thus, will show a pattern on the film. Thus, this should be prevented.

Effect of screens

1. *Unsharpness*: There are three types of screens available in the market:

- i. High definition.
- ii. Normal.
- iii. High speed.
- The manufacturer controls the screen thickness, crystal size and the amount of dye included in order to produce the optimum combination of intensification factor and screen unsharpness.

2. *Mottle*: This consists of faint irregular pattern of density

- variations which are not present in the X-ray beam.
- *Screen mottle*
- *Quantum mottle*

GRIDS

Grids

- These are devices which reduce the amount of scattered radiation reaching the film whilst still allowing the patterns containing the primary beams to reach the film.

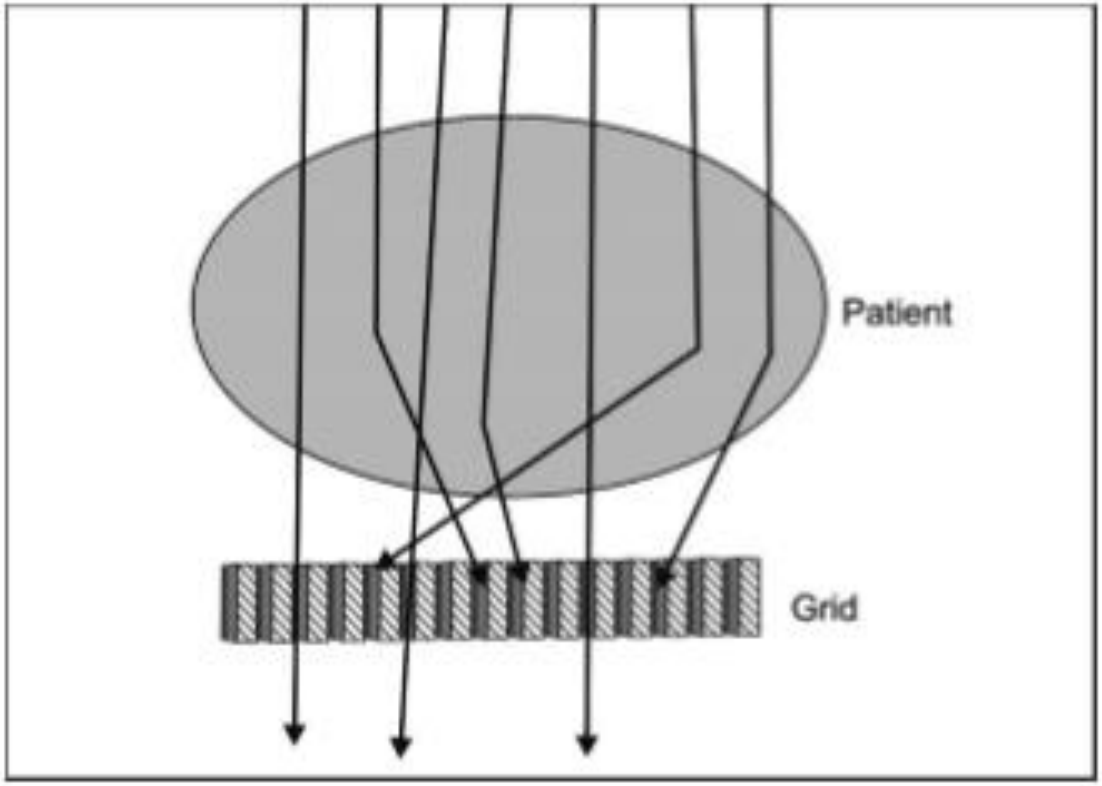


Fig. 9.17: Obliquely moving scattered radiation is stopped by the grid, whilst the forward moving primary photons pass to the film

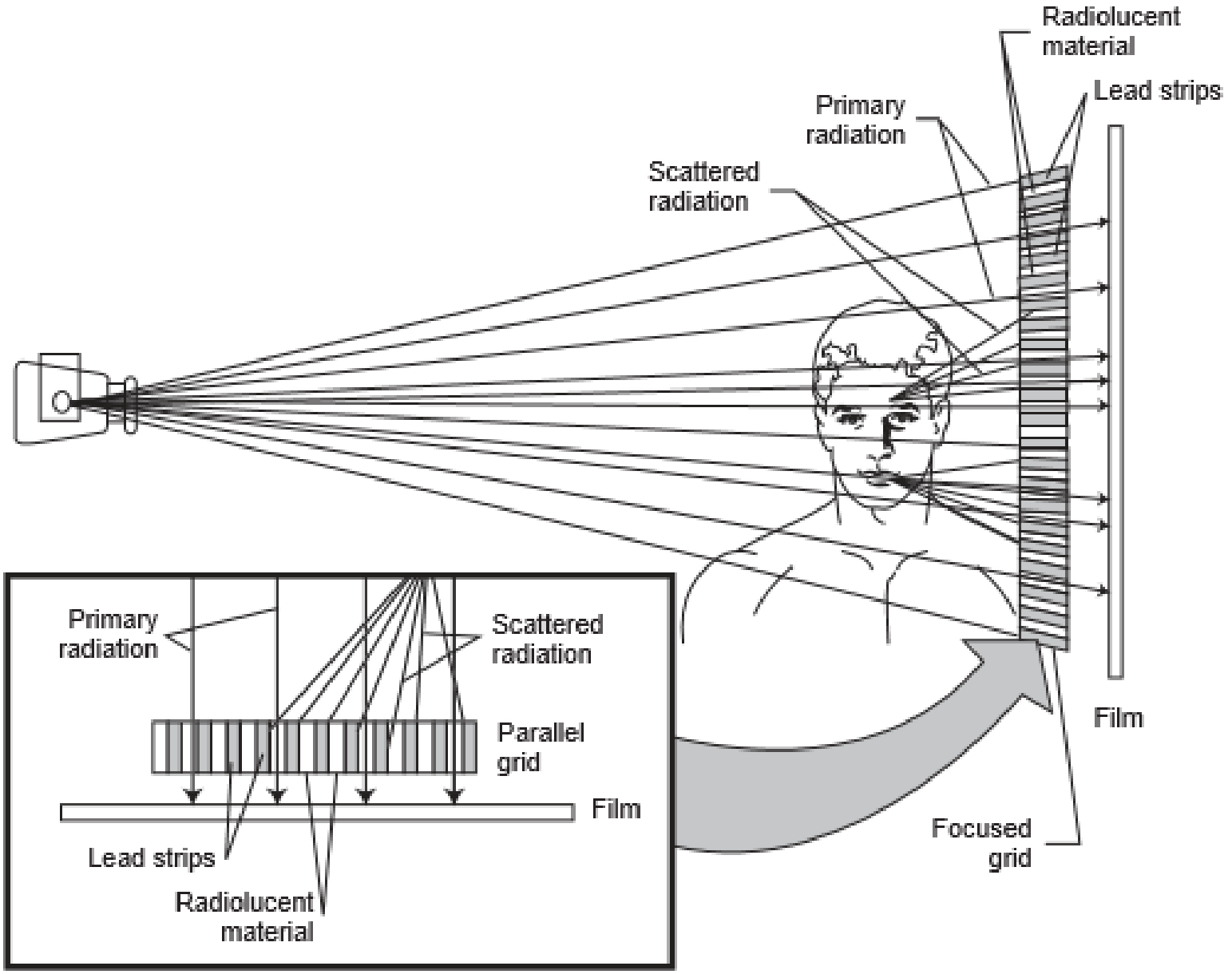


FIG. **5-21** An x-ray grid absorbs scattered x-ray photons from the primary beam and prevents them from fogging the film. In a focused grid the absorber plates are angled toward the anode; in a parallel grid the absorber plates are parallel.

Types of Grids

A. Focused grids and Non focused grids.

B. Stationary grids and Moving grids

•Stationary grids - As the name suggests, the grid is stationary and does not move.

1. The linear grid: The strips of lead used are placed strictly parallel to each other. In this, the primary radiations travelling radially from the X-ray tube focal spot to the film will encounter the grid obliquely.
2. The focused grid: In this grid the strips of lead are angled progressively from the center to the edge so that inter spaces point at the focal spot, thus their direction coincides with the direction of the path of diverging photons in the primary X-ray beam, thereby accommodating their passage through the grid. This helps to prevent the primary cut off.

3. The pseudo-focused grid: In this grid the height of the strips is reduced progressively from the center resulting in a reduced grid ratio from the center to the edge.
4. The crossed grid: The linear grids are placed mutually at right angles so that even a sm[illegible]ked.

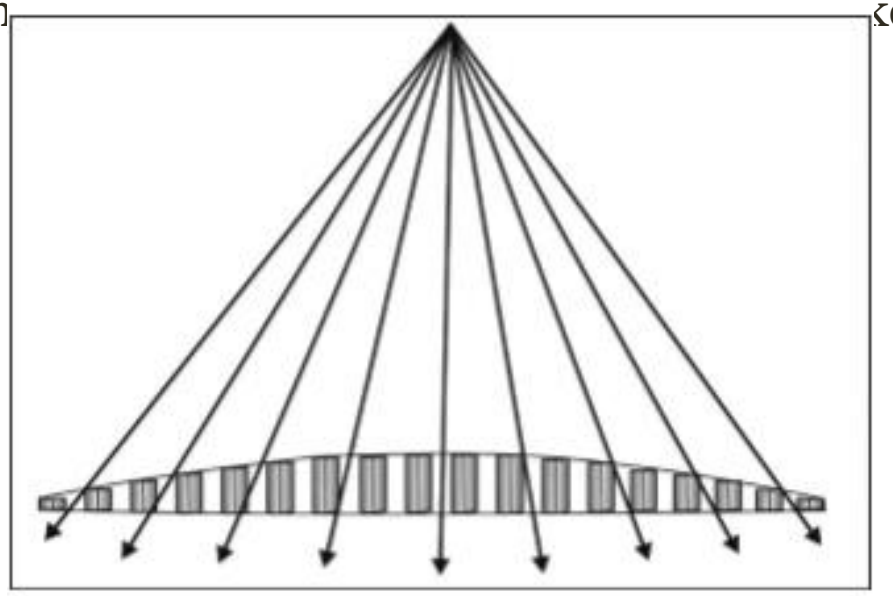


Fig. 9.19: A psuedo focused grid

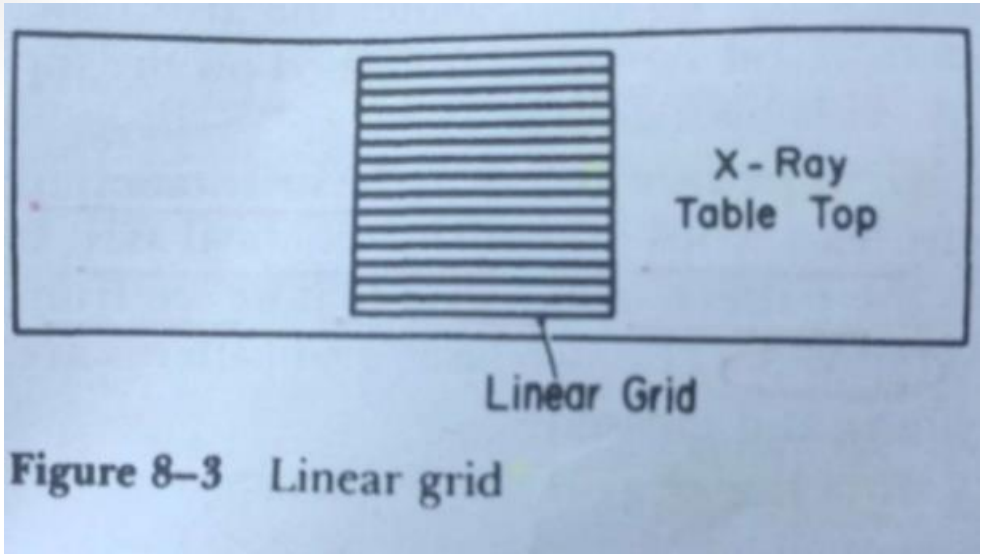


Figure 8–3 Linear grid

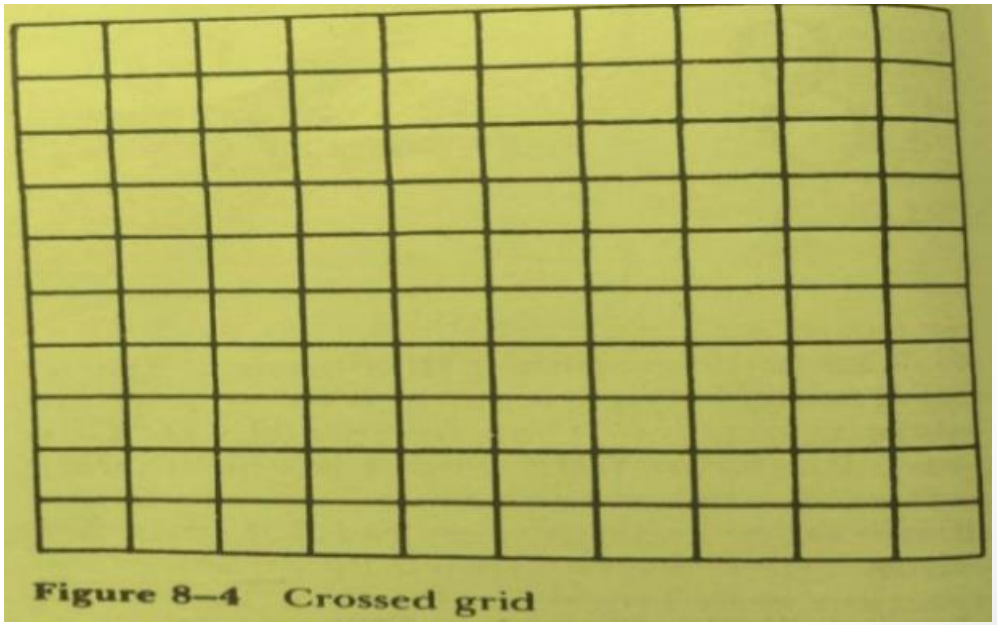


Figure 8–4 Crossed grid

Moving Grid (Potter Bucky Grid)

- In this the grid is moved side ways across the film during exposure. This leads to the blurring out of the shadows of grid strips, thus they are not visible on the film. Thus the image of the radiopaque grid lines on the film can be deleted by mechanically moving the grid in a direction of 90° to the grid lines, (but not the object) during exposure.

- Composition

- It is composed of a series of long parallel strips of an opaque material (usually lead) held apart and parallel to each other by an X-ray transparent interspace material (usually plastic).

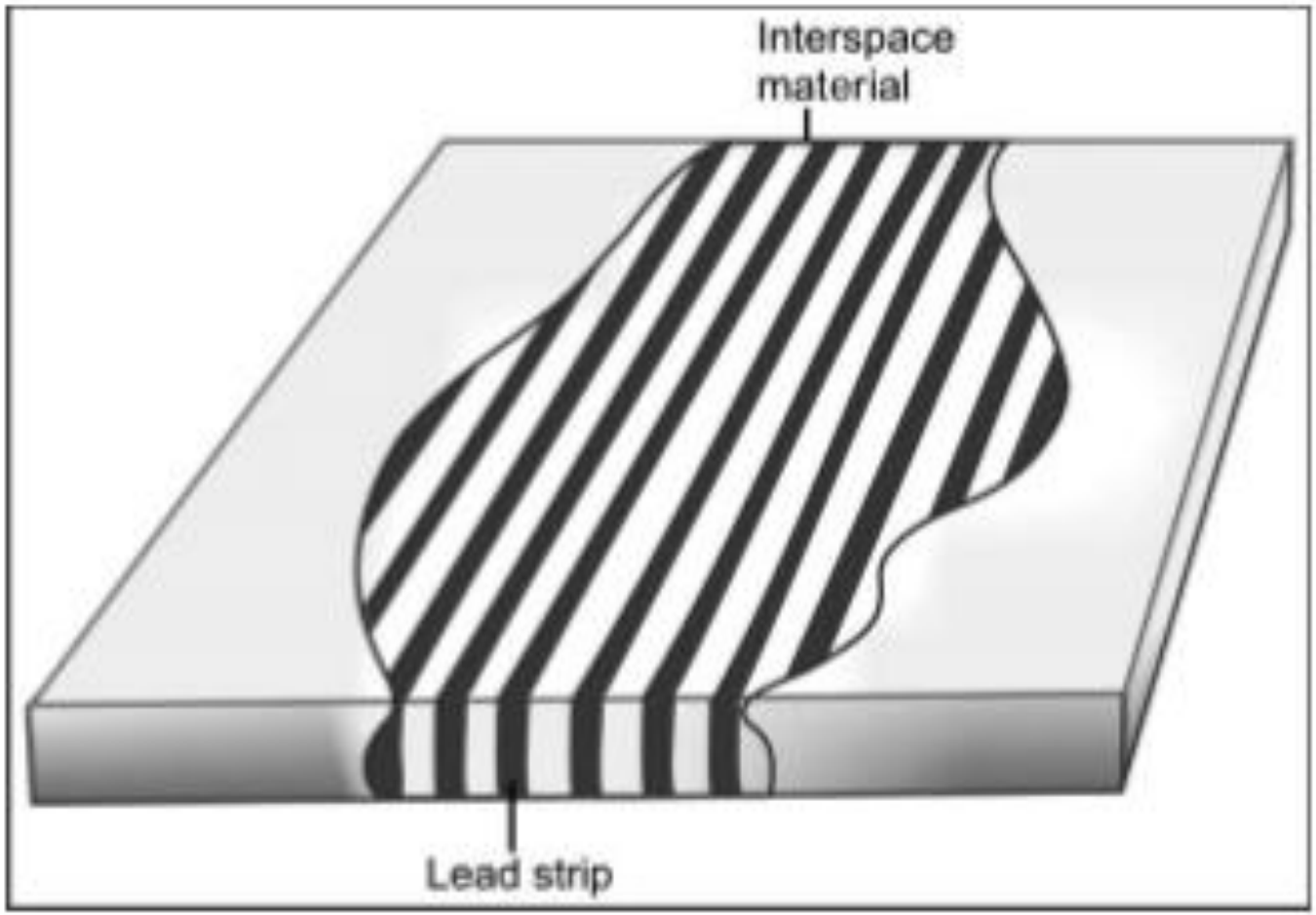


Fig. 9.20: A grid showing the long, thin parallel lead strips separated by wider interspace material. The whole is enclosed in a metal outer covering

- The presence of the grid is usually able to remove as much as 80% - 90% of the scattered radiation. This largely helps to improve the contrast.
- The contrast improvement factor (K) is calculated as;

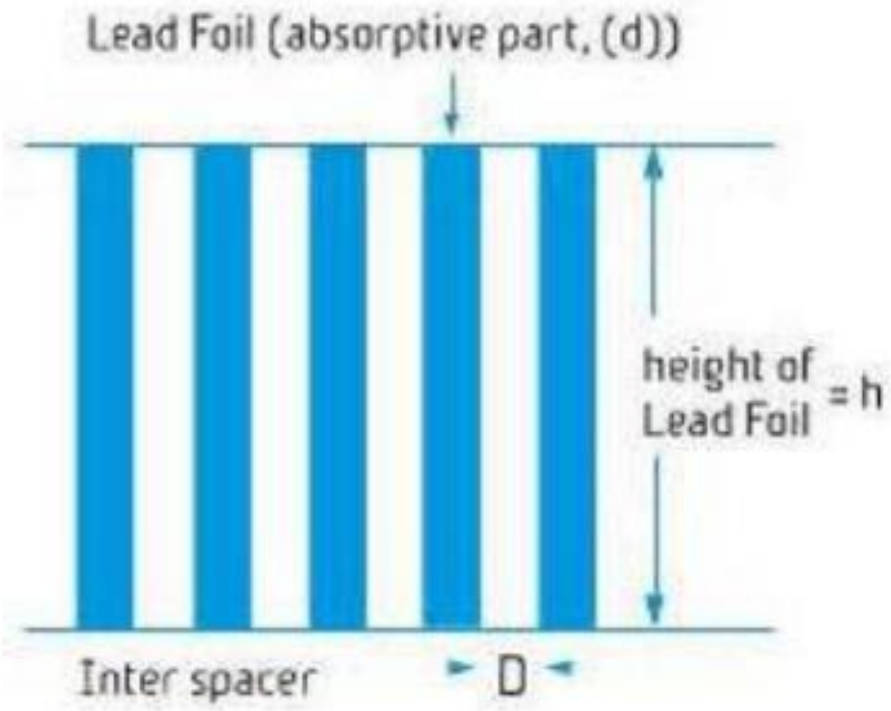
$$K = \frac{\text{X-ray contrast with grid}}{\text{X-ray contrast without grid}}$$

- Larger the value of K, better is the contrast. Grids usually have K equal to

1.5 to 3.5.

- Larger the value of K, better is the contrast. Grids usually have K equal to 1.5 to 3.5.
- Grids with a grid ratio of 8 to 10 are preferred.

GRID RATIO


Lead Foil (absorptive part, (d))
height of Lead Foil = h
Inter spacer
D

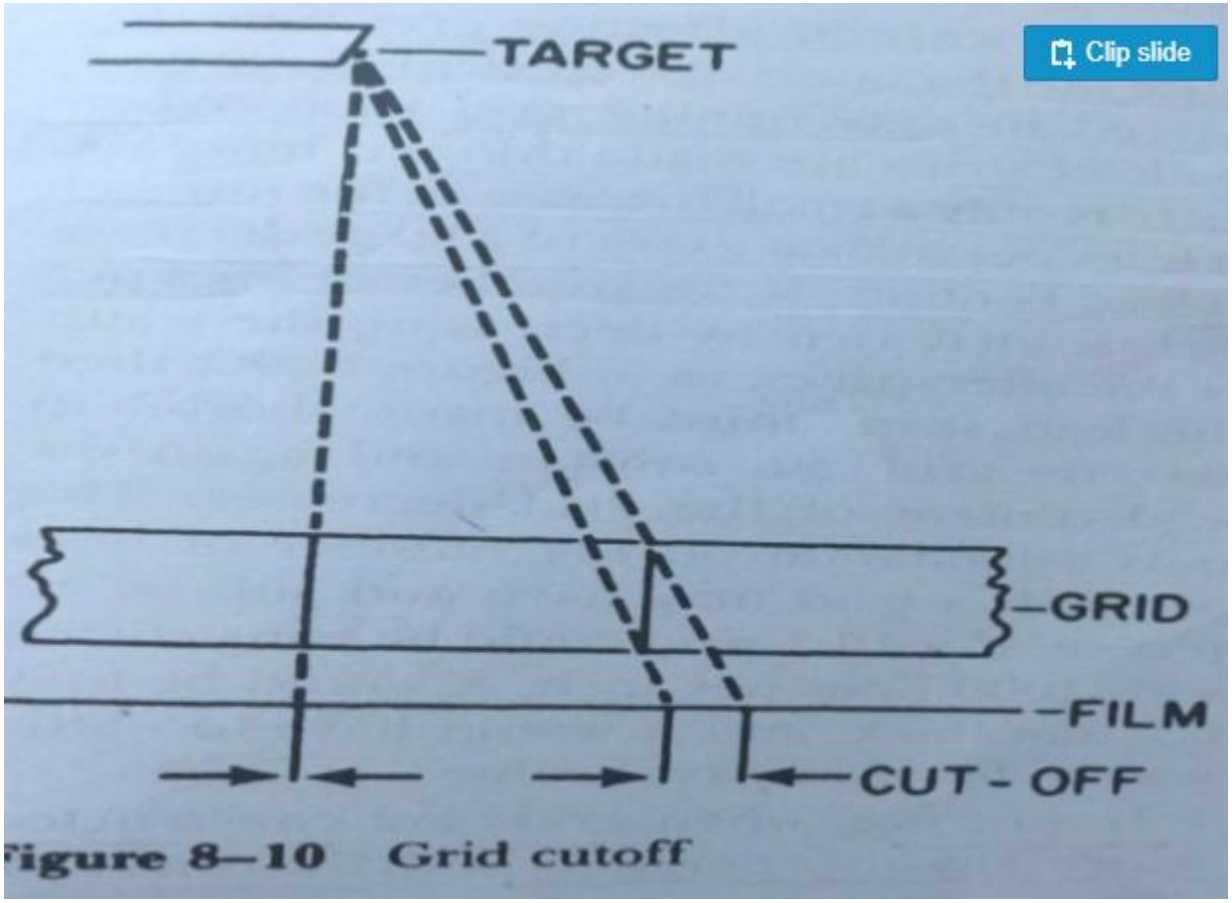


Figure 8–10 Grid cutoff

- **Advantages of a Grid**
- • Scattered radiation exiting an irradiated object may be largely removed or reduced from the beam reaching the film by placing an X-ray grid between the object and the film. This helps to reduce film fog and increase radiographic (film) contrast.
- **Disadvantage of a Grid**
- • The exposure required to produce a radiograph when a grid is used approximately doubles compared to that used in the absence of a grid. This is to compensate for the presence of lead strips in the grid, an increased exposure time must be used to expose a film.