

X ray UNIT



*Wall-mounted type or
fixed to the floor*

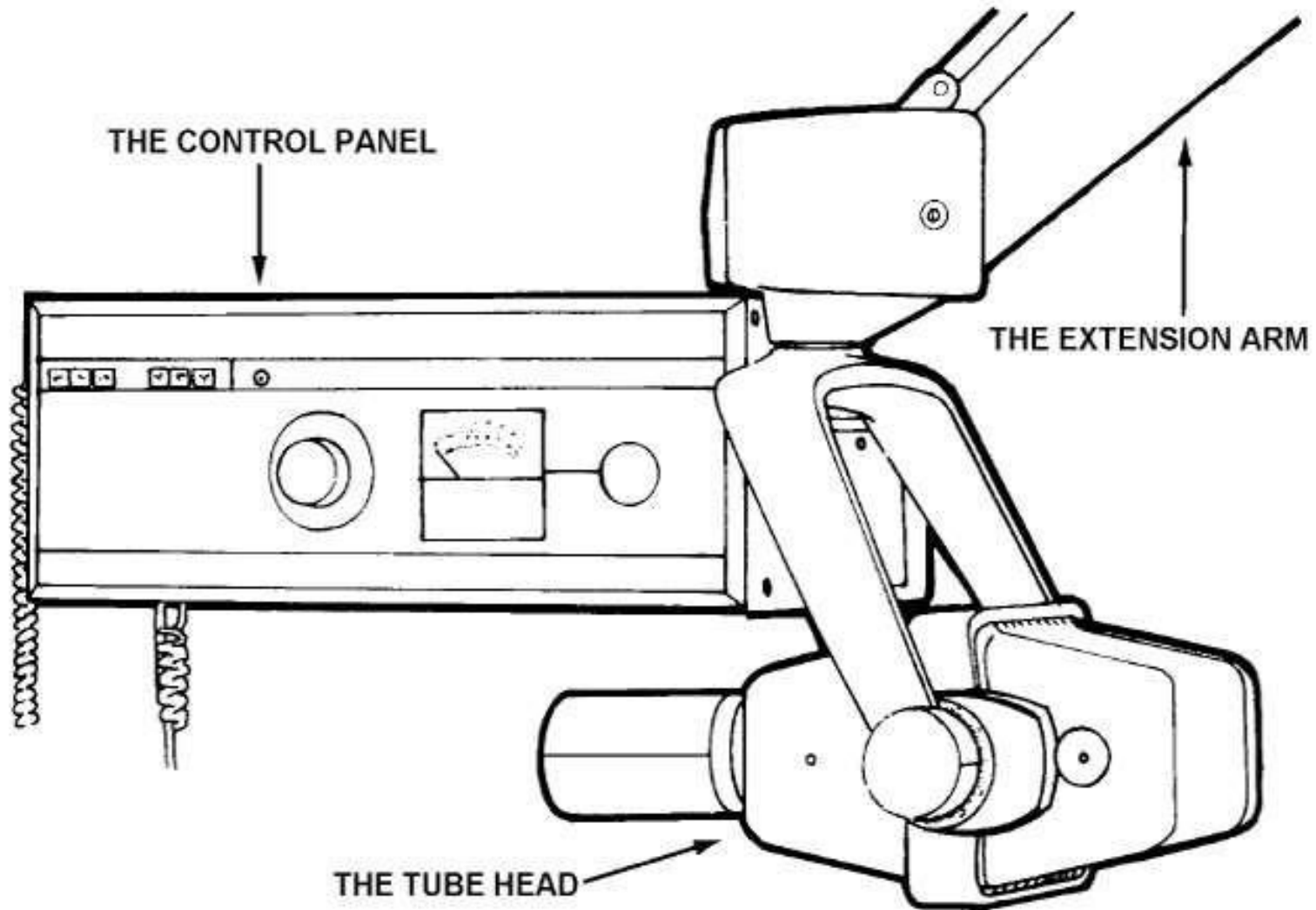


*Portable handheld X-
ray units*



*Mobile units mounted
on a stand*

Parts of an X ray machine



Parts of X-ray machine

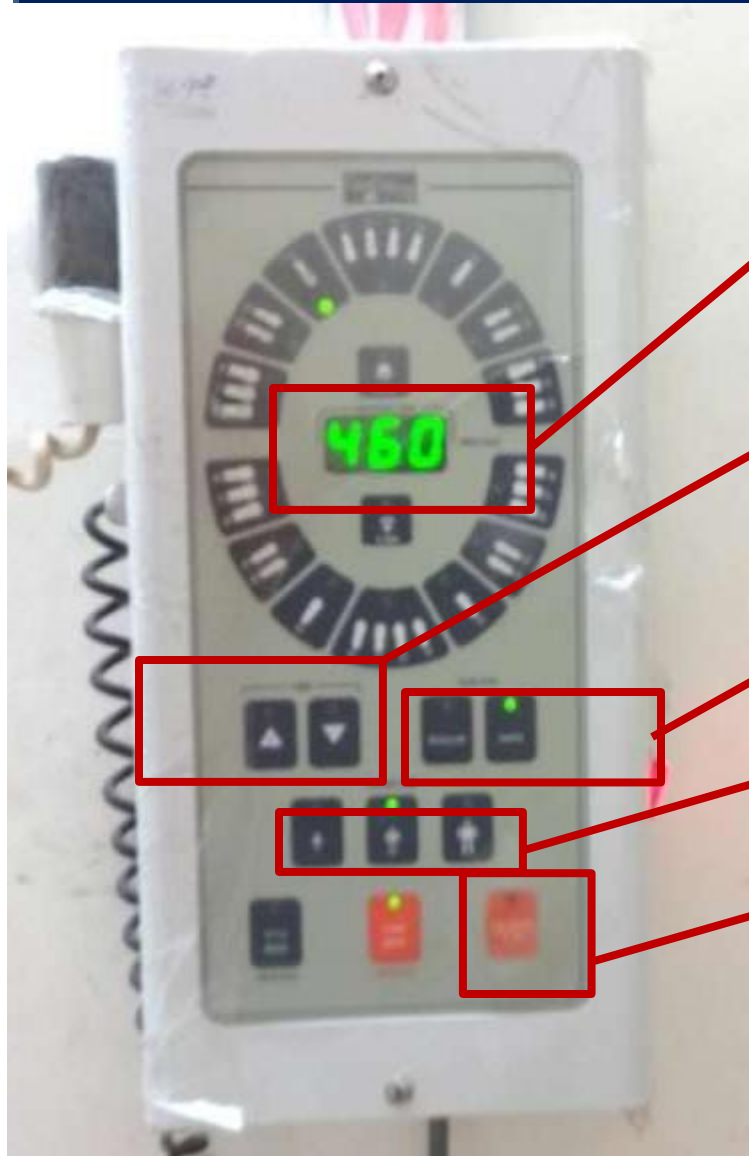
CONTROL PANEL



1. Main on/off switch and warning light
2. Timer (electronic or impulse or clockwork)
3. Exposure time selector mechanism
numerical(sec), anatomical (area of mouth)

Parts of X-ray machine

CONTROL PANEL



Exposure time (ms)

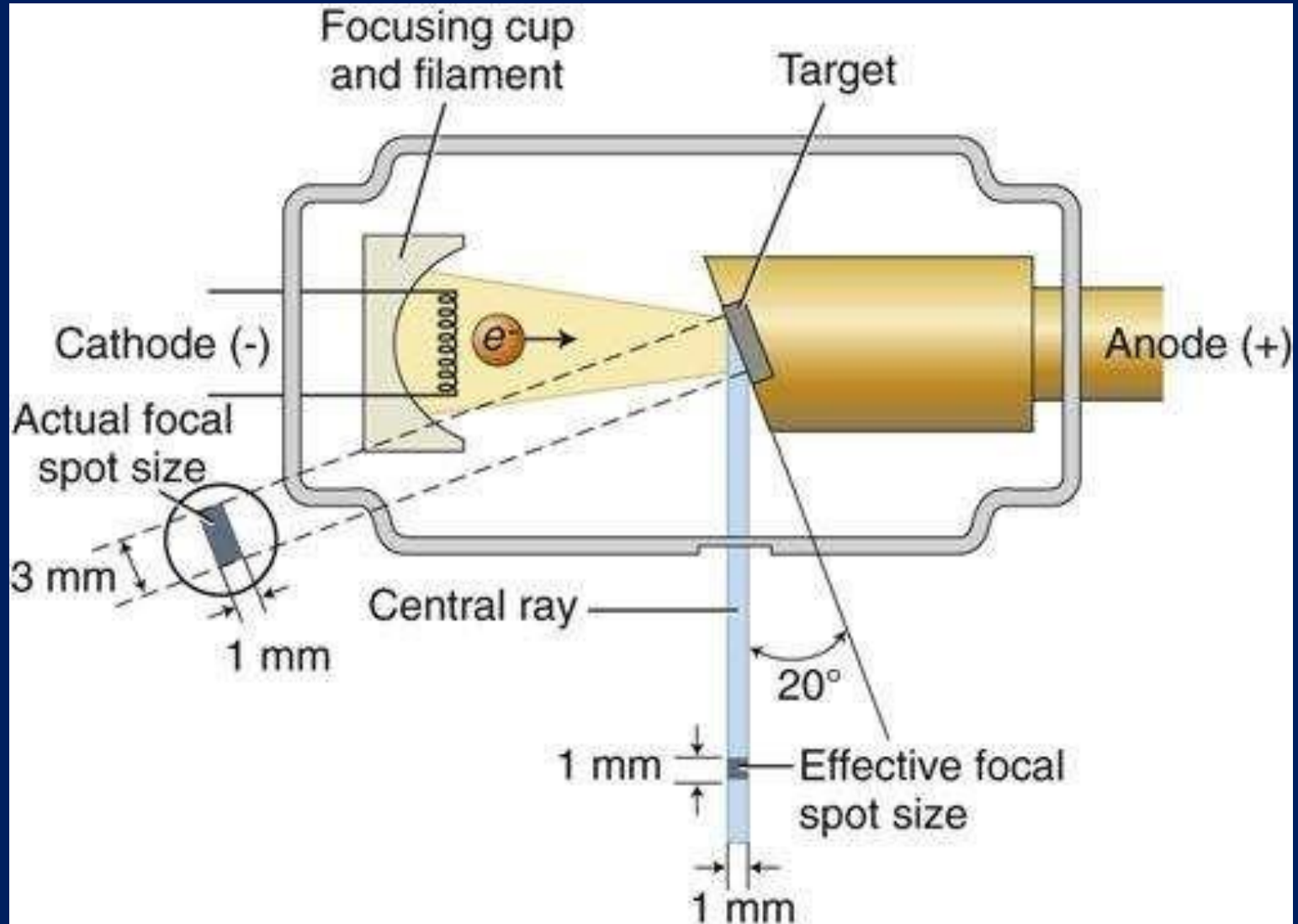
Increasing or decreasing exposure time

Type of film selector

Patient size selector

Warning light

FOCAL SPOT



POWER SUPPLY

- Primary functions of power supply of X-ray tube:
 - ❖ Provide low-voltage current to heat X-ray filament
 - ❖ Generate a high potential difference between the anode and cathode

TUBE CURRENT

- Flow of electrons through the tube; i.e. from cathode to anode, then back to cathode
- 2 types:
 1. Direct current (DC) – when electrons flow in one direction only
 2. Alternating current (AC) – electrons move in two opposite directions
- Filament transformer reduced voltage of incoming AC current to about 10 volts in the filament circuit, which is regulated by the filament current control (mA selector) -> Adjusts resistance and thus current flow across filament

TUBE CURRENT

- Milliampere control provides for fine adjustment of voltage across the filament & in turn the flow of heating current through it
- It controls the quality of electrons & tube current
- Tube current dependent on tube voltage

TUBE VOLTAGE

- High voltage required between anode and cathode to give electrons sufficient energy to generate X-rays
- Actual voltage used on X-ray machine -> Auto-transformer
- Primary voltage from input converted to desired secondary voltage
- High voltage transformer can boost peak voltage of incoming line current (110V) upto 60,000-100,000 V (60-100 kV)
- kVp dial: selects peak operating voltage between anode and cathode

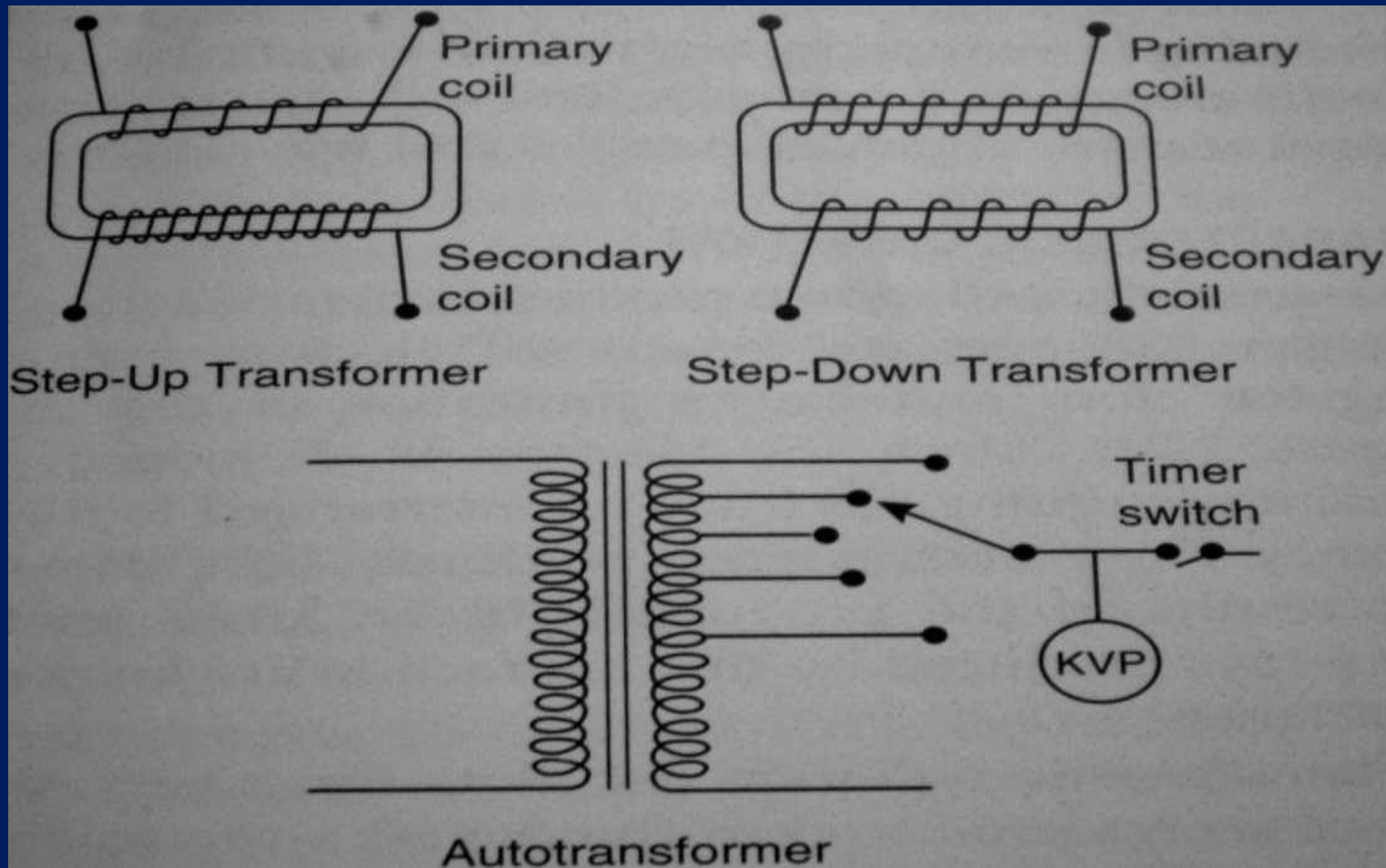
TRANSFORMER

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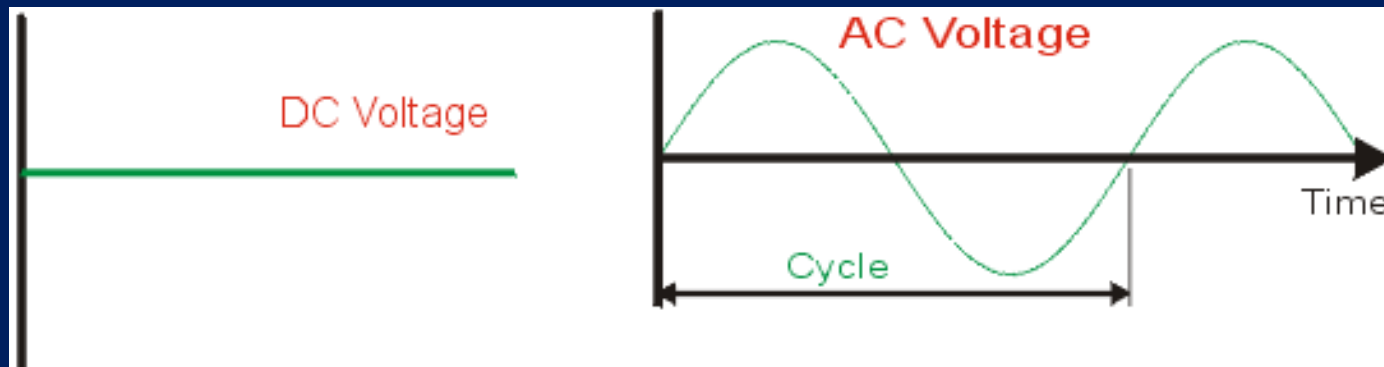
TRANSFORMER

- **Step down transformer**- ↓se voltage from 110-220 line voltage to 3-4V
- **Step up transformer**- ↑se voltage from 110-220 line voltage to 65,000-1,00,000volts
- **Auto transformer**— serves as voltage compensator that corrects the minor fluctuations in the current

TRANSFORMER



- **Rectification** – it is conversion of AC to DC
- Polarity of line current alternates (60 cycles/second) -> Polarity of x-ray tube alternates at same frequency
- When cathode is positive, it would attract electrons back to cathode. Undesirable, as no useful x rays formed, n such electrons would further heat filament n reduce lifetime.



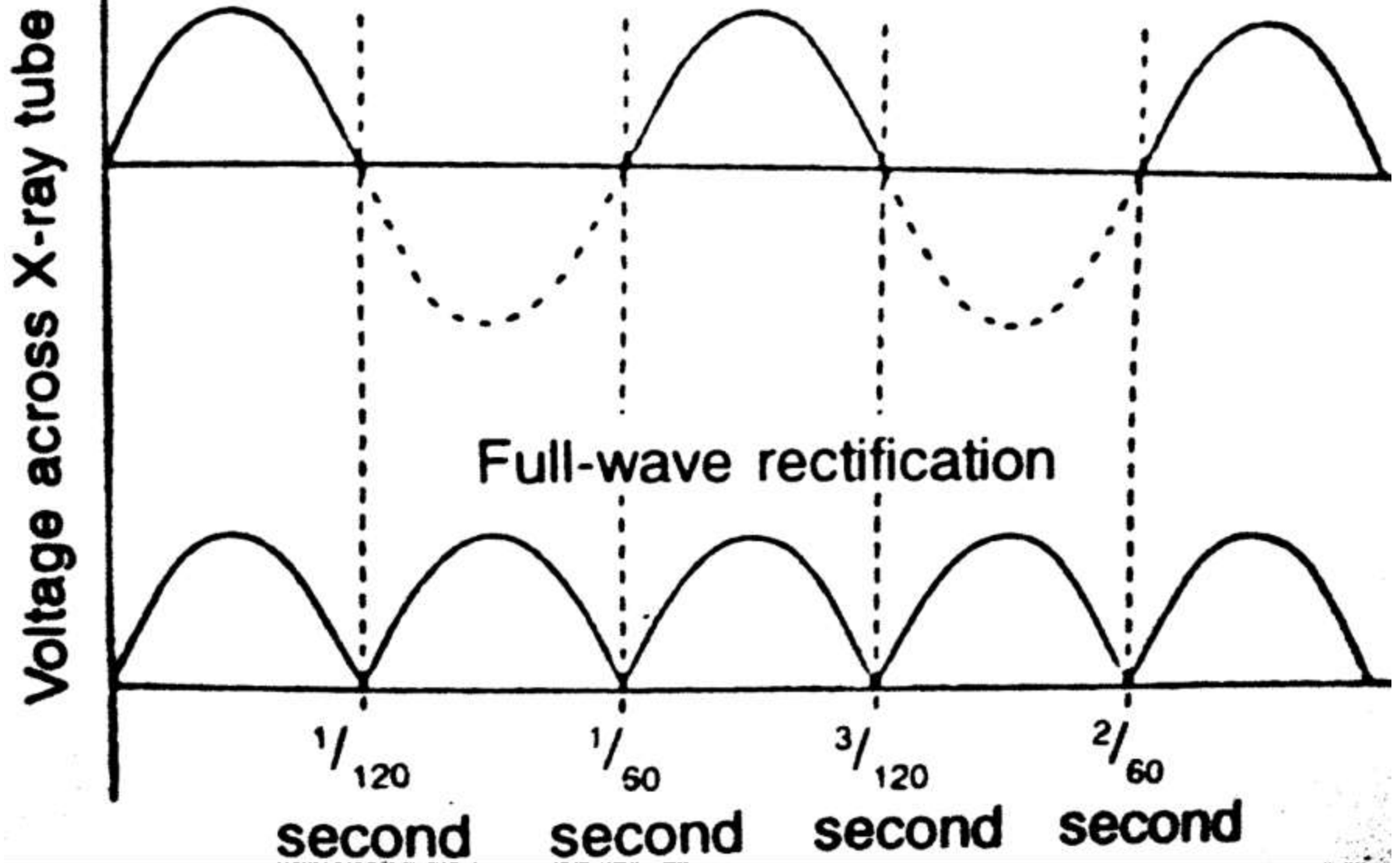
X-ray tube- self rectifying or half wave rectifying

- First phase – e flow from cathode & hit anode → x-rays
- When current changes direction, cathode becomes positively charged -> Electrons do not flow across gap -> **Inverse voltage or reverse bias.**
- Type of circuitry, where alternating high voltage applied across tube limits X-ray production to half the AC cycle



Self-rectified or half-wave rectified

Half-wave rectification



- Modern designs favour constant potential circuitry, often referred to as DC units
- These keep the kilovoltage at kV_{peak} throughout exposure
 - ✓ *X-ray production / unit time : More efficient*
 - ✓ *More high energy, diagnostically useful photons produced*
 - ✓ *Fewer low energy, harmful photons produced*
 - ✓ *Shorter exposure time possible*

TIMER

- Used to control duration of X-ray exposure
- The timing circuit first sends a current through the filament for half-second to get proper operating temperature.
- Once the filament is heated, a time delay switch applies power to high voltage circuit.
- Calibrated in fraction of a second or impulses

Tube rating & duty cycle

- Each tube has rating specification that describes the operating limits of the tube
- **Tube rating** describes the longest exposure time the tube can be energized for a range of kVp and mA values without risk of damage to target from overheating
- **Duty cycle** – refers to how frequently successive exposures can be made



PRODUCTION OF X-RAYS

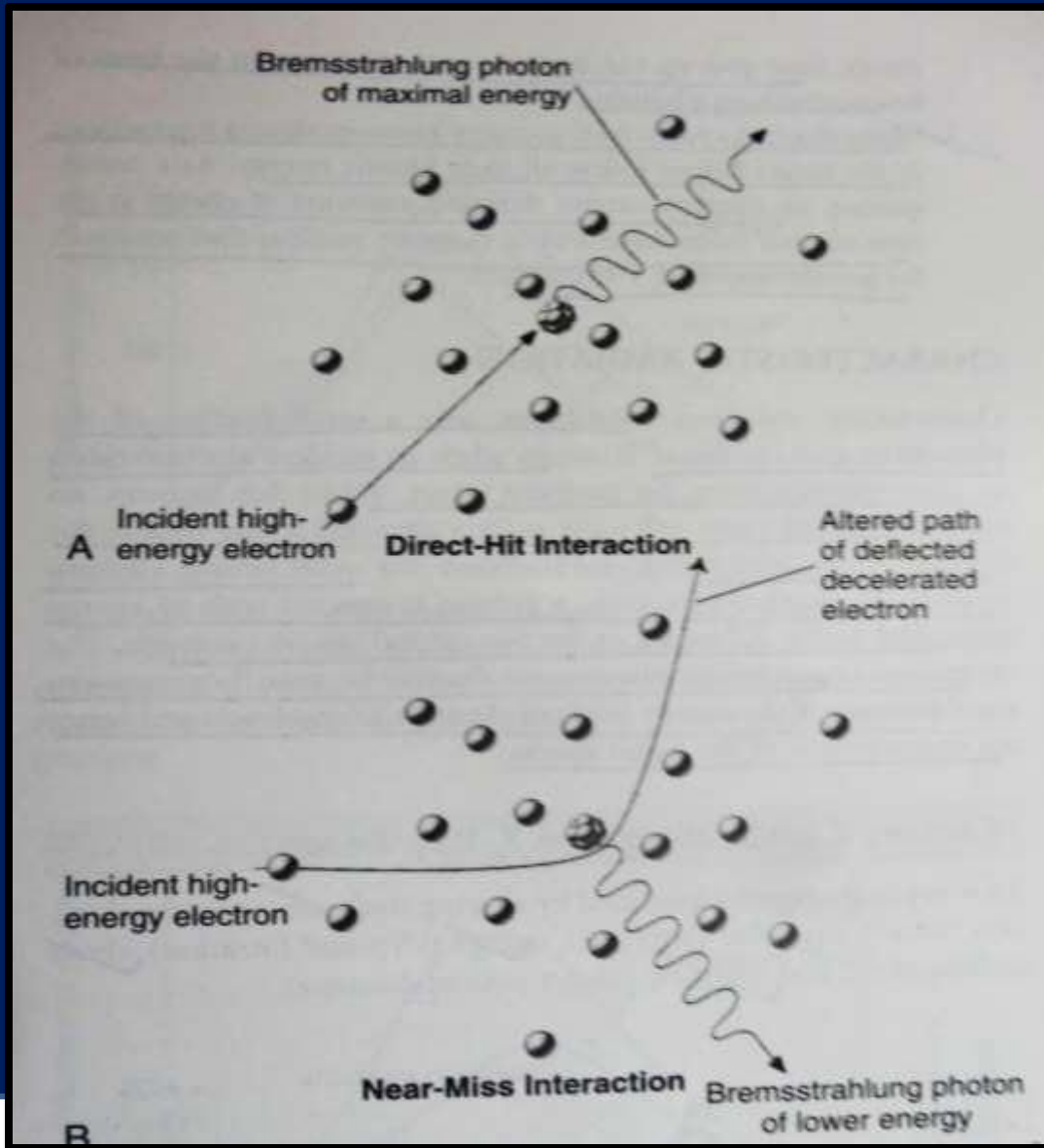
X ray producing collisions

- Continuous spectrum → Bremsstrahlung /Braking radiation
- Characteristic spectrum/ line spectrum→ ionization or excitation

BREMSSTRAHLUNG RADIATION

- Sudden stopping / slowing of high speed electrons by tungsten nuclei in target -> Produces Bremsstrahlung Radiation
- Braking radiation
- All kinetic energy of electron is transferred into a single x-ray photon
- Energy of resulting photon numerically equal to energy of electron
- Of 2 types : Direct hit, Near-miss interactions

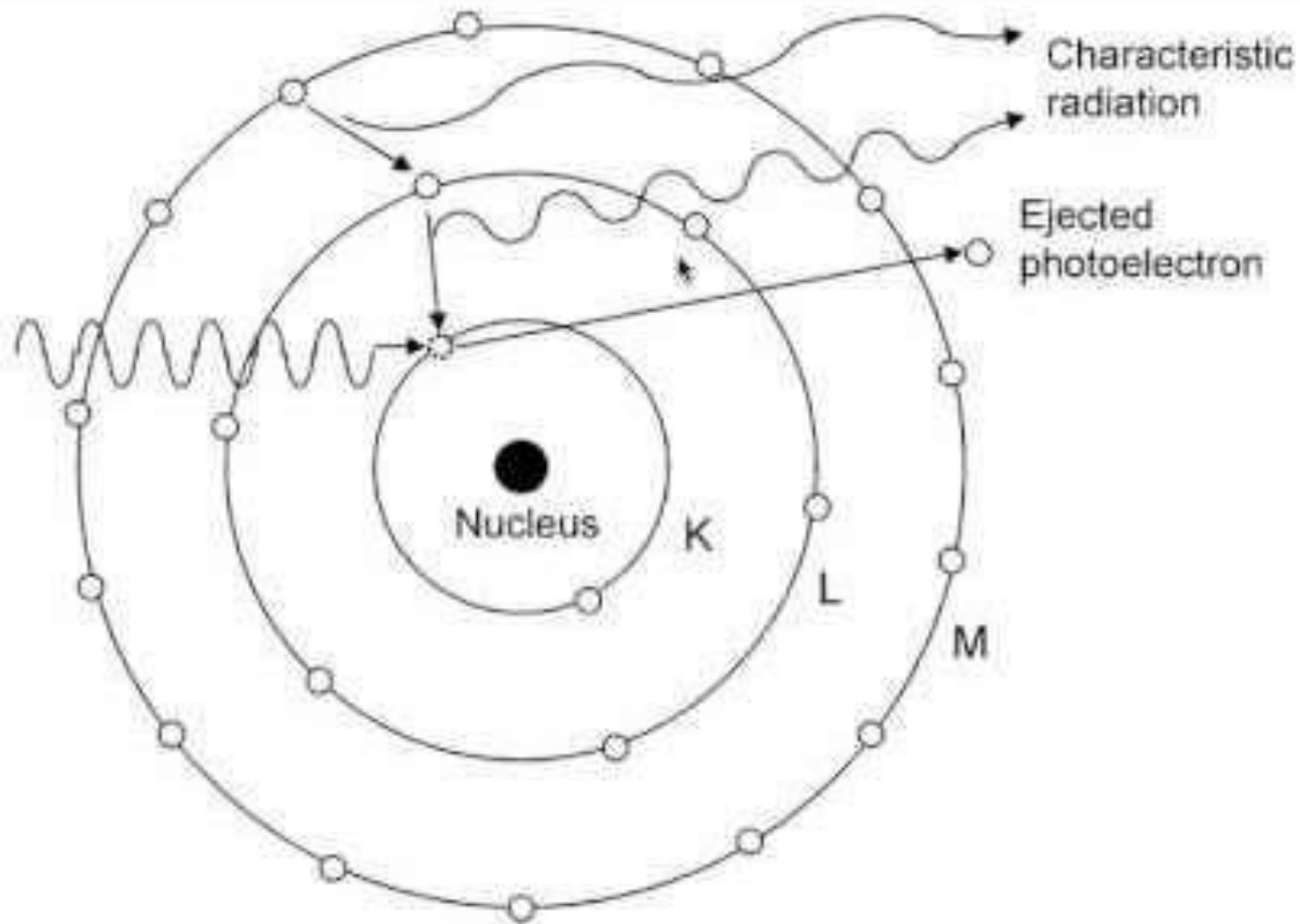
BREMSSTRAHLUNG RADIATION



CHARACTERISTIC RADIATION

- Contributes only a small fraction of photons in an X-ray beam
- Incident electron ejects an inner electron from tungsten target
- Causes atom to become ionized
- Electron from outer orbital attracted to void in deficient inner orbit
- Energy in form of Characteristic Radiation released

CHARACTERISTIC RADIATION



CHARACTERISTIC RADIATION

- K lines → diagnostic importance
- L lines → too little energy
- Bombarding high speed electron must have sufficient energy (69.5kV – critical voltage) → K line
- Dental X ray operates within 50 and 90 kV