Fundamentals of Radio-physics

First Semester

Lecture 2 part 1.
The x-ray generator

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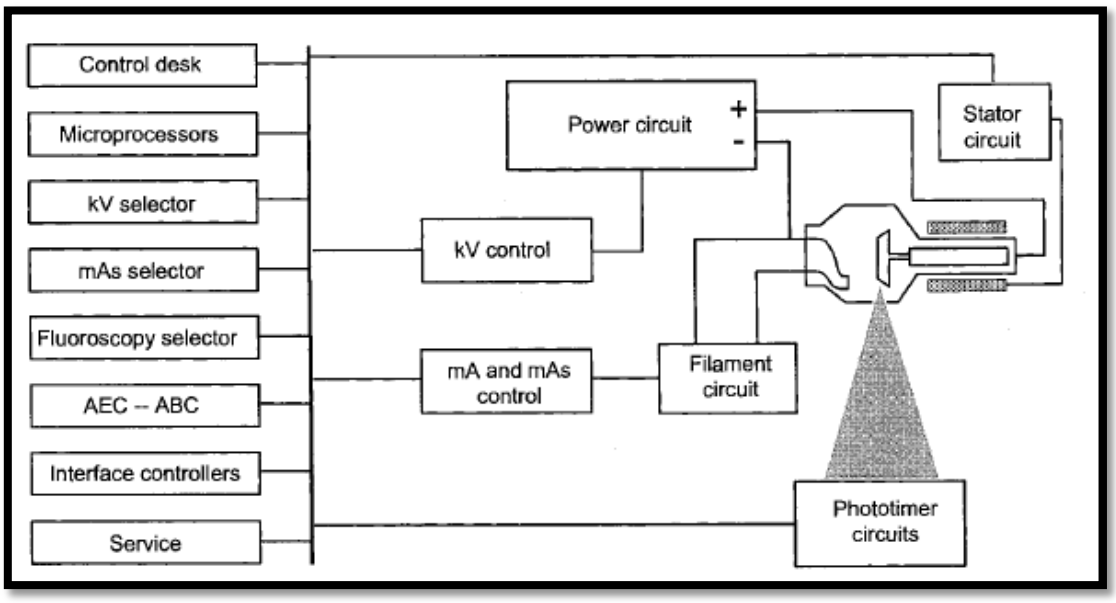
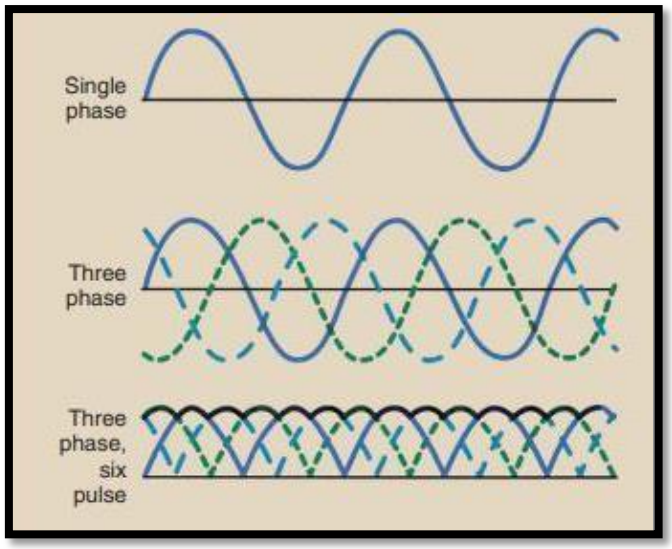
- **The x-ray generator:** is the power source of the x-ray tube which provides electrical power and signals required for the operation of the x-ray tube.
- It supplies current at a high voltage to the x-ray tube (20 to 150 kV) needed for x-ray production.
- The tube voltage is supplied Symmetrically to the tube, i.e. a net potential difference of 150 kV is achieved by feeding -75 kV to the cathode and +75 kV to the anode

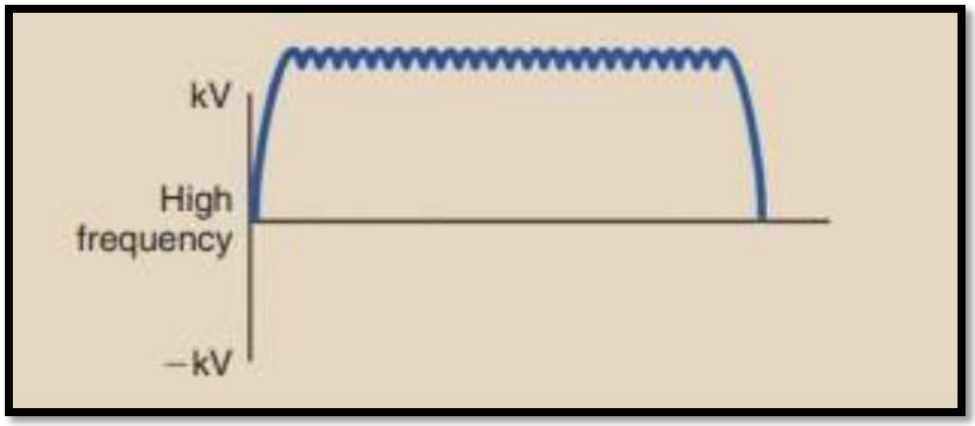
  In Mammography with tube voltages <40 kV and with some high performance tubes one electrode is kept at ground potential schematic diagram showing the basic components of the x-ray generator



  schematic diagram showing the basic components of the x-ray generator
- **Single-phase generator**: uses a single-phase input line voltage source and produces either a single-pulse or a two-pulse DC waveform, depending on the high-voltage rectifier circuits.
- **Three-phase generators**: use a three-phase AC line source (3 voltage sources) each with a single-phase



- **the high-frequency generator:** is the recent choice for medical diagnostic x-ray systems. A high-frequency alternating waveform (up to 50,000 Hz) is used for efficient transformation of low to high voltage. High-frequency has many distinct advantages such as (i) single phase or three-phase input voltage can be used, (ii) closed-loop feedback and regulation circuits ensure reproducible and accurate kVp and mA values, and (iii) variation in the voltage applied to the x-ray tube is like three-phase generator.



- **Ripple, or voltage ripple,** refers to the fluctuation in voltage output of some X-ray generators. **The voltage ripple** of a DC waveform is defined as the difference between the peak voltage and the minimum voltage, divided by the peak voltage and multiplied by 100 . It is given a percentage value

$$R = (kVp - kV_{min}) / kVp$$

Single-phase and two-phase generators have 100% ripple. Three-phase generators have ripple values between 5 and 15%. Modern X-ray generators use high-frequency inverters to create an approximate DC waveform, minimizing the ripple effect to less than 1%.

- **The Exposure Time.**

The exposure time controls the length of the x-ray exposure by determining how long the current **(mA)** will be passing through the x-ray tube.
Exposure Timers It consists of a mechanical or electronic device whose action is to make and break the high voltage across the tube on the primary side of the high voltage section.

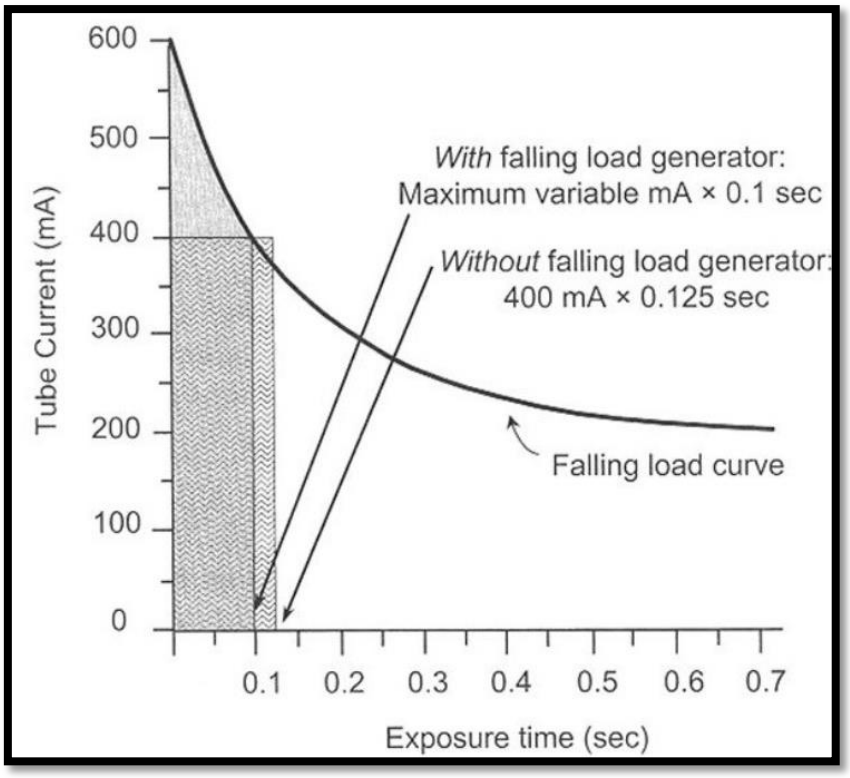
There are five types of timers:

- Mechanical Timers
- Synchronous Timers
- Electronic Timers
- mAs Timers
- Phototimers

❖ Falling load generator

The purpose of falling load generator is to produce an x-ray exposure in the shortest possible exposure time by the operating x-ray tube at it maximum kilowatt rating during the entire exposure.

- To avoid image blurring due to patient motion, short exposure times are mandatory. To produce the shortest possible exposure
- In a Falling load generator, when a mAs is selected, the generator starts with maximum mA possible based on the heat-loading potential of the x-ray tube. When the tube reaches its maximum heat load, the generator automatically reduces the mA to the next lower level, that the tube can handle and the exposure continues with lower levels of mA till it delivers the set mAs.
  With this technique the generator always uses the shortest exposure time possible to deliver the set mAs.
  Please see the graphical representation of the technique for easy understanding:



- **Limitation of the x-ray tube**

1.Low output

2. Unstable X-Ray production.

3.This tube cannot produce x- rays continually.

4.We cannot operate the kVp and the mAs independently as there is presence of gases.