Radiation Physics

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Lecture 7: The X-Ray Tube

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The x-ray tube

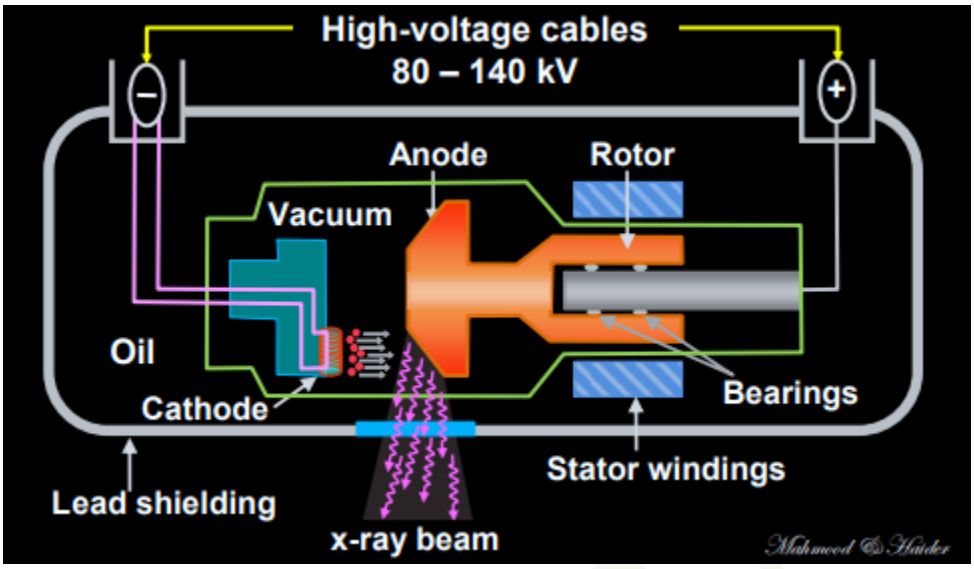
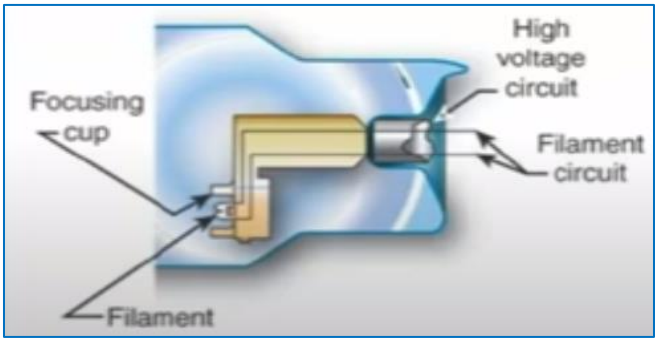


Figure (1): x-ray tube with a rotating anode and a heated filament.

We will look at each of the pieces of the x-ray tube and what they do to help with the production of x-ray

The cathode

- Filament, surrounded by a focusing cup
- The filament (electron emitter) is usually a coiled wire filament 0.2–0.3 mm (e.g. tungsten)
- Focusing cup is used to focus the electrons on a small area (focal spot) in the anode.

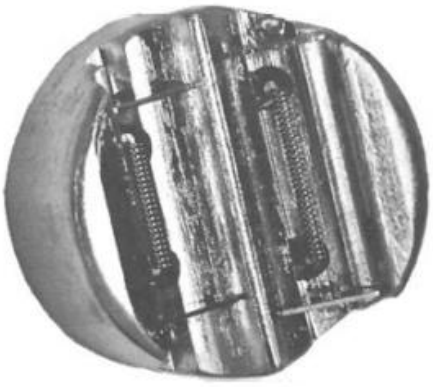


Figure(2): The cathode

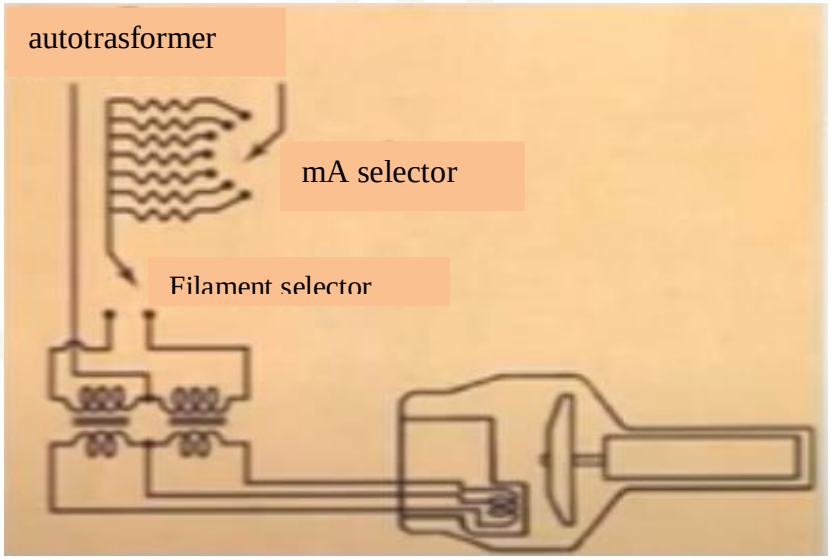
The Filaments

many x-ray tubes have two filaments (dual focus) so that the tubes can have a greater variety of exposures

- The small filament provides a smaller focal spot and a radiograph with greater detail, provided that the patient does not move.
- The larger filament is used for high-intensity exposures of short duration.



Figure(3): Cathode assembly of a dual-focus x-ray tube.



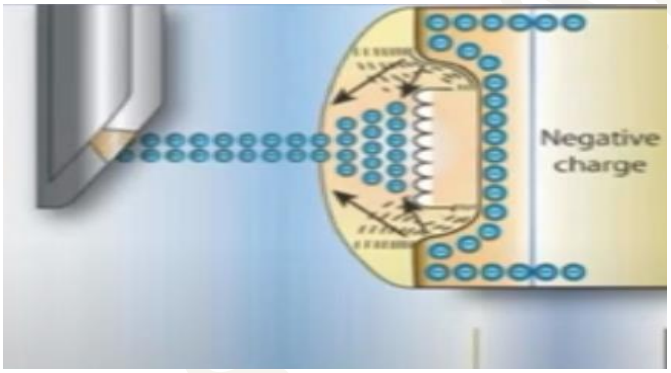
- The figure above shows the wiring for a dual tube. the autotransformer where you select the miliamperage for the filament. The filament selector is where the different filaments selected

Focusing Cup

The focusing cup controls the width of the electron distribution, and directs the electron toward the target

Space charge effect: When the applied kV is zero or small, the electrons surrounding the filament forms a cloud, resulting in space charge effect. As the kVp is increased, (0–40 kV) the effect of space charge reduces gradually and the tube current also increases.

Saturation: Above 40 kVp, the space charge effect is overcome, and the tube current is controlled by the filament current. This is called the saturation



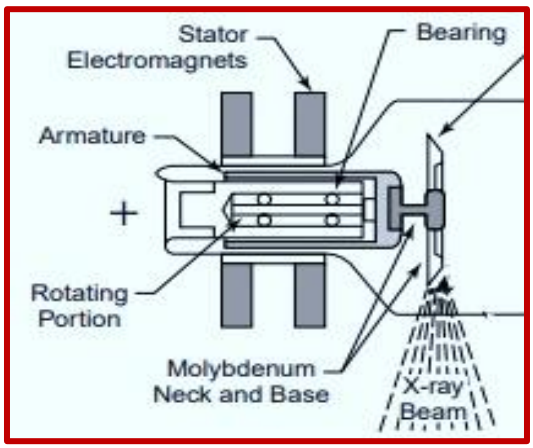
The Anode

The anode is the target electrode, consists of stator and rotor which is maintained at a positive potential

Stator and Rotor

- The anode disk is connected to a rotor, which is made up of copper bars arranged around a cylindrical iron core.
- There are electromagnets surrounding the rotor are called stator (Figure 4).
- The anode assembly is rotated with the help of bearings, which are made of steel ball.
- Both the stator and rotor is called as an induction motor.

When the stator coils are energized, a rotating magnetic field is produced.



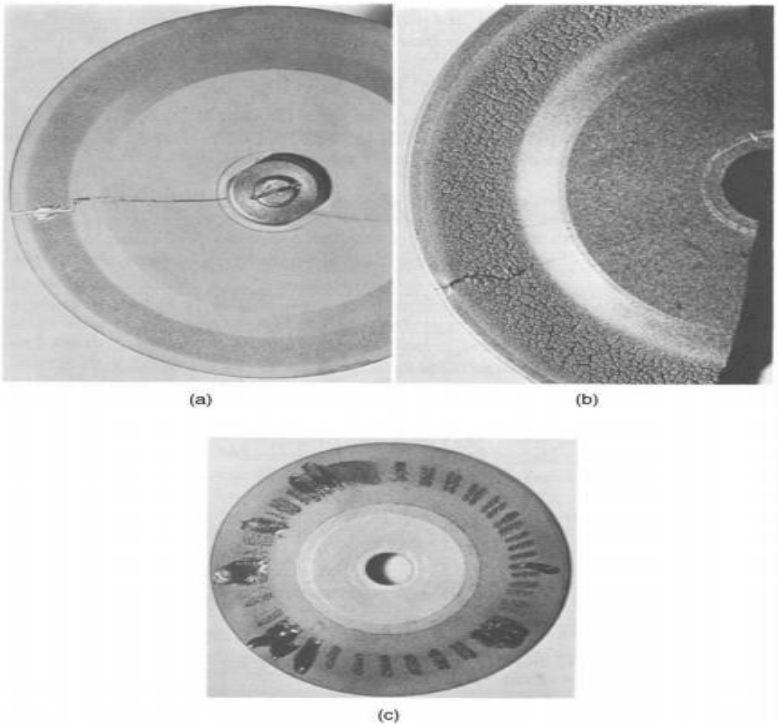
Figure(4): The Anode

What is the purpose of anode?

1. Serves as a target surface for the high-voltage electrons
2. Conducts the high-voltage from the cathode back into the x-ray generator circuit
3. Serves as the primary thermal conductor

Modern X-ray tubes

1. Stationary anode X-ray tube
2. Rotating anode X-ray tube



a: Target cracked by lack of rotation.

b: Target damaged by slow rotation and excessive loading.

c: Target damaged by slow rotation.