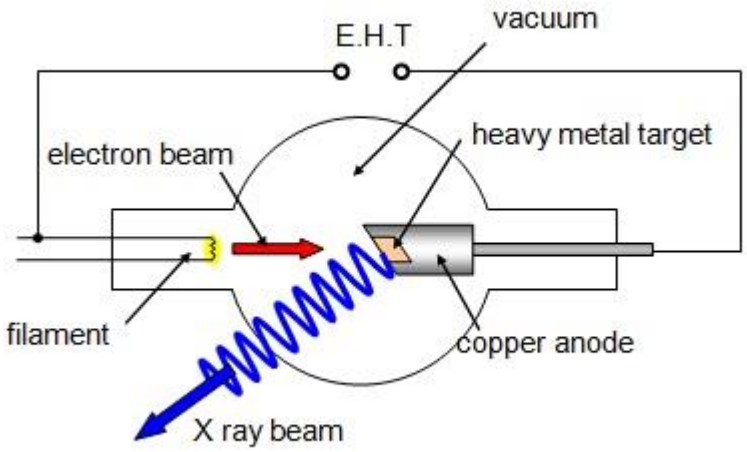
X-Ray Tube Working Principle

Radiology - Basic X-Ray Machine

It is a special branch that deals with the study and application of imaging technology using X-ray radiations or such other radiation devices for the purpose of obtaining visual information to diagnosing and treatment of diseases. X-ray machines are devices that generate exceedingly high frequency high energy electromagnetic waves that penetrate the body during medical procedures to provide visual information. The x-ray tube working principle and diagram is shown below.

Generation of X-rays in X-ray tubes.

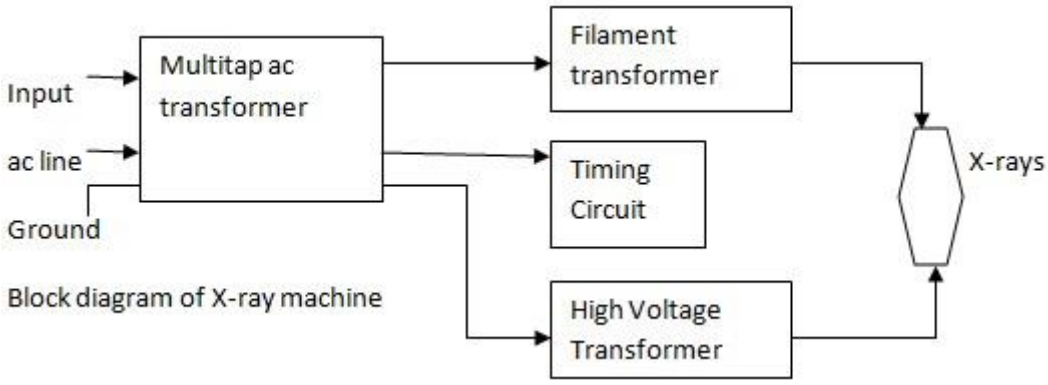
An X-ray generator is a device used to generate X-rays .An X-ray imaging system consists of an X-ray source or generator (X-ray tube) and an image detection system. The X-ray tube (high vacuum diode) operates by emitting electrons from a heated cathode tungsten filament toward a rotating high voltage anode disc. The point where the electrons (beam) strike the target is called the focal spot. At the focal -spot X-ray photons are directed at all directions. X-rays arise from the target disc at right angles and are focused by a collimator. For more viewing contrast we use, photomultipliers. The images are received and viewed on a photographic plate. Here light and dark areas on the film represent high and low tissue penetration. The basic schematic of an X-ray tube is shown below.



X-ray machines work by applying controlled voltage and current to the X-ray tube. So the beam intensity of X-rays can be controlled by controlling voltage or current. The beam is projected on the object. Some of the beams will pass through the object and some are absorbed. The resulting pattern of radiation is detected in a photographic film as told earlier. In an X-ray tube, the rotating anode is used to overcome the overheat problem. Also the anode is made of tungsten alloy which helps in avoiding over heat.

Block Diagram of X-ray Machine

The block diagram of X-ray machine is shown in figure below. The function of each block of an X-ray machine is also explained below.



block diagram of x-ray machine

1. **Multitap ac transformer**

   We use a multi-tap ac transformer in order to select taps to compensate for incoming line variations. The number of outputs is referred to as 'taps' and it may range from 2 outputs to many outputs depending on the type of multi-tap transformer used. The advantage of multi- tap transformer is that it has different taps in different voltages. So we can select a higher voltage tap or lower voltage tap depending on the intensity of X-ray exposure needed. These also permit the operator to choose voltages for specific applications.

2. **X-ray tube filament transformer:**

   This transformer transforms the ac line to supply power for heating the cathode filament. This power can be selected by taps to change the filament heat which in

turn change the X-ray tube current and total energy delivered to the patient.

3. X-ray tube high voltage transformer and bridge rectifier

This block together transforms the ac line to supply the high dc voltage for accelerating the electrons from cathode to anode. The high dc voltage is selected by taps.

4.Timing circuit

Timing circuit is used to control the turn-on, turn-off and length of X-ray exposure delivered to the patient. It consists of an electronic counter that applies high voltage to the X-ray tube anode for short periods of time.

Advantages of X-rays in medicine:

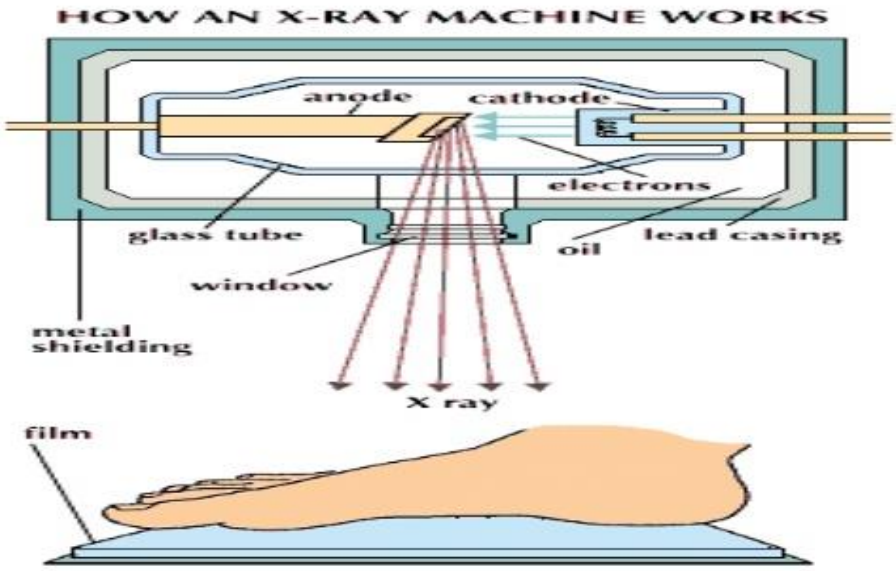
1. X-ray can be used to produce an image of any body parts.
2. It is also available as a portable unit which can be used in hospitals widely and X-rays can be taken anywhere even in bedside.
3. It is less costly when compared to other imaging models like MRI scan.

4. It can produce fast results.
5. It is a comparatively easy technique.

Applications of X-rays in medicine:

1. X-ray machines are used in healthcare for Visualizing bone structures and other dense tissues such as tumors.
2. The two main fields which use X-ray machines are radiography and dentistry.
3. Radiography is used for fast and highly penetrating images.
4. By using X-rays cancer cells can be treated in radiotherapy.

WORKING



X ray Machine - Components & Working Mechanism viedo link :-

https://youtu.be/KTDBMXQ3c68

or viedo in hindi

https://youtu.be/uzJUwBokNuU