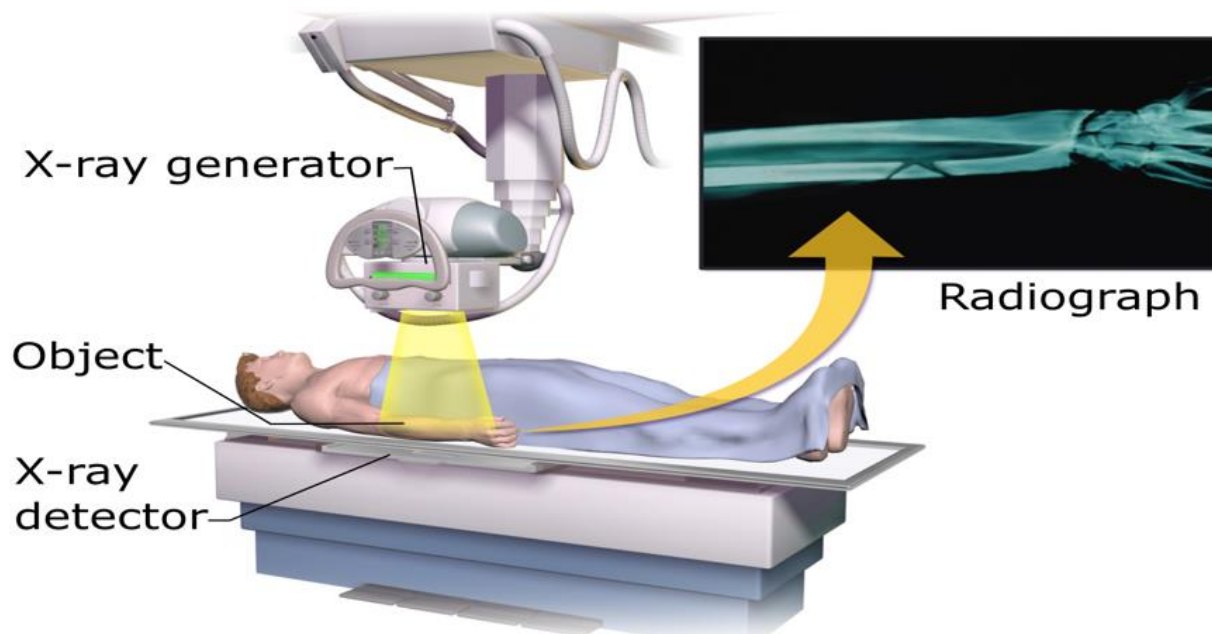




1. X-rays

- X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body.
- Medical x-rays are used to generate images of tissues and structures inside the body.
- If x-rays traveling through the body also pass through an x-ray detector on the other side of the patient, an image will be formed that represents the “shadows” formed by the objects inside of the body.

Projectional radiography





2. When X-rays are used

X-rays can be used to examine most areas of the body. They're mainly used to look at the bones and joints, although they're sometimes used to detect problems affecting soft tissue, such as internal organs.

Problems that may be detected during an X-ray include:

- bone fractures and breaks
- tooth problems, such as loose teeth and dental abscesses
- scoliosis (abnormal curvature of the spine)
- non-cancerous and cancerous bone tumours
- lung problems, such as pneumonia and lung cancer
- dysphagia (swallowing problems)
- heart problems, such as heart failure
- breast cancer

3. X-rays room

- Normally in any hospitals, X-ray equipment are installed in an easy accessible place. Because the X-room should be reachable easily in case of emergencies.
- When an X-ray is taken for a patient, the people in out of the X-ray room should not be exposed to X-ray radiation. For this all the X-ray room Layout



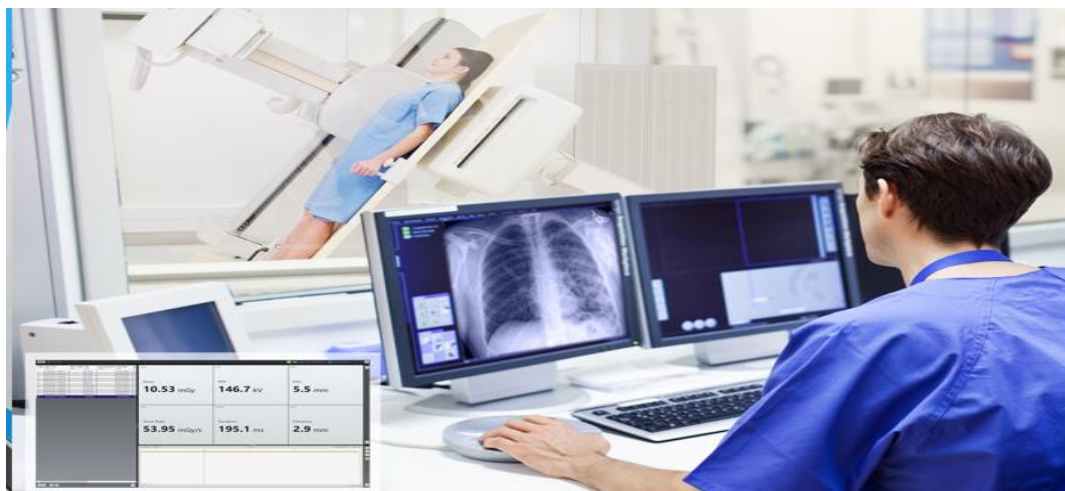
Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class:Third
Subject: Medical Instrumentation (II)
Lecturer: Msc. Forqan Ali Wahhab
Lecture: X-rays

need to be designed carefully so that adequate shielding is done for the X-ray room walls too.



4. Control Booth

- Should contain the operator console and technique charts and space to store cassettes.
- The wall between the booth and xray unit is shielded.





5. Types of X – ray machines

- Portable-X-ray
- Dental X-ray
- Fixed X-ray



6. X – ray machine parts

X-ray has three main components:

- Operating Console
- High Frequency Generator
- X-ray Tube

1. Internal

2. External

- Other Parts include
- Collimator and Grid
- X-ray Film



6.1. Operating Console

The control console is device that allows the technologist to set technical factors (mAs & kVp) and to make an exposure.



6.2. High Frequency Generator

Voltages in the range of 30–200 kV are required for the production of X-rays for diagnostic purposes, and they are generated by a high voltage transformer. A high ratio step up transformer is used so that the voltages applied to primary winding are small in comparison to those taken from the secondary winding. Typically, the ratio would be in the range of 1:500 so that an input of 250 V would produce an output of 125 kV. Usually the high tension transformer assembly is immersed in special oil which provides high level of insulation.



Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class:Third
Subject: Medical Instrumentation (II)
Lecturer: Msc. Forqan Ali Wahhab
Lecture: X-rays



High Frequency Generators Modern X-ray machines make use of high frequency generators for producing high voltage. The single most important feature that differentiates high frequency, three-phase and single phase power is the ripple in the output. A lower ripple provides a more efficient radiation output and a shorter relative exposure for equivalent contrast radiographs. Fig. 5 illustrates comparative wave shapes for single phase with 100% ripple, RMS three-phase with typical 6–12% ripple and RMS high frequency with typical 1–2% ripple. The high frequency used in these generators varies from 500 Hz–20 kHz. High frequency is generated by first converting the 50 Hz 91 power line frequency into high frequency oscillations in the converter circuit. The frequency conversion permits the use of much smaller transformers than those required with conventional equipment. Basically, the circuit uses same switching arrangement for thyristors through a series resonant circuit, comprising L and C1, where L is the inductance of the primary of the high tension transformer. If the circuit is switched by the thyristors at its resonant frequency, the effective current flowing through L is maximized. This primary current is transformed and rectified in the high tension circuit. The net voltage appearing across the Xray tube is determined by the voltage present on



C2. This voltage, in turn, is supplied by the charging current and drained by the current flowing through the X-ray tube.

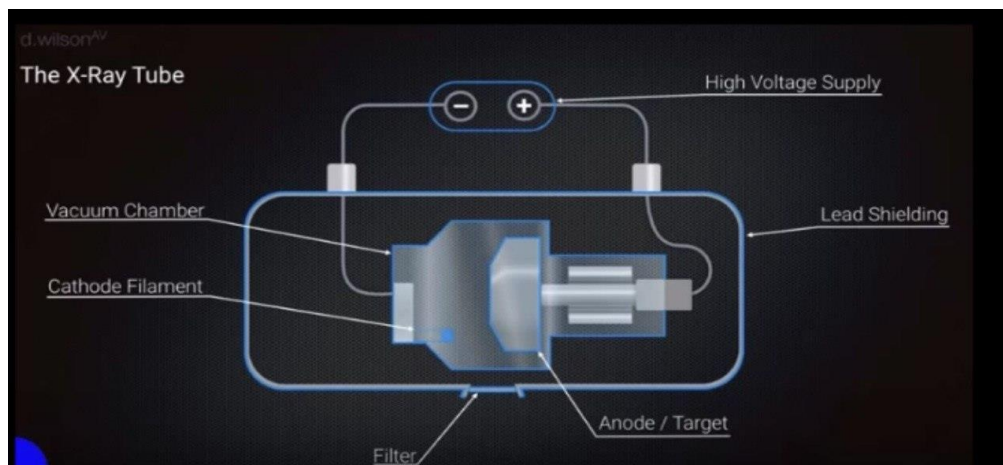
6.3. X-ray Tube

X-ray has three main components:

1. Cathode structure.
2. Anode structure.
3. Glass envelope.

Functions of x-ray tube:

- An x-ray tube converts its input of electrical energy into an output of x-ray energy.
- In the case of low power equipment, an xray tube also acts as a rectifier.





6.3.1. Cathode:

Cathode consists of the following components:

1. Filament.
2. Focusing cup.
3. Supporting wires.
4. Cathode support.

Filament:

- The source of electron is a filament, heated by an electric current. The current increases the vibration of atoms within the filament so much that it emits heat and light.
- So much heat energy is acquired by the atoms that some of their electrons (outer) can break free and temporarily leave the filament's surface. This phenomenon is known as thermionic emission.
- The filament is made of thin coiled tungsten wire for the following reasons:
 1. Tungsten is a good thermionic emitter.
 2. Tungsten has a low vapour pressure, i.e. it does not vaporise easily. It therefore lasts a long time.
 3. Tungsten is rugged and able to be drawn into the thin wire required.
 4. Easy to be shaped.

6.3.2. Anode



Anode is constructed of the two materials copper and tungsten, known as a compound anode. Anode consists of:

1. The block and stem is made of copper.
2. The target or an inset of a thin (~ 2-3 mm) tungsten plate on the inclined face of the copper block. Electrons from the filament are focused on the target.
 - 1% of energy is converted to x-rays, plus heat.
 - The anode rotates to increase heat load capacity.
 - Electrons accelerated to positively charged anode.
 - Requires high potential difference to produce x-rays.
 - Diagnostic energy range usually 30 kV – 150 kV.
 - Types of Anode X-ray tube

1. Stationary anode x-ray tube

- Low electric power.
- Relative simplicity of design and construction and therefore low cost.
- Suitable for the production of X-rays at low or medium intensities.
- Used for applications such as dental radiography and mobile work where no sophisticated procedures such as rapid sequential imaging are required.

2. Rotating anode x-ray tube

- Higher X-ray intensities and electrical power are providing by the anode tube since it has more efficient anode cooling.



6.4. Collimator and Grid

- Collimator is a device used to minimize the field of view , avoid unnecessary exposure using lead plates. Lead shutter are used to restrict the beam. The collimator is attached to the X-ray below the glass window where the useful beams is emitted.
- Grid is similar to a collimator except they have different positions. Grid is placed right after the patient. It is made up of lead strips, which is used to eliminat light. These strips only allow rays at 90°.

6.5. X-ray Film

- X-ray film displays the radiographic image and consists of emulsion (single or double) of silver halide (silver bromide (AgBr) is most common) which when exposed to light, produces a silver ion (Ag⁺) and an electron. The electrons get attached to the sensitivity specks and attract the silver ion. Subsequently, the silver ions attach and clumps of metallic silver (black) are formed .
- The silver can be reclaimed from old x-ray film, in a process known as silver recovery.

7. Malfunctions and problem

1. No Exposure

Check the mAs and kVp settings to ensure that they are not set too high. Some exposures place an unacceptable heat load on the x-ray tube. Most machines have



been programmed to recognize these extreme settings and shut the exposure off before the machine is damaged. Usually a red light will appear on the console, indicating that there is a problem with the technique selected.

2. Filament breaks

Fault Phenomenon:

The filament does not light after electric is connected.

Reason:

Severe vibration to the x ray tube makes the break of filament.

3. Anode focal target surface is damaged

Fault Phenomenon:

The image clarity is reduced due to the absorb of x ray beam and x ray astray causing by the unevenness of the focal plane or metal powder splashed. At this time, when the filament is heated, the brightness of the filament is darker than usual.

Causes:

Mainly due to the excessive use and inadequate time interval of the cooling time of x ray tube, so the heat of the focal surface gradually accumulates and exceeds the maximum limit, which consequently leads the focal plane melt or partially evaporate.



5. Rotating anode does not rotate

Fault Phenomenon:

There are two cases: one is that there is no reaction when starting the rotating anode; the other is that there is an abnormal sound when starting the rotating anode.

Causes:

Besides the failure of the rotating anode starting circuit, this phenomenon can be also caused by the axial deformation of the anode rotor in the tube, or friction increase of the rotor, or the excessive use of the rotor, or the anode bearing's severe wear.