The X-Ray Production

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X-Rays are produced by converting electrical energy into an electromagnetic wave. This is done by accelerating electrons from an electrically negative cathode towards a positive 'target' anode. When the electrons hit the target they decelerate rapidly, causing them to lose energy which is converted into heat energy and X-Rays. The anode and cathode effectively form a circuit which is completed by the flow of electrons through the vacuum of the tube.

The basic layout of an X-Ray tube therefore contains the following objects:

Glass Casing
If electrons are fired through a space containing any air or gas, the electrons will interact with the molecules of the gas, colliding with them and producing lower energy secondary electrons. This is not desirable in an X-Ray tube as it would make the quantity and quality of X-Rays produced very difficult to control. For this reason, the anode and cathode are surrounded by an airtight glass enclosure, thus allowing a vacuum to be created inside the tube. Glass expands less when heated than most metals, and so special alloys which expand roughly the same amount as glass when heated are used to seal the gaps between metal and glass components. Meanwhile, the tube is shaped so that the anode and cathode are far enough apart to avoid electrical discharge between the two.

Tube Housing
During operation both the glass and metal parts of the tube become very hot, so the glass casing is usually surrounded by oil which acts as a coolant and heat distributor. The part containing the oil, tube and electrical connections is known as the tube housing, and has a small window at the bottom to allow the X-Rays to leave. The rest of the tube housing is lined with lead to prevent stray X-Rays from escaping, and the housing also functions to protect those present from electrocution by the tube's electrical circuits.

Cathode
The negative cathode consists of a thin filament, usually made of tungsten, which is connected to two separate circuits. The first of these usually runs at about 10V and 5A and heats the filament ready for use, while the second provides the precise high voltage and low current which produces the stream of electrons which are accelerated towards the anode. The cathode may also be surrounded by a negatively charged focusing cup, which acts to focus the beam of electrons towards the anode. The process through which electrons escape the cathode will be discussed later.

Anode
The anode consists of a small piece of tungsten embedded in a large lump of copper, with the former being bombarded by electrons while the latter acts as a heat sink to prevent the tungsten from becoming damaged. While tungsten has a high atomic number, which makes it good for X-Ray production, and a high melting point (3,370°C), it has been found that an alloy of 90% tungsten and 10% rhenium is more resistant to damage from overheating and continuous electron bombardment. However, the copper heat sink has a lower melting point (1,070°C) than tungsten, and so the tungsten target must be a little bigger than necessary so that it loses some of the heat before passing the rest on to the copper. The tungsten face may be grooved in places to allow easier expansion upon heating, and the back of the anode can be coated with carbon or a similar black compound to help aid dissipation of heat.
The tungsten edge of the anode is angled slightly so as to direct X-Rays down towards an exit window in the tube housing. Due to the high level of heat produced while in use, most modern anodes now consist of a large copper wheel with a continuous tungsten target forming the outermost section, with the anode being rotated rapidly during exposure so as to spread the heat produced across a large surface area.

Thermionic Emission
Thermionic emission is the name given to the process through which the electrons escape the negative cathode on their way towards the anode. When the heating circuit is activated, the current flowing through the tungsten filament heats the wire to about 2,200°C, giving some of the electrons in the metal enough energy to move a little way from the surface of the metal. This leads to a cloud of electrons hovering around the filament - this is known as the Edison effect, and leads to a negative 'space charge' existing around the filament.

http://health.howstuffworks.com/x-ray2.htm
http://www.bbc.co.uk/dna/h2g2/A14017943
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