PRODUCTION OF DENTAL X-RAYS

Now that the component pans of the x-ray machine, the x-ray tube, and the x-ray generating apparatus have been renewed, a discussion of the production of dental x-rays is possible. A step-by-step explanation of x-ray production follows:

1.Electricity from the wall outlet supplies the power .to generate x-rays. When the x-ray machine is fumed on, the electric current enters the control panel via the cord plugged into the wall outlet. The current travels from the control panel to the tubehead via the electrical wires in the extension arm.

2.The current is directed to the filament circuit and step-down transformer in the tubehead. The transformer reduces the 110 or 220 entering line voltage to 3 to 5 volts.

3. The filament circuit uses the 3 to 5 volts to heat the tungsten filament in the cathode portion of the x-ray tube. Thermionic emission occurs; thermionic emission is the release of electrons from the tungsten filament when the electric current passes .through it and heats it up. The outer shell electrons of the tungsten atom acquire enough energy to move away from the filament surface, and an electron cloud forms around the filament. The electrons stay in an electron cloud until the high-voltage circuit is activated.

4. When the exposure button is pushed, the high voltage circuit is activated. The electrons produced at the cathode are accelerated across the x-ray tube to the anode. The molybdenum cup in the cathode directs the electrons to the tungsten target in the anode.

5. The electrons travel from the cathode to the anode. When the electrons strike the tungsten target, their energy of motion **(kinetic energy)** is converted to x-ray energy and heat. Less than 1% of the energy is converted to x-rays: the remaining 99% is lost as heat.

6. The heat produced during the production of x-rays is carried away from the copper stem and absorbed by the insulating oil in the tubehead.

The x-rays produced are emitted from the target in all directions; however, the leaded-glass housing prevents the x-rays from escaping from the x-ray tube. A small number of x-rays are able to exit from the x-ray tube via the unleaded glass window portion of the tube.

7. The x-rays travel through the unleaded glass window, the tubehead seal, and the aluminum disks. The aluminum disks remove or filter the longer wavelength x-rays from the beam.

8. Next, the size of the x-ray beam is restricted by the lead collimator. The x-ray beam then travels

down the lead-lined PID and exits the tubehead at the opening of the PID.

TYPES OF X-RAYS PRODUCED

N01 all x-rays produced in the x-ray tube are the same; x-rays differ in energy and wavelength. The energy and wavelength of x-rays varies based on how the electrons interact with the tungsten atoms in the anode. The kinetic energy of the electrons is converted to x-ray photons via one of two mechanisms: **general (Bremsstrahlung) radiation** or **characteristic radiation.**

GENERAL RADIATION

Speeding electrons slow down because of their interactions with the tungsten target in the anode. Many electrons that interact with the tungsten atoms undergo not one but many interactions within the target. The radiation produced in this manner is known as general (Bremssirahlung), or **braking radiation.** The term braJdng refers to the sudden stopping, or "braking," of high-speed electrons when they hit the tungsten target in the anode. Most x-rays are produced in this manner; approximately 70% of the x-ray energy produced at the anode can be classified as general radiation.

General radiation is produced when an electron hits the nucleus of a tungsten atom or when an electron passes very close to the nucleus of a tungsten atom. An electron rarely hits the nucleus of the tungsten atom. However, when it does, all of its kinetic energy is convened into a high-energy x-ray photon. Instead of hitting the nucleus, most electrons nearly miss the nucleus of the tungsten atom. When the electron comes close to the nucleus, it is attracted to the nucleus and slows down. Consequently, an x-ray photon of lower energy results. The electron that misses the nucleus continues to penetrate many atoms, producing lower-energy x-rays before it imparts all of its kinetic energy. As a result, general radiation consists of x-rays of many different: energies and wavelengths.

CHARACTERISTIC RAC-TION

Characteristic radiation is produced when a high speed electron dislodges the inner shell electron from the tungsten atom and causes ionization of that atom. Once the electron is dislodged, the remaining orbiting electrons are rearranged to fill the vacancy. This rearrangement produces a loss of energy that results in the producrion of an x-ray photon. The x-rays produced by this interaction are known as characteristic x-rays.

Characteristic radiation accounts for a very small part of x-rays produced In the denial x-ray machine and occurs only at 70 kVp and above because the binding energy of the K shell electron is approximately 70 keV.

X-RADIATION DEFINITIONS

Terms such as primary, secondary, and scatter are often used to describe x-radiation. A knowledge of these terms is required before **L--e** interactions of x-radiation with matter can be discussed.

PRIMARY RADIATION

Primary radiation refers to the penetrating x-ray beam that is produced at the target of the anode and exits the tubehead. This x-ray beam is often referred to as the **primary beam** or **useful beam.**

SECONDARY RADIATION

Secondary **radiation** refers to x-radiation that is created when the primary beam interacts with matter. (In dental radiography, matter includes the soft tissues of the head, the bones of the skull, and the teeth.) Secondary radiation is less penetrating than primary radiation.

SCATTER RADIATION

Scatter **radiation** is a form of secondary radiation and is the result of an x-ray that has been deflected from its path by the interaction with matter. Scatter radiation is deflected in all directions by patient tissues and travels to all pans of the patient's body and to all areas of the dental operatory. Scatter radiation is detrimental to both the patient and the radiographer.