

Medical Solutions

For the daily and trade press

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Background information: X-ray technology

In 1895, Wilhelm Conrad Röntgen invented the X-ray tube, an invention that allowed us for the first time to obtain images inside the human body without surgery. X-ray tubes are the tool for diagnostic imaging. Today, they are not only used for classic X-ray systems, but also for computed tomography and angiography systems. Next to the detector that "reads" out radiation, the X-ray tube is the most important component. Classic X-ray systems may still use X-ray film in place of modern detectors.

Configuration and Functions

In its most simple form, an X-ray system consists of an X-ray tube and the detector. The patient is located between these two components. A special generator provides the voltages necessary for generating X-rays. The detector is an image receptor that converts X-rays into an image after they penetrated the patient.

With classic X-ray systems, the rays are attenuated differently by bones and organs when passing through the body. Bones are much less radiolucent than, for example, organs such as the lungs or muscles. These differences are projected onto film or a high-resolution electronic detector (flat detector or X-ray image intensifier). The results are shown as an X-ray pattern.

In X-ray terminology, we differentiate between radiographic exposures and fluoroscopic exposures. A radiographic exposure is a latent projection that shows the superimposed bones and organs. This type of exposure is used for bone fractures, outpatient examinations, as well as trauma victims and lung exposures.

With fluoro exposures, the X-ray tube does not just light up briefly (in the millisecond range), instead it lights up continuously. In addition to static images, it is also possible to show moving organs or blood flow using contrast agent.

History

The first industrial X-ray tube was produced in 1896 at the Reiniger-Gebbert-Schall factories. At first glance, the tube, known as an RGS tube, looked very simple as compared to a modern tube: It consisted of a glass envelope that contained a cathode without the anode of today's tubes. The cathode generated electrons that, due to the missing anode, impinged in all directions on the walls of the glass envelope. This led to a high amount of scatter radiation. The resulting images were quite blurred. Despite exposure times of several minutes, the quality achieved remained poor. When compared to today's standards, the quality of tubes has increased hundredfold: a modern X-ray tube has an exposure time of several milliseconds resulting in images with a resolution of approximately one tenth of a millimeter.

Other developments followed, providing X-ray tubes first with stationary and later on with rotating metallic anodes that could handle much larger loads. These are offered today in three different configurations: stationary anode X-ray tubes, rotating anode X-ray tubes, and the rotating envelope X-ray tubes.

The "Dura Akron Q" is a modern rotating anode tube which means that the tube has a rotating anode disk. The rotation of the anode ensures that the X-ray beam does not appear as focal spot as it does with the first X-ray tubes (stationary tube) but rather as a focal path. As a result, rotating anodes can withstand higher thermal loads than stationary

tubes. In addition, the traditional glass envelope of the first X-ray tubes has been replaced by a metal-ceramic housing which allows for an even higher load.

Ready for even higher loads than the rotating anode tubes are the rotating envelope tubes, such as the “Straton” tube. It represents the world’s first rotating envelope tube which was developed by Siemens Medical Solutions. Since it successfully meets today's extreme demands of imaging methods, it is used in computed tomography, an imaging modality that calls for highest tube performance levels. The anode disk of the Straton tube is rigidly connected to the tube envelope which in turn is completely submerged in the cooling oil bath. The difference with respect to conventional X-ray tubes is that the Straton tube does not have an anode rotating inside the vacuum tube. Instead it is the tube itself that is turning. Direct contact with the cooling oil means that the heat dissipation generated is discharged approximately one hundred times faster than with conventional tubes. This means that the X-ray tube can handle much larger loads without negative effects.

The Straton tube represents an enormous advance in comparison to conventional X-ray tube technology with rotating anode disk. The core element is the so-called z-Sharp technology enabling the X-ray tube to generate two alternating and overlapping X-ray projections that double the image information. This allows for improved image resolution: the dual X-ray beam turns a 32 detector line into a 64 slice CT. Somatom Sensation 64 from Siemens is the first computed tomograph world-wide that is based on this technology.

Future

A large part of X-ray images is still created via film exposure although the future belongs to digital radiography. The radiation passing through the body is measured with an electronic sensor or imaging plate, subsequently converted into digital signals, and then processed by a computer. The advantages are that it is no longer necessary to load, transport and develop film cassettes. Instead the images are immediately available in digital format and their excellent quality ensures safer diagnosis and therapy. Repeat exposures are a thing of the past and image corrections may require nothing more than a mouse click.

In addition the radiation dose of modern tubes and technologies is reduced by 95 percent as compared to conventional methods. This means that radiation exposure for the patient is greatly reduced as well.

The background information is supplemented by a number of images located in the Internet under: <http://www.siemens.com/med-pictures/x-ray>

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