Radiological Equipment Techniques (Lec 3)

The Operating Console

1 - introduction

The operating console allows radiologic technologists to control the x-ray tube current and voltage so that the useful x-ray beam is of proper quantity and quality.

The operating console usually provides for control of line compensation, kVp, mA, and exposure time. Some consoles also provide a meter for mAs.

Figure 1: operating console

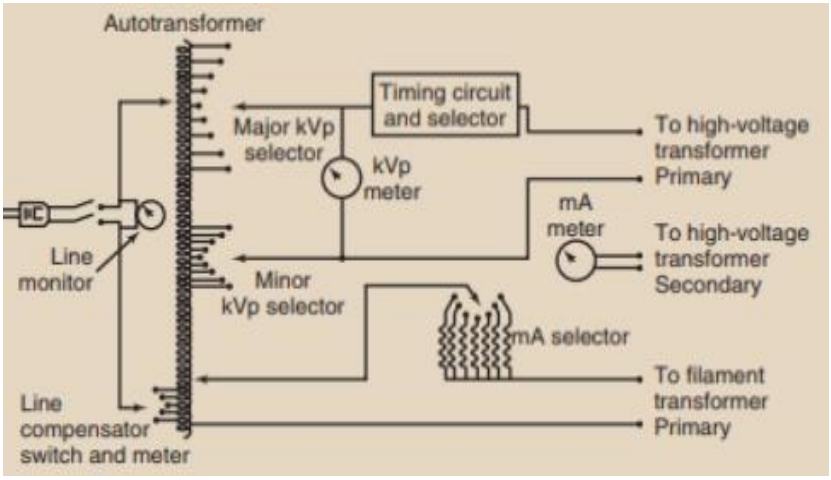

Figure 2: Circuit diagram of the operating console, with controls and meters identified.

All of the electric circuits that connect the meters and controls on the operating console are at low voltage to minimize the possibility of hazardous shock.

2 - Voltage Compensator Control (Line Compensation)

The line compensator measures the voltage provided to the x-ray imaging system and adjusts that voltage to precisely 220 V. so that a constant voltage may be used during exposure and not a varying voltage. Today's x-ray imaging systems have automatic line compensation and hence have no meter.

Most x-ray imaging systems are designed to operate on 220 V power, although some can operate on 110 V or 440 V. Unfortunately, electric power companies are not capable of providing 220 V accurately and continuously.

3 - Control of Milliamperage (mA)

X-ray tube current is controlled through a separate circuit called the filament circuit. Connections on the autotransformer provide voltage for the filament circuit.

The filament transformer is a step-down transformer; therefore, the voltage supplied to the filament is lower.

4 - The effect of Milliamperage

The x-ray tube current, crossing from cathode to anode, is measured in milliamperes (mA). The number of electrons emitted by the filament is determined by the temperature of the filament. The filament temperature is in turn controlled by the filament current, which is measured in amperes (A).

As filament current increases, the filament becomes hotter, and more electrons are released by thermionic emission. Filaments normally operate at currents of 3 to 6 A.

5 - Adjustment of Kilovolt Peak (kVp)

It allows precise selection of desired kV. In some machines, this control is automatically linked to a certain milliamperage (mA) value. In such a case, a high kVp is available at a relatively low mA and vice versa.

6 - The effect of kilovoltage

As already stated, it is the passage of a high voltage current across an x-ray tube which results in a production of x-rays. The higher the kilovoltage employed for this purpose, the more rapidly the electrons travel, the greater the amount of energy released on impact and the shorter the wavelength of the x-rays produced.

The circuit has two transformers, namely, an autotransformer and a step-up transformer.

The kilovoltage applied across an X-ray tube determines maximum energy and hence, the penetrating power of the X-rays. To have a wide range of penetrating power of X-rays.

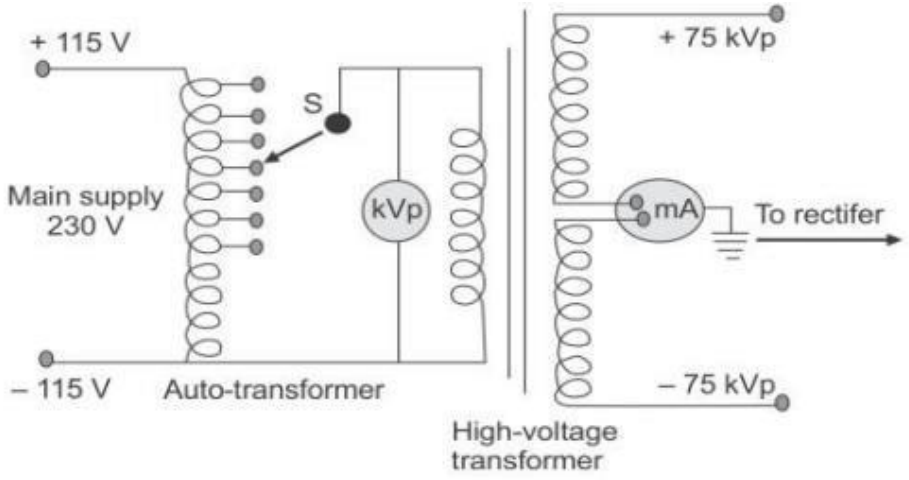

Figure 3: Kilovoltage control circuit

7 - Exposure Time

For any given radiographic examination, the number of x-rays that reach the image receptor is directly related to both the x-ray tube current and the time that the x-ray tube is energized.

For radiography, exposure durations are extremely short, typically 100 ms, combined with large tube current (200 –1,000 mA) to achieve high photon fluence.

For fluoroscopy, the exposure duration is continuous and is usually initiated and terminated by foot pedals that signal mechanical contactor switches in the low voltage section of the x-ray generator.

Timer accuracy is somewhat poor (no greater than about 8 ms or 1/120 s), but for fluoroscopy applications (1 to 5 mA tube current) this is more than acceptable.

For CT operation, exposure durations of 0.4 to tens of seconds with tube currents of 50–400 mA are required for typical operation, depending on the type of examination and acquisition protocol.

8 - Types of timing circuits

There are four types of timing circuits. Three are controlled by the radiologic technologist, and one is automatic:

1. Synchronous Timers

2. Electronic Timers

3. mAs Timers

4. Automatic Exposure Control timers (AEC)

8-1 Synchronous Timers

A synchronous motor is a precision device designed to drive a shaft at precisely 60 revolutions per second (rps).

Synchronous timers cannot be used for serial exposures because they must be reset after each exposure.

8-2 Electronic Timers

Electronic timers are the most sophisticated, most complicated, and most accurate of the x-ray exposure timers. It consists of rather complex circuitry based on the time required to charge a capacitor through a variable resistance.

Allow a wide range of time intervals and they can be used for rapid serial exposures.

8-3 mAs Timers

A special kind of electronic timer, called an mAs timer, monitors the product of mA and exposure time and terminates exposure when the desired mAs value is attained.

8-4 Automatic Exposure Control (AEC)

AEC is a system used to consistently control the amount of radiation reaching the image receptor (IR) by terminating the length of exposure. It automatically terminates the exposure when the image receptor has received the required radiation intensity.

All AEC devices work by the same principle of operation: radiation is transmitted through the patient and converted into an electrical signal, terminating the exposure time.

9 - Types of AEC systems

Two types of AEC systems have been used:

1- Phototimers

Phototimers use a fluorescent (light-producing) screen and a device that converts light into electricity. Radiation interacts with these paddles, producing visible light. This light is converting into electricity. The timer is tripped.

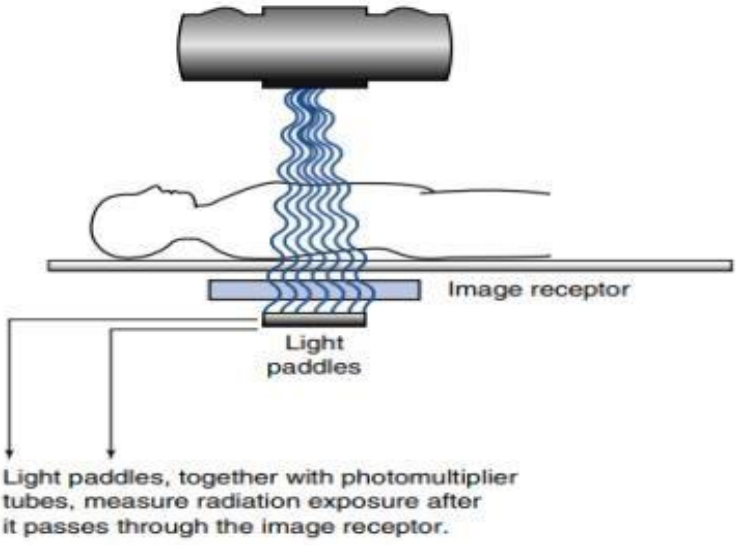

Figure 4: The phototimer AEC system

2- Ionization Chambers

An ionization chamber, or ion chamber, is a hollow cell that contains air and is connected to the timer circuit via an electrical wire. Radiation can interact with the detectors just before interacting with the IR. When the ionization, the air inside the chamber becomes ionized, creating an electrical charge. This charge travels along the wire to the timer circuit. The timer is tripped

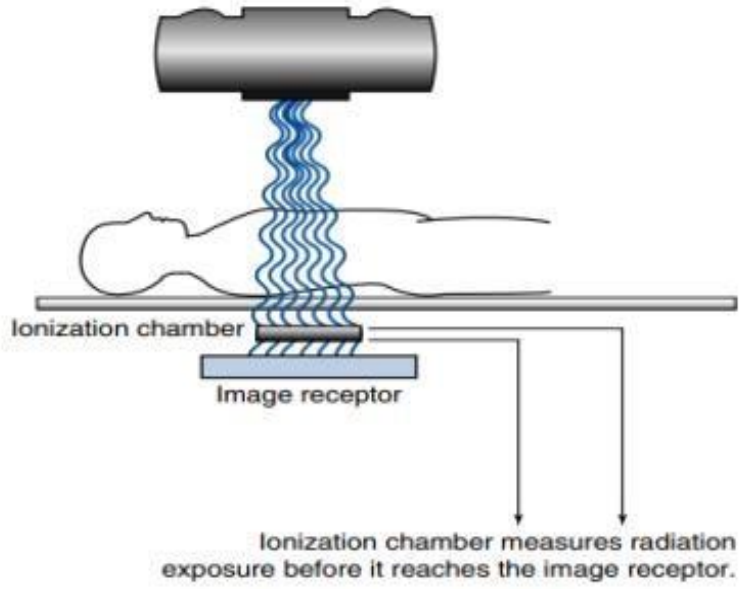

Figure 5: The ionization chamber AEC system