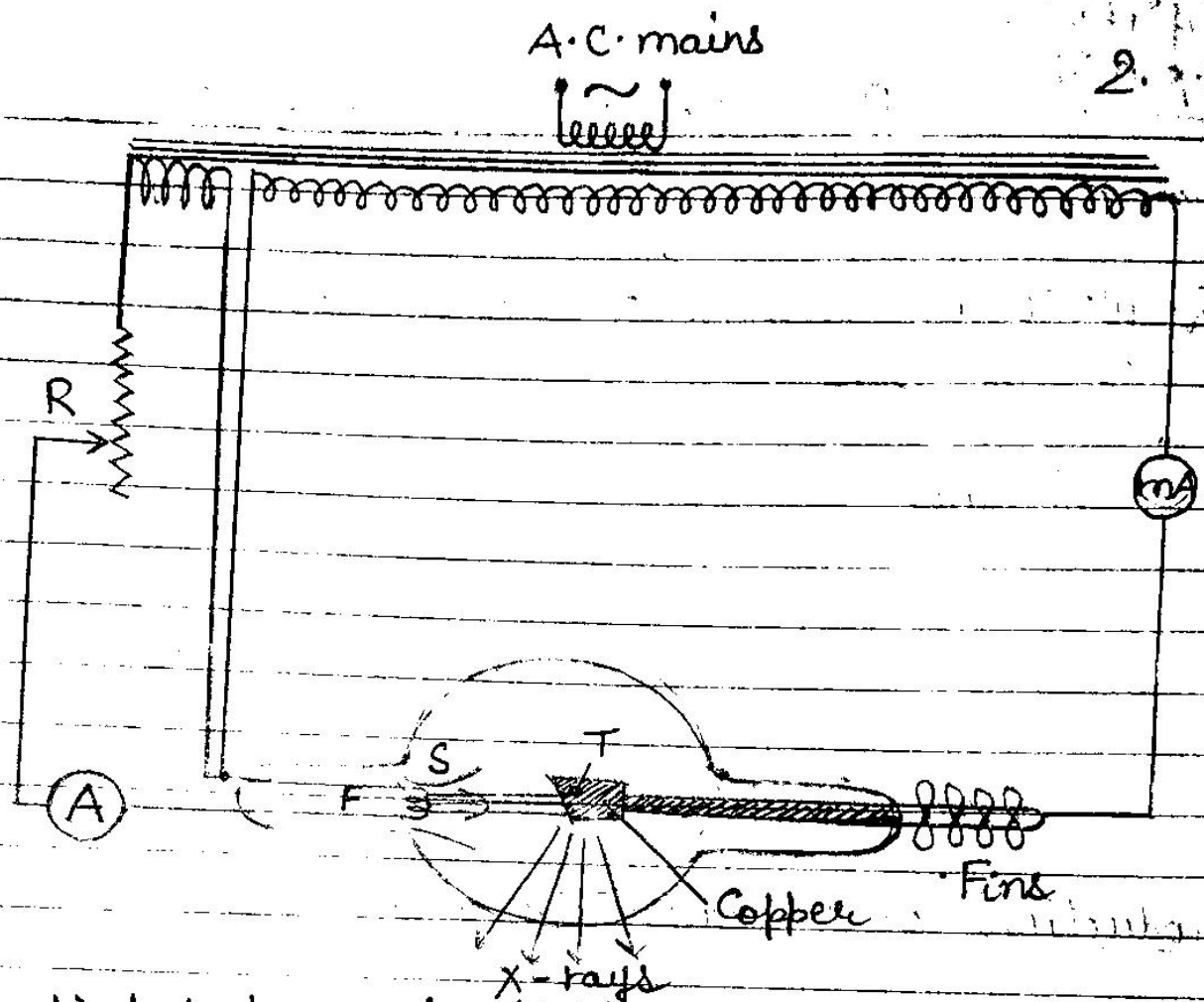


Production & Properties of X-rays
Q-2 (Sub)

Q. Write an account of the production and properties of X-rays.

Ans. - X-rays - Roentgen, in 1895, discovered that when fast-moving electrons strike a dense target, a highly-penetrating radiation is produced. He called this radiation as X-rays. Later experiments showed that X-rays are electromagnetic waves having a wavelength of the order $1\text{\AA}$.

Production of X-rays: Coolidge Tube - An X-ray tube contains a cathode which serves as the source of electrons and an anode (or target) upon which the electrons strike. A modern tube designed by Coolidge is shown in fig. It contains a glass tube evacuated to about 10^{-6} cm of Hg so that no discharge can pass in it. The cathode is a tungsten filament F heated by a low-voltage current drawn from the separate tapping of a transformer.



A cylindrical metal shield S surrounds the filament and is kept at a negative potential with respect to the filament. It focuses the electrons emitted from the filament on a tungsten target T . The target is mounted on the surface of a copper block fixed to the end of a copper rod. The rod is fitted with fins for air-cooling, or made hollow and cooled by circulating water through it.

A p.d. of about, 20,000

voltage is applied across the tube by means of a step-up transformer. The electrons emitted from the filament are accelerated and focused on the target which radiate X-rays. The intensity of X-rays depends on the rate of emission of electrons from the cathode, and can be controlled by varying the filament-current by means of a rheostat R in the filament circuit. The quality (penetrating power) of X-rays depends on the p.d. across the tube, and can be controlled independently of the intensity. The electrons emitted from the filament strikes the target only when the target is at a positive potential with respect to the filament. The tube thus acts as its own rectifier; running easily on A.C. mains.

Properties of X-rays — The X-rays show the following important properties :

- (i) X-rays travel in straight lines with the speed of light.
- (ii) They blacken a photographic plate.
- (iii) They are not deflected by either electric or magnetic fields.
- (iv) They liberate photo-electrons from

certain metals on which they fall.

(vi) They ionise the gas through which they pass.

(vi) They produce fluorescence on screens of zinc sulphide, barium platinocyanide, calcium tungstate etc.

(vii) They penetrate considerable thickness of substances which are opaque to ordinary light such as wood, paper, cardboard, thin sheets of metals, flesh etc.

(viii) They exhibit reflection, refraction, interference, diffraction and also polarisation under special circumstances.

(ix) They produce a reddening of the skin which may prove fatal.

(x) When a beam of primary X-rays falls on a plate of some chosen element, a part of the radiation goes through the plate and the rest is transformed into heat, or into some secondary radiations.

The latter consists of scattered X-rays, characteristic X-rays, scattered β -rays and characteristic β -rays.