

Catalogue Number 1706 X-ray Tube Used by Bragg

Although the Bragg Spectrometer (catalogue 1704) is rightly considered as the crucial experimental component of the work leading to the establishment of the Bragg law, $n\lambda = 2d\sin\theta$, -- and the award of the Nobel Prize in Physics -- it is often forgotten that at that time the generation of the X-rays themselves was a delicate and dangerous operation.

Partially evacuated glass tubes of similar dimensions known as *gas discharge tubes* were developed in the second half of the 19th century, and were used in studies of electrical discharges and cathode rays. More elaborate tubes with a greater number of electrodes were specially developed as sources of X-rays. An ideal pressure for the residual gas in the tube was about 0.3mmHg so that the application of a high voltage between the electrodes ionized the gas with positive ions migrating towards the cathode. This caused the emission of electrons or *cathode rays* which were accelerated towards the positive anode resulting in the emission of X-rays.

For the tube illustrated here the cathode and anode are shown on the left and bottom right respectively of the thumbnail image. It was quickly found that such a simple 2-electrode design had to be refined, and in the present case we see (i) that the cathode was curved so as to focus the electrons onto (ii) a subsidiary target known as an anticathode in the centre of the tube. This was connected electrically to the anode, but curved and angled to produce a fine stream of X-rays passing through the glass container well away from the electrodes. The final component at the top of the apparatus was a small discharge tube used to release a small quantity of gas if the vacuum in the tube became too 'hard' following gas adsorption within the tube during the experiment. There is no record of the safety precautions adopted in the dangerous surrounding area although the fatalities of pioneers in the medical profession experimenting with X-rays are fully recorded.

The tube itself is hand-blown and is marked, Cuthbert Andrews, 47 Red Lion Street, High Holborn, London. On his retirement Andrews wrote, "It was in 1909 that I myself entered, with a little premeditation, into the business of X-ray tube manufacture with the result that I made X-ray tubes for almost exactly 40 years. I never knew much about them but that didn't matter at the beginning because most people knew even less."