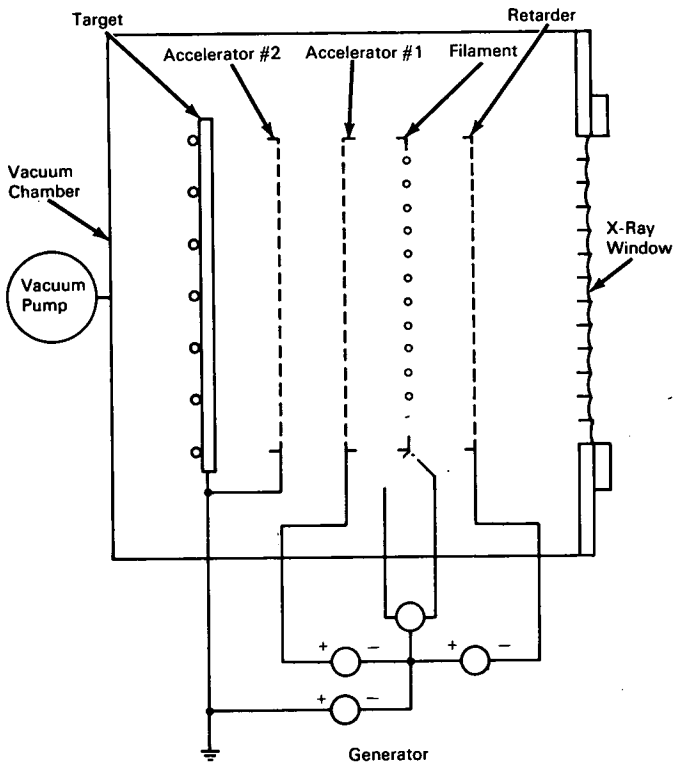
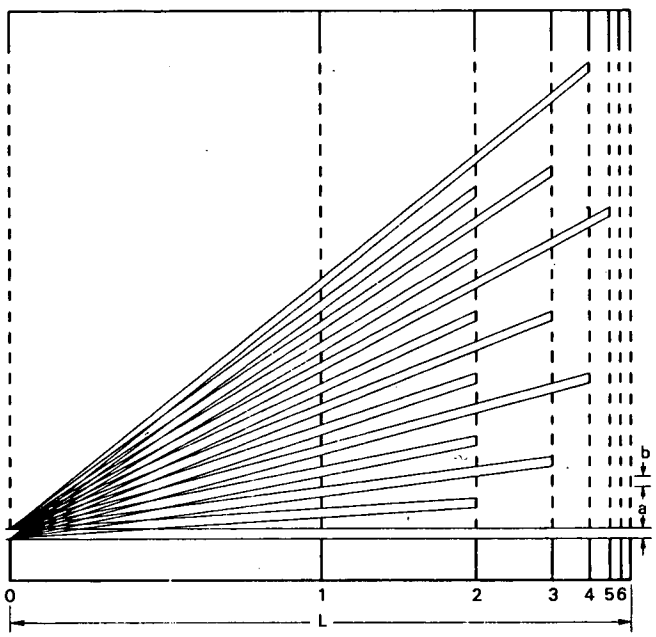
NASA TECH BRIEF

Electron Beam Parallel X-Ray Generator





A broad X-ray source has been developed which produces a highly collimated beam of low energy X-rays. The device has been used in the calibration of collimators used for X-ray astronomy in rocket and satellite instrumentation. Previously, a point source of X-rays at one end of a long vacuum tube had been necessary to produce a beam of small angular divergence. The present device produces a beam with 2 to 5 arc minutes of divergence at energies between 1 and 6 keV in less than 5 feet. Beam intensity at these values is typically greater than 500 counts/sec/cm^2 with less than a 15% variation from one region to another.

The X-ray beam is generated by electron bombardment of a target from a large area electron beam gun. Electrons emitted from a screen type filament are accelerated toward the target in a manner which irradiates the target uniformly. The X-rays produced from this bombardment radiate back through the filament and accelerating screens and pass through a thin membrane outside of the vacuum chamber. The beam is then collimated by passing through a series of precisely aligned slits which transmit only X-rays within the divergence of the collimator. The X-rays emerge from the collimator as a nearly parallel beam of high

(continued overleaf)

uniformity and intensity. A test collimator can then be mounted to a fixture and rotated through the X-ray beam. The collimator and test fixture are typically one meter in length and can be easily enclosed within an atmospheric chamber of helium for low energy work.

The filament, accelerators and retarder of the generator are parallel to the target and perpendicular to the electron and X-ray beams. The electrons are emitted from discrete wire filaments and are slowly accelerated toward the target by the accelerator and retarder. The potential of these grids with respect to the filament, the separation of filament wires, and the spacing of the grids from the filament determine the uniformity of electron bombardment.

The accelerators are fabricated of stainless steel frames and tungsten mesh. The retarder electrode is similar but uses 0.00025-inch aluminum to shield the X-ray window from thermal radiation from the filament. The filament consists of a series of tungsten wires held in tension by tungsten springs.

The X-ray beam emerges from the vacuum chamber through the X-ray window and enters the collimator which transmits only those X-rays having an angular divergence of less then 5 arc minutes. The collimator consists of a series of thin sheets containing accurately aligned slits. The sheets are precisely located along the X-ray axis to effectively block all divergent X-rays. The spacing of each sheet L_n and the separation of each slit a and b are related to the angle of divergence θ.

The slit width a, the separation of each slit b, the overall length L_o, and the spacing of each sheet L_n are functions of the angle of divergence θ and maximum collimation angle θ_n.

The sheets for the collimator are of beryllium–copper and are held in accurate registry by a series of aluminum frames. Lack of registration will cause a decrease in transmission only and not in collimation angle. The collimator is mounted on an optical bench between the X-ray generator and test fixture. Collimators may be easily tested by placing them on a rotary table and measuring their angular response with an X-ray detector.

Notes:

1. Thermal protection provided by the retarder permits use of an inexpensive thin plastic window in place of the conventional and expensive beryllium window.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Reference: B67-10372

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Paul Payne
of American Science and Engineering, Inc.
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