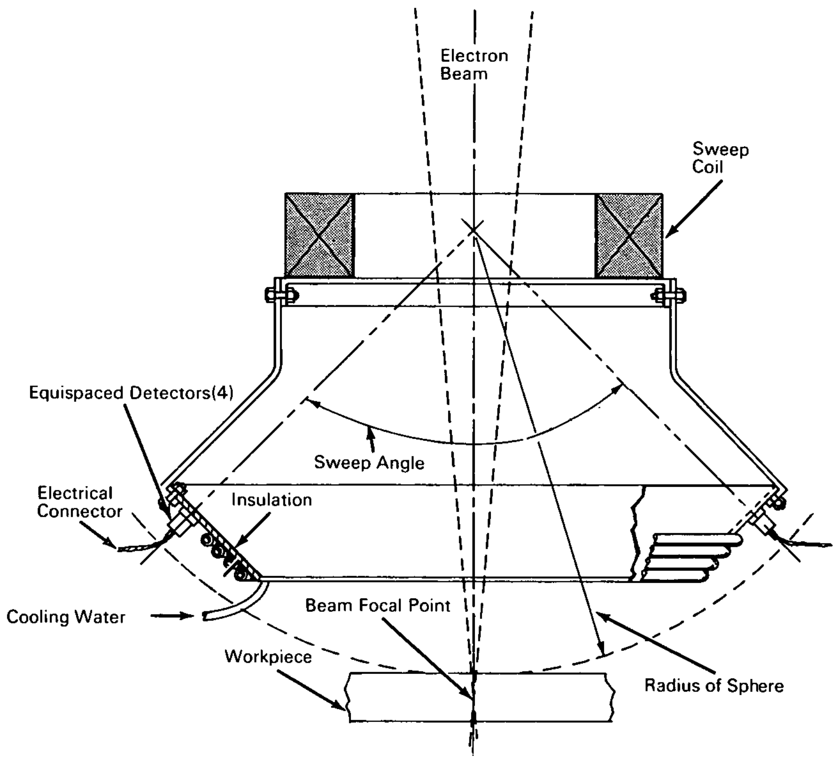
NASA TECH BRIEF

Electron Beam Deflected to Determine Focal Point Location



The problem:

To design a system that locates the focal point of an extremely high intensity electron beam. This focal point must be positioned precisely with respect to a workpiece, such as for welding, which is to be subjected to the beam power. It is necessary that the relative position be determined prior to bringing the full intensity of the beam to bear so as to properly weld and prevent damage to the workpiece. During these determinations, power input to the workpiece must be reduced to a safe level.

The solution:

The electron beam is swept and scanned cyclically with deflection coils located beneath a focusing lens. This causes the beam focal point to move in such a way that the locus of its positions will be a spherical surface symmetrical with respect to the beam axis.

Faraday cages or other suitable detectors are symmetrically spaced on a plane normal to the at-rest axis of the electron beam. If the beam raster is symmetrical with respect to the detectors, each detector will collect charge at an equal rate (equal current) when the axis of symmetry of the detectors coincides with the at-rest

(continued overleaf)

axis of the beam. Suitable circuitry is employed to time average the charge collected by each detector. Adjustment of the beam position is made (by steering yokes or other means) until these currents are equal. The unswept focal point will then lie along the axis of symmetry of the detectors. The position of the focal point along this line is set by adjusting the focal point (using the lens or mechanical position) so that the integrated charge reading to the detectors is a maximum.

How it's done:

This locator system causes the focused beam to sweep cyclically in such a fashion as to periodically enter two or more small Faraday cages whose location with respect to a desired point in space is known precisely. The pulsed charges received by the Faraday cages are then integrated, by a suitable circuit, and the beam location is deduced from the relative signals indicated by such detectors. Suitable adjustment is made to equalize these signals by steering the beam with electrostatic, electromagnetic, or mechanical means. When the deflection circuits are then interrupted, the beam axis will be located midway between the detectors.

In a like manner, one can with another sweep direction deduce the unswept beam axis location with respect to another axis in the plane of the detectors. The intersection of these two sweep-direction axes is a point through which the unswept beam axis will fall.

The X–Y position of the beam can thereby be determined if these detectors are located precisely with respect to each other on the corners of a square and the swept beam is steered or directed so that the charges collected by the detectors are equal. The unswept beam axis will then pass perpendicularly through the center of the square. This system uses detectors located at the same spherical surface that the focused beam generates to deduce the location of the focal point along the center axis. The maximum charge flow occurs when the beam is focused on detectors which have small acceptance areas.

Notes:

1. A refinement of this system is to utilize the detectors in an automatic positioning system to control the location of a beam to a specific place. Unbalance signals derived from X, Y, and Z sensors may be utilized to automatically steer the beam focal point to a predetermined position.
2. A related system is described in NASA Tech Brief 67-10650. Inquiries may also be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10649

Patent status:

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

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