To be presented at the Thermionic Converter Specialist Conference in Gatlinburg, Tennessee, October 7-9, 1963.

VOLUME IONIZATION PROCESSES IN CESIUM CONVERTERS*

by

Harald L. Witting and Elias P. Gyftopoulos
Department of Nuclear Engineering and
Research Laboratory of Electronics
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

*This work was supported in part by the U.S. Army Signal Corps, the Air Force Office of Scientific Research, and the Office of Naval Research; and in part by the National Science Foundation (Grant G-24073).

VOLUME IONIZATION PROCESSES IN CESIUM CONVERTERS

Harald L. Witting and Elias P. Gyftopoulos

Department of Nuclear Engineering and
Research Laboratory of Electronics
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ABSTRACT

The mechanisms leading to ion formation in the plasma of a low emitter temperature cesium converter, operating in the ignited mode, are investigated.

It is found that most of the ions are molecular and that they are formed by collisions between excited atoms (1). Excited atoms are produced by inelastic electron collisions.

The concentration of excited atoms (6p) is found from a rate balance. Excitation and de-excitation cross sections are calculated by means of the compact parameter method (2) and the principle of detailed balance (3), respectively. The effect of resonance radiation trapping is treated in detail by computing the photon escape probability as a function of frequency and integrating over the emitted line shape. Radiation and diffusion losses are found to be small except close to the boundaries.

The concentration of molecular ions (and electrons) is also derived from a rate balance. The ionization rate is determined from the measured recombination rate for molecular ions (4) by means of the principle of detailed balance and statistical thermodynamics. The plasma concentration is determined as a function of the electron temperature.

On the basis of the preceding results, performance characteristics of converters operating in the ignited mode are derived, without adjustable constants. Good agreement between theory and available experimental results is established.

References

1. Freudenberg, K., Z. Phys. 67, 417, 1931.
2. Seaton, M.J., Proc. Phys. Soc., London, 78, 1105, 1962.
3. Mitchell, A.C.G., and M.W. Zemansky, Resonance Radiation and Excited Atoms, Cambridge University Press, p. 56, 1961.
4. Dandurand, P.M. and R.B. Holt, Phys. Rev. 82, 278, 1951.