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**XI. Cathode Rays.** By J. J. THOMSON, M.A., F.R.S.,  
*Cavendish Professor of Experimental Physics, Cambridge\*.*

THE experiments† discussed in this paper were undertaken in the hope of gaining some information as to the nature of the Cathode Rays. The most diverse opinions are held as to these rays according to the almost unanimous opinion of German physicists they are due to some process in the surface to which—namely—as in a uniform medium

New England States. If all the water power of the United States were to be similarly developed, it would probably be necessary to install plants having less or four times the capacity of the estimated maximum power of water power as given in the table. This condition should be fully considered in estimating the amount of potential water power that may still be available in any State at the present time.

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SPECIAL ARTICLES

THEOREMATIC EFFECTS CAUSED BY ALKALI VAPORS IN VACUUM TUBES

A transparent filament was mounted in a vacuum tube in the axis of a cylindrical anode consisting of three parts insulated from one another. In this way on the ground ring principle, the electron emission from the central portion of the filament could be measured, as well as that due to the cooling by the leads were connected. With metallic anodes it was found that at 55° C. the cathode vapor forms an adsorbed coating of a single layer of atoms completely covering the filament and that the temperature of 600° K. was the stability temperature of 100° K. or more. The atomic

of some of the metal. But the tendency of the metal to be held by such a surface has therefore been increased, with the result that the emission film remains on the surface at its even lower filament temperature. The filament consists of two layers, each of atomic thickness, the first being of electro-negative, the second of electro-positive atoms (ions).

In this way the emission film remains intact up to temperatures of about 900° K. and at this temperature (below a white red heat) emits saturation currents of about 0.3 amperes per square cm. of filament surface. At higher temperatures the emission film is destroyed in part and the electron emission falls rapidly. On lowering the temperature the emission film reforms and the electron emission returns to its former value. At temperatures below that at which evaporation is appreciable, the saturation current from a vacuum tube is independent of the filament work function, is independent of temperature, remains constant at

$$i = 0.0175 \sqrt{A} \text{ amp. per sq. cent.}$$

$$A = 16000 \text{ ergs.}$$

This corresponds to a value of 1.29 volt for the work function. It is of interest to note that  $\phi$ , expressed in volts, is

**THERMAL IONIZATION**

Langmuir, I.; Kingdoo, KH. (1923)

"Thermionic effects caused by alkali vapors in vacuum tubes." *Science*, 57, p58.

[illegible]

## A NEW METHOD OF POSITIVE RAY ANALYSIS.

By A. J. DEMPSEY.

THE analysis of positive rays has been the determination of the ratio of the charge to the mass of various constituents. The corresponding measurement for the negative corpuscle has however been carried to a much greater degree of accuracy by means of methods involving the magnetic deflection of the rays through large angles, and the refocusing of rays which make slightly varying angles with each other. Apart from the magnetic measurement, there is also in these methods a great resolution between slightly different speeds; thus Rutherford and Robinson<sup>1</sup> have separated distinct groups of  $\beta$  rays from RaC which differ by 2 per cent. in energy; also the photographs given by Classen<sup>2</sup> for electrons show such sharpness that if electrons had masses differing by as little as 1 in 100, the various groups would be separated. In the present method, however, as by Richardson<sup>3</sup> is suitable for weak sources and allows a fairly exact measurement of a mean molecular weight, but the curves given in the above paper show that the power of separating different elements is very small. The method used by J. J. Thomson is capable of comparatively great resolving power, elements being sharply separated which differ in molecular weight by as little as 16<sup>4</sup> but this is obtained only with a great loss in intensity. The method developed in the accompanying experiments is

A NEW METHOD OF POSITIVE RAY ANALYSIS AND ITS APPLICATION TO THE MEASUREMENT OF IONIZATION POTENTIALS IN MERCURY VAPOR

BY WALKER BLESANSKY  
PHYSICS LABORATORY, UNIVERSITY OF MINNESOTA,  
(Received June 8, 1929)

ABSTRACT

A new method of positive ray analysis is described which lends itself particularly well to the study of the nature of the ions formed by single electron impact in gases, the efficiency of their production, and the measurement of their ionization potentials. The novel feature of the method is the use of the uniform magnetic field of a large solenoid as to concentrate a beam of electrons as to provide a linear source of a large number. The ions are then pulled across the magnetic field and subjected to an  $n/m$  analysis by a specially designed analyzer.

Some preliminary results are given for mercury vapor in which the ionization potentials of  $\text{H}^{+}$ ,  $\text{H}_2^{+}$ ,  $\text{Hg}^{+}$ , and  $\text{Hg}_2^{+}$  are found to be 30, 71, and 143 volts respectively.

THE object of this paper is to describe a new method of positive ray analysis which may be quite generally applied to the study of (1) the nature of the ions formed by single electron impact in gases, (2) the efficiencies of the production of these ions, (3) the accuracy of the values of their ionization potentials. Some preliminary results are given on the values of the first, second, and third ionization potentials in mercury vapor.

1929-10-10

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**Atmospheric Pressure Ionization Mass Spectrometry: Discharge Ion Source for Use in Liquid Chromatograph Spectrometer—Computer Analytical System**

D. I. Carroll, I. Ludiñt, R. N. Stillwell, K. C. Haegele, and C. S. Horning  
Division for Life Research, Baylor College of Medicine, Houston, Texas 77030

A concise source for a liquid chromatograph-mass spectrometer-computer analytical system is described. The performance was compared with that of the "70 eV source" commonly employed at other major agencies. Both the discharge and the 70 eV source gave the same positive ion mass spectra. The discharge source had a larger variation of response with respect to retention time of several compounds than the 70 eV source. The discharge source was used with UV detection. With selective ion activation, the hydrophobicity of the compounds was determined by measuring retention. Retention time detection was used to monitor the elution of each hydrophobic compound.

The technique of atmospheric pressure ionization mass spectrometry, using a "70 eV source" for ionization, has been used for the analysis of discharges, was later employed in the analysis of discharges from a liquid chromatograph-mass spectrometer (LC-MS). The primary purpose of this note is to compare the performance of an atmospheric pressure ionization source, and to determine the relative sensitivity of detection of compounds. The discharge source ionizes compounds and, as determined by the relative intensity of ion peaks, ionizes more ions than spectra and lower ionization cross sections. This note compares the

**APCI-LCMS**

Carroll, DI; Dzidic, I; Stillwell, K; Haegele, KD; Horning, E (1975)

[illegible][illegible][illegible]

*The Netherlands;*

"A new method of positive-ray analysis  
and its application to the measurement of  
ionization potentials in mercury vapor."  
*Phys Rev*, 34, p157.

Mobley, RC; Ferguson, LD; A  
MB. (1968)  
"Molecular beams of macroions." *J C*  
*Phys*, 49(5), p2240.