SPECIAL ARTICLES

THE INITIAL ENERGY OF THERMIONIC ELECTRONS

MEASUREMENTS of the initial energy of thermionic electrons have been made by Richardson and Brown, Richardson, Schottky and Sih Ling Ting, working under Richardson.[1] With the exception of Ting's work these experiments substantially confirmed the belief that electrons are emitted from a hot body with velocity components distributed according to Maxwell's law for a gas having the temperature of the emitting surface and molecular weight equal to that of the electrons. The measurements of Ting, however, were quite at variance with the former results, and his experimental conditions were apparently better than those under which Richardson had worked.

The present investigation was undertaken with the hope of getting more reliable data than have been hitherto obtained and with the expectation of carrying out measurements upon the distribution function over a very wide energy range. The experimental method of Schottky was adopted. In order greatly to extend the range of the measurements, various experimental refinements have been found necessary, but the method is essentially that of Schottky's work.

The source of the thermionic electrons is a straight tungsten filament lying along the axis of a cylindrical electrode. The experiment consists in the determination of the fraction of the total number of electrons from this filament which possesses sufficient initial energy to move against an opposing electric field and to arrive at a small opening in the cylinder near its center. This fraction is determined as a function of the potential between filament and cylinder, emission currents being measured only during short intervals of time during which the entire surface of the filament is at the same potential.

In the former work upon this subject the fastest electrons measured have had energies corresponding to a potential difference of about 2 volts. In the present experiments the fastest electrons measured have energies corresponding to about 5.35 volts. This is at a filament temperature of 2475° K. giving a saturation emission of $.24 \times 10^{-3}$ amp. Measurements have yet to be made at considerably higher temperatures and it seems probable that the distribution function will be investigated as far as "6-volt electrons" at these higher temperatures.

If the emitted electrons leave the filament at the temperature T with velocities distributed according to Maxwell's law the fraction of the saturation current which reaches the surrounding cylinder at a potential φ negative to the filament is given by,

$$\frac{i}{i_0} = \frac{2}{\sqrt{\pi}} \left\{ \sqrt{\frac{\varphi e}{kT}}\, \varepsilon^{-\frac{\varphi e}{kT}} + \int_{\sqrt{\frac{\varphi e}{kT}}}^{\infty} \varepsilon^{-x^2}\, dx \right\} \quad (1)$$

Here e is the electronic charge and k is Boltzmann's gas constant. The derivation of this expression, which was given by Schottky, assumes the diameter of the filament small in comparison with the diameter of the cylinder and the elimination of end effects at the extremities of the latter. In the present experiments these requirements are satisfactorily met. Furthermore, this equation holds only for values of φ so large that the potential of the collecting cylinder is more negative than the potential of any region between it and the filament.

The experimental data which have been obtained are in excellent agreement with this theoretical equation. Data have been obtained connecting i/i_0 and φ at eight different temperatures ranging from 1440° K. to 2475° K. These temperatures are determined with fair accuracy. At the lower temperatures the data are given throughout by the above equation within the limits of error of the measurements. At the higher temperatures the data deviate from the theoretical relation only for values of φ near zero, and in the direction to be anticipated from the mutual repulsion of the elec-

[1] Richardson and Brown—Phil. Mag. 16 p. 353 (1908).

Richardson—Phil. Mag. 16 p. 890 (1908); 18 p. 681 (1909).

Schottky—Ann. d. Phys. 44 P. 1011 (1914).

Sih Ling Ting—Roy. Soc. Proc. 98 P. 374 (1920-21).

trons in the space between the electrodes. No one of the eight sets of data is satisfactorily represented by equation (1) if the value of the temperature T is taken 10 per cent. in error.

The range of the measurements which have been made thus far is as follows:

1440° K.—1.0×10^{-11} amp. saturation current to 1.0×10^{-14} amp. at 1.02 volts.

2475° K.—$.24 \times 10^{-3}$ amp. saturation current to 2.0×10^{-14} amp. at 5.35 volts.

Data are still to be taken at temperatures below 1440° K. and above 2475° K., and at all temperatures the range of the measurements may be somewhat extended by further refinements to eliminate some of the disturbing factors which are still present.

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RESEARCH LABORATORIES OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY, INC. AND THE WESTERN ELECTRIC COMPANY, INC.
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THE AMERICAN PHYSIOLOGICAL SOCIETY

THE thirty-fifth annual session of the American Physiological Society met at the University of Toronto, Toronto, Canada, December 27, 28 and 29, 1922. The scientific meetings were held in the physiological lecture room of the University of Toronto. There were six scientific sessions lasting through three days with over seventy-five titles. Two of these sessions were combined programs in which the physiologists joined with the biochemists, pharmacologists and pathologists of the Federation of American Societies for Experimental Biology. Of the sessions the combined program of the last afternoon discussing various aspects of the internal secretion of the pancreas and its physiological rôle in the body aroused the greatest enthusiasm and the largest general attendance. The individual programs as a whole were of high quality and of the usual variety, covering all fields of physiological endeavor. The American physiologists are justly proud of the high standard of the research contributions.

The most important business transacted at the annual session was the following:

Dr. William T. Porter, of Harvard University, continued his research fellowship grant of $1,200. The council announced the appointment to this fellowship for the year 1922-23 of Miss Florence B. Seibert. The occupant of the fellowship under the terms of the grant is privileged to choose any research laboratory in which to carry forward the researches. Miss Seibert elected to work under the guidance of Professor L. B. Mendel, of Yale University.

It was announced by the council that Dr. William T. Porter had donated to the society all the remaining volumes and plates of the *American Journal of Physiology* issued under his editorship. This generous grant puts the society in possession of all the reserve sets of the *American Journal of Physiology.*

The council reported before the society that the *American Journal of Physiology,* now in its sixty-fourth volume, and *Physiological Reviews,* now in its third volume, were both at the present time self-supporting with a sufficient credit balance to maintain publication on a very stable basis. The commendable financial condition of the journals is largely credited to the conservative and skilful financial management of the managing editor, Dr. Donald R. Hooker, of Baltimore. As an expression of appreciation by the membership of the society as a whole, Dr. Hooker was given an enthusiastic vote of thanks for his unselfish and tireless labors in maintaining not only the financial success but the high research ideals and standards of publication in the journals of the society.

Dr. Donald R. Hooker was elected managing editor of the *American Journal of Physiology* for the year 1923. The board of editors for *Physiological Reviews* designated for 1923 consists of:

William H. Howell, Johns Hopkins School of Hygiene, *chairman*; Donald R. Hooker, Baltimore; J. J. R. Macleod, University of Toronto; L. B. Mendel, Yale University; Reid Hunt, Harvard University; H. Gideon Wells, University of Chicago; Walter J. Meek, University of Wisconsin.

Professor A. J. Carlson, University of Chicago, was nominated representative of the society on the National Research Council.

The following scientists were elected to membership in the society: