doubt caused by the increase of η at the high core temperature. We can equate (3) and (4) at the arc boundary,[8] where $r=0.36$, $dv/dr=130$, and solve for η with the result that

$$\eta=0.0018 \text{ poises.}$$

By Hassé and Cook[4] the temperature of air corresponding to a viscosity of 0.0018 is 7000°K. This concept, therefore, leads to reasonable values of extrapolated viscosity in the correct range of measured arc temperatures, or, conversely, can be viewed as a direct measure of viscosity at high temperature, showing agreement with the extrapolated data of Hassé and Cook. It should be noted that both $\Delta\rho$ and η depend upon temperature. However, when T is large, the dependence of $\Delta\rho$ upon T is negligible in the present instance.

[8] The arc "boundary" as a measurable is discussed in detail in a paper now in preparation.

JANUARY 15, 1939 PHYSICAL REVIEW VOLUME 55

The Probability of Ionization of Mercury Atoms by Collision with Low Velocity Electrons[1]

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(Received September 27, 1938)

INTRODUCTION

THE study which is briefly reported here was undertaken late in 1934 and completed in May 1937, with the principal object in mind of establishing beyond any doubt the true form of the ionization probability curve of mercury vapor in the immediate neighborhood of the ionization potential. The two schools of thought are well typified by the experimental results of E. O. Lawrence[2] on the one hand, and of P. T. Smith[3] on the other. Lawrence has maintained that the ionization function rises rapidly with increasing electron energy at the ionization potential and then falls, after which an "ultra-ionization" potential is reached giving rise to another rapid increase in ionization probability followed by another decrease, and so on. The opinion typical of the opposing group is well represented by a quotation from Smith's paper which follows: "The curve indicates that the ionization does not rise sharply at the ionization potential, the rapid rise occurring almost a volt above this potential. Curves obtained with a poor velocity distribution did, however, show a more rapid rise at 10.40 volts." The results here reported are in excellent agreement with Lawrence's experimental findings, although complete agreement with his theoretical deductions is not implied. As will be illustrated below, an apparent ionization was found below the ionization potential of mercury which cast some doubt over the detailed validity of the work, since it was not certain whether this apparent ionization was caused by some impurity, the mercury molecule, or photoelectric emission from the ion collector. Since it was within the range of possibility that this unknown mechanism was also responsible for the maximum and minimum in the ionization curve, it was considered necessary to repeat the work with a more elaborate tube. This work has served as a forerunner of the much more extensive study made by W. B. Nottingham and reported in the paper following this one.

EXPERIMENTAL APPARATUS

After experimenting with a tube design very similar in principle to that used by Lawrence, except that all metal parts were made of tantalum and no wax joints were used, this was abandoned because of the small intensity of electrons

[1] A complete report of this research is on file in the library of the Massachusetts Institute of Technology.
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[2] E. O. Lawrence, Phys. Rev. **28**, 947 (1926).
[3] P. T. Smith, Phys. Rev. **37**, 808 (1931).

delivered to the ionization chamber. The final tube used evolved after considerable experimentation from a suggestion made by Dr. P. T. Smith that good resolution might be obtained by sending the electrons around an analyzer with a very low velocity after which they could be accelerated into the ion chamber. A diagram of the apparatus is shown in Fig. 1. The indirectly heated cathode of the kind used in the type '77 radio tube was supported concentric with respect to the small cylinder at *C* which was an integral part of the electron analyzer *a*. With a 1.5-volt applied potential between the cathode and the analyzer, the magnetic field was adjusted so that the maximum number of electrons were bent in a circle one centimeter in radius and emitted through the 0.4-mm exit slit. In theory it should have been possible to determine the electron energy from the magnetic field and the dimensions of the ion chamber, but this did not work out in practice probably on account of the disturbing effects of contact potentials and the magnetic field produced by the cathode heating current even though the heater was nearly "noninductive." The voltage scale was established by the retarding potential method. The effect of the magnetic field on the retarded electrons and also reflection effects were neglected. It was assumed that there was no contact difference in potential between the inside and the outside of the ion chamber.

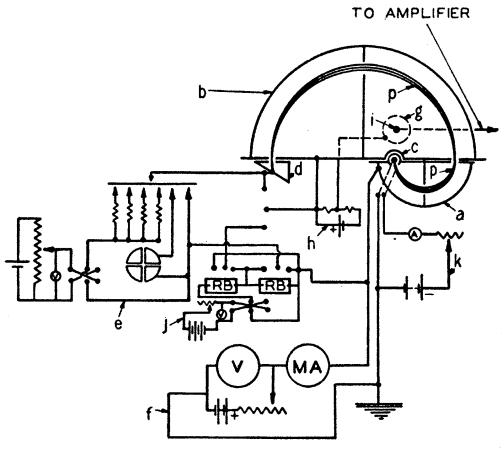

FIG. 1. Diagram of the apparatus. *a*—analyzer; *b*—ion chamber; *c*—cathode; *d*—electron collector; *e*—electron measuring system; *f*—potential source for analyzer; *g*—ion grid; *h*—bias for ion grid; *i*—ion collector; *j*—potential for ion chamber; *k*—cathode supply; *RB*—Leeds & Northrup resistance boxes; *p*—electron path.

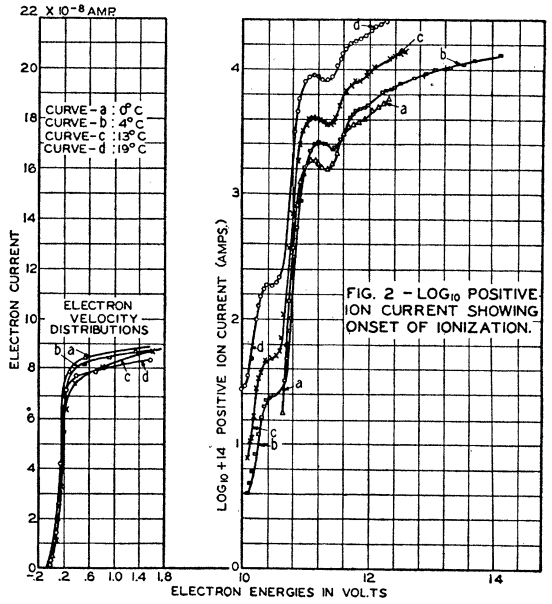

FIG. 2. Plots of the electron velocity distribution and of the positive ion current to show the onset of ionization.

SURVEY OF RESULTS

The results obtained are well illustrated by the curves of Fig. 2 which show the logarithm of the current measured at the collector *i* as a function of the electron energy as computed by the retarding potential method. These plots bring into prominence the fact that current was observed when the electron energy was less than the ionization potential of 10.38 volts. Subsequently, Nottingham's results showed clearly that this current was caused by the emission of photoelectrons from the ion collector and not caused by the ionization of the mercury molecule or the effects of some unknown impurity. These curves indicate perfectly satisfactory agreement with Lawrence's work since they show all of the essential structural details found in his curves. The chief aim of this research was thus accomplished, and although it opened up a new problem and showed more clearly that additional work should be done to establish the results in terms of the usual standard conditions, it was impossible for the author to continue the work to its logical conclusion. Since this has been done in the very extensive study made by Professor Nottingham, the present research, which was the forerunner of that work, is being reported as briefly as possible.