diameter, has been used, divided into two equal layers ¼ in. deep, by a glass disk held at half the depth of the electrolyte. The top liquid layer, in which the potential field to be explored is set up, is thus contiguous with the lower layer around the periphery and may be shown to be electrically 'matched', such that it simulates an infinite sheet of electrolyte. The measured error in potential at the extreme edge is less than ½ per cent.

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[1] Rollet, A. P., *C.R. Acad. Sci., Paris*, **185**, 457 (1927).

[2] Shipley and Goodeve, *Trans. Amer. Electro-Chem. Soc.*, **52**, 377 (1927).

Electron Emission from Oxide-coated Cathodes under Electron Bombardment

THE electron emission from thermionic cathodes of the alkaline-earth oxide-coated type when under electron bombardment has been investigated recently by Johnson[1] and by Pomerantz[2]. Johnson concluded that the secondary-electron emission produced by the bombardment changed little with the cathode temperature, that at 850° C. the maximum value, δ_m, of the secondary to primary ratio was about 5, and that the bombardment produced a temporary improvement in the thermionic activity of the cathode, which gave an 'enhanced thermionic emission'. Pomerantz, on the other hand, concluded that the secondary-electron emission increased exponentially with the cathode temperature, and deduced from extrapolation of the results obtained at lower temperatures that, at 850° C., δ_m exceeded 100. The effect which Johnson interpreted as "enhanced thermionic emission" was also observed; but that interpretation was not accepted. It has been suggested[3] that "enhanced thermionic emission" rather than secondary-electron emission enables the anode current in a magnetron to exceed the thermionic emission provided by the unbombarded cathode. The experiments the results of which are indicated below were designed to throw light on the disagreement in the conclusions of the above investigators regarding the temperature dependence of the secondary-electron emission, and on the nature of the "enhanced thermionic emission" effect.

The target cathodes used in the experiments were coated with various thicknesses of a standard barium–strontium carbonate coating mixture. The measurements were made in electron-gun type tubes, the primary electrons being focused on the target through a hole in the collector surrounding the target. The secondary-electron yield of each target was measured as a function of the energy of the bombarding electrons, of the thermionic activity of the target, of coating thickness, and of target temperature in the range 20°–850° C. At temperatures at which thermionic emission was appreciable, both the thermionic emission and the emission caused by the bombardment were collected by pulsed collector voltages, pulses of 5–100 microsec. duration being used. In respect of the pulsed collection of the thermionic emission, and in the use of high collecting voltages (up to 5 kV.), the measurements differed from those made by other investigators.

The experiments showed that the secondary-electron yield of the various targets when at room temperature increased with the energy V_P of the primary electrons, reached unity at V_P 35 ± 5 eV. and a maximum value δ_m at V_P 1,100 ± 100 eV. δ_m varied from target to target, and values as low as 4 and as high as 14 were observed. When the targets were heated, δ_m usually changed to some extent in the lower temperature range, but in the temperature range, up to 850° C., in which the thermionic emission was appreciable, all the targets gave values of δ_m between 5 and 10 independent of the temperature. Incidentally, targets coated by evaporation in vacuum, and on which the coatings were so thin that they appeared merely as tarnishings of the nickel bases, gave δ_m values of about 4 or 5 which were completely independent of target temperature in the range investigated, 20°–850° C.

The results obtained with target coatings of various thicknesses and of varying degrees of activation supported the view that the variation of δ_m with temperature in the lower temperature range was not of a fundamental nature but was due to disturbing effects resulting from the appreciable resistance of the coating at those temperatures. On this view it would appear that Pomerantz was not justified in extrapolating from the yield values he obtained at the lower temperatures in order to deduce yield values at temperatures about 850° C., for the cause of the variation at the lower temperatures would have had negligible effect at the higher temperatures.

No evidence was obtained of the effect which Johnson interpreted as "enhanced thermionic emission". The electron current released from each target by a given pulsed bombardment rose immediately (in less than a microsecond) to a value which remained constant during the bombardment and dropped to zero immediately after the bombardment, and the magnitude of this current changed little with the target temperature. It is possible that the effect observed by both Johnson and Pomerantz followed from the continuous collection of the thermionic emission from the targets in their experiments. Continuous collection of thermionic emission from an oxide cathode is known to lower its thermionic activity, partly through increasing the concentration of 'foreign' atoms on the surface. Reduction of this concentration by the bombardment could then cause enhancement of the thermionic emission. Another reason for the absence of the effect in the present experiments might have been the adequate elimination of disturbing space-charges by the high collecting voltages that were used.

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[1] Johnson, J. B., *Phys. Rev.*, **66**, 352 (1944); **69**, 693 and 702 (1946).

[2] Pomerantz, M. A., *Phys. Rev.*, **70**, 33 (1946); *J. Franklin Inst.*, **241**, 415 (1946); **242**, 41 (1946).

[3] Fisk, J. B., Hagstrum, H. D., and Hartman, P. L., *Bell Syst. Tech. J.*, **25**, 257 (1946).