Experiments on the Periodic Deviation From the "Schottky Line"

Measurements made with extreme care have verified the discovery made by Seifert and Phipps[1] that the thermionic emission from a heated filament does not increase linearly with the square root of the electric intensity as called for by the Schottky mirror image theory. The maxima and minima which have been checked are near *25.6*, 40, *65.5*, 121 and *255* kv per cm (italicized numbers for minima). Seifert and Phipps[1] state that "the heights of the maxima and minima for a given filament decrease slightly with increasing temperature" while Turnbull and Phipps[2] state that "the magnitude of the percent deviation, δ, increases with temperature." There is agreement that within experimental error the location of the maxima and minima is independent of the temperature. My observations show that the amplitude of the deviations are *independent* of the temperature except at the lower fields where the nonperiodic deviations are greater the lower the temperature, as has already been pointed out.[3]

The principal object of this letter is to stress the importance of this temperature independence of both the amplitude of the effect and the position of the maxima and minima on the electric intensity scale. The results impose serious limitations on any theory which tries to explain the periodic deviations observed as a change in the transmission properties of the surface barrier unless the theory incorporates a temperature factor exactly compensating for the difference in the electron energy distribution which is a necessary consequence of the change in temperature or else the transmission function must change with the electric field in such a way that its alteration is independent of the energy of the electron transmitted through the surface of the metal. It does not appear that either of the theories[4] so far suggested are capable of explaining the observed facts.

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[1] R. L. E. Seifert and T. E. Phipps, Phys. Rev. **56**, 652 (1939).
[2] D. Turnbull and T. E. Phipps, Phys. Rev. **56**, 663 (1939).
[3] W. B. Nottingham, Phys. Rev. **49**, 78 (1936).
[4] H. M. Mott-Smith, Phys. Rev. **56**, 668 (1939); C. J. Mullin and E. Guth, Phys. Rev. **57**, 349 (1940).

Erratum: On the Yield of Nuclear Reactions with Heavy Elements

(Phys. Rev. **57**, 472 (1940))

The relations given in the caption of Fig. 1 of the above-named paper contain an error in exponent of the numerical factors, 10^{26} appearing instead of 10^{24}. They should read: $(2m\epsilon/\pi\hbar^2)S_p=1.52\times10^{24}S_p$ for protons and $(2m\epsilon/\pi\hbar^2)S_\alpha=6.08\times10^{24}S_\alpha$ for α-particles. The other two relations in the caption remain unchanged.

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Notes on the Separation of Alloys and Isotopes by the Centrifuge

Density differences of two percent were produced by Joly and Poole[1] in liquid alloys of lead, tin, and bismuth by use of a centrifuge. With a Beams ultracentrifuge I have changed the density of liquid Wood's metal by as much as 13 percent.

The centrifuge consisted of two hardened steel rotors held together by a bolt as indicated in Fig. 1. Opposite faces of the rotors were ground and polished to almost optical flatness. Four radial slots in the lower rotor held ingots of the alloy. The vacuum chamber containing the rotor was heated to 100°C and then the rotor run at 500 r.p.s. The hydrostatic pressure at this speed forced the rotors apart slightly so that some metal leaked out. With the removal of material, the pressure was reduced and the leakage stopped. The remaining metal (about 25 percent) in the four slots had densities of 8.40, 8.33, 8.29, and 8.33 g/cc. The original material (Pb 50 percent, Bi 25 percent, Sn 12.5 percent, Cd 12.5 percent) had a density of 9.57 g/cc.

Separation by use of the centrifuge of the constituents of an alloy in the liquid state is possible but any attempt to separate isotopes in a liquid, without counter-currents, seems futile because of the slowness of the molecular sedimentation. This limitation exists even though vibrations and temperature inequalities, to which earlier failures have been attributed,[1-4] can be removed. For mercury, the sedimentation velocity under unit force is about 10^{-14} cm/sec., if one calculates by the classical hydrodynamic method. With a force field as high as 500,000 g the velocity imposed on a heavy molecule, 5×10^{-9} cm/sec., is still negligible. If the "cage model" of a liquid[5] is used, the influence of the field on a single molecule is again found to be small in a force field of 500,000 g. The ratio of the energy an atom might acquire in moving freely as far as 3×10^{-8} cm under the influence of this field to its thermal energy is about 7×10^{-8}. So separation in the field would be negligible in comparison with mixing due to diffusion.

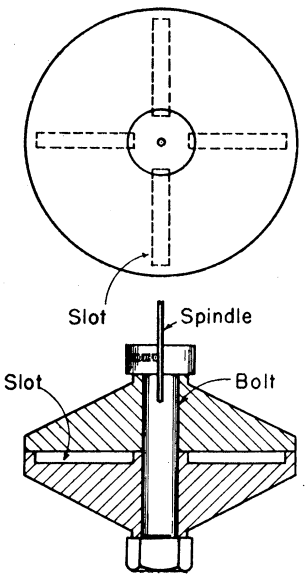

FIG. 1. Compound rotor.