MEETING OF THE DIVISION OF ELECTRON PHYSICS AT THE COLLEGE OF THE
CITY OF NEW YORK ON JANUARY 30–31, 1951

(Joint Meeting with the Panel on Electron Tubes of
the Research and Development Board)

Invited Papers

Energy Levels in BaO, J. A. KRUMHANSL, *Cornell University*
Cathode Interface Effects in Oxide-Coated Cathode Tubes, L. S. NERGAARD, *RCA Laboratories*
Ejection of Electrons from a Metal by Positive Ion Impact, H. D. HAGSTRUM, *Bell Telephone Laboratories*
Production and Measurement of Ultra High Vacua, DANIEL ALPERT, *Westinghouse Research Laboratory*
Life of Secondary Electron Emitters at High Current Densities, D. A. JENNY, *RCA Laboratories*
Application of Electron Counting to Emission Problems, A. S. EISENSTEIN, *University of Missouri*

Contributed Papers

EP1. Pulse Emission and Life Test Data on *L* Cathode.
J. BABAKIAN, *Air Force Cambridge Research Laboratories*
(Introduced by A. LEDERMAN).—Philips results on dc emission were verified using high vacuum diodes. Activation phenomena was observed and compared with oxide-coated cathodes. Peak emission measurements at 1050°C to 1200°C brightness gave from 30 to 80 amp/cm². These tests involving four tubes were conducted at pulse lengths from $\frac{1}{2}$ to 3 μsec, and voltage from 1200 to 2500. Low duty cycle tests were made at pulse lengths up to 80 μsec. Normal and high duty cycle tests (0.001–0.01) were made at 40 μsec. Under none of these conditions was there any droop in the pulse shape such as occurs with oxide-coated cathodes. The life test was set up at 2250 volts 500 pps 1-μsec pulse length with the cathode at 1100°C brightness. Under these conditions the peak emission was 40 to 50 amp/cm². One tube has been on life test for 400 hours. Another tube has 200 hours on life at 2200 volts, 2.2-μsec pulse length, 1250 pps and 46 peak amperes. A fair amount of barium evaporation was noticeable in the 400-hour tube. It was considered tolerable for possible use in switch tubes. Under prolonged sparking induced by long pulse lengths (50 μsec) and high voltage (2800 volts), the peak emission recovered rapidly and remained unimpaired.

EP2. Concerning the Mechanism of Operation of the "*L*-Cathode." F. K. DU PRÉ AND E. S. RITTNER, *Philips Laboratories*.—Emission is considered to come from the tungsten, the work function of which is lowered by a surface double layer of barium on oxygen. The unactivated cathode is believed to have a chemisorbed layer of oxygen on the tungsten and the activation process supplies the required barium to the external surface via the following steps: (a) chemical reduction of BaO by W, yielding Ba vapor of low partial pressure at the bottom of the porous tungsten plug, (b) transport of barium through the plug by means of Knudsen flow through the pores and by means of surface diffusion over the pore walls, (c) diffusion over the external emitting surface. Barium is slowly lost from the cathode by evaporation from this surface and by pore flow. Termination of life appears to be associated with the exhaustion of the barium supply.

EP3. Thermionic Properties of Uncoated and Thoria-Coated Rhodium and Iridium Cathodes. O. A. WEINREICH, *Bartol Research Foundation*.—Richardson plots of rhodium and iridium, cleaned by prolonged heating in high vacuum,

were made in temperature ranges from 1550°K to 1950°K for Rh and from 1700°K to 2200°K for Ir. The *A* constant for Rh was ∼100 amp/cm² deg², and φ=4.9 ev. Previously published values are *A*=33 amp/cm² deg², φ=4.8 ev. For iridium the measured constants were *A*≅100 amp/cm² deg², and φ=5.3 ev. A search in the literature yielded no published values of the thermionic constants for Ir. Cleaned rhodium and iridium filaments were coated with purified thoria and the electron emission measured in vacuum and in oxygen at different pressures. At an O₂ equilibrium pressure of 10⁻³ mm Hg, thoria on iridium yielded *A*=6×10⁷ amp/cm² deg², and φ=6.2e v. It is believed that these data represent a state in which all thorium donors are destroyed. Thoria-coated iridium cathodes can be used in ionization gauges. They are not damaged when exposed hot to open air, and continuous pressure readings in O₂ up to 10⁻² mm Hg are possible.

EP4. Dc and Pulse Emission of Several Rare Earth Oxides.
E. N. WYLER AND F. C. TODD, *Battelle Memorial Institute*.—Techniques and equipment have been developed and employed for reproducible determinations of the dc and pulse emission constants for oxides. A platinum-coated and water-cooled anode is employed to minimize contamination of the emitting surface by metal from the anode. The anode surface was thoroughly cleaned prior to insertion of each new cathode. The heater for the oxides is a sintered, conducting sleeve of 18 to 20 percent powdered molybdenum and 82 to 80 percent of powdered thoria. The oxide for investigation is coated on this sleeve in a layer of two to four mils thickness. For comparison with published measurements, the emission current and voltage at saturation are employed for evaluation of the constants. The techniques and equipment were checked by measuring the dc and pulse emission constants of thoria, and values were found which agree well with those of Wright.* After checks on the reproducibility, measurements were made and will be given for lanthanum oxide and for the following oxides in the 4*f* series of rare earths: cerium, praseodymium, neodymium, samarium, europium, gadolinium, dyprosium, and ytterbium.

* D. A. Wright, Nature 160, 129 (1947). Project for Evans Signal Laboratory and Wright-Patterson Air Force Base.

EP5. Boride Cathodes. J. M. LAFFERTY, *General Electric Company*.—The thermionic emission properties of the borides of the alkaline-earth and rare-earth metals and thorium have been investigated. These compounds all have the same formula MB₆ and the same crystal structure, consisting of a

three-dimensional boron framework in whose interlattice spaces the metal atoms are embedded. The valence electrons of the metal atoms are not accepted by the B_6 complex, thus giving rise to the presence of free electrons, which impart a metallic character to these compounds. This, together with the strong bonds between the boron atoms in the framework, produces a series of compounds which have high electrical conductivities and high thermal and chemical stabilities—ideal properties for a cathode material. When this structure is heated to sufficiently high temperature, the metal atoms at the surface evaporate away. They are, however, immediately replaced by diffusion of metal atoms from the underlying cells. The boron framework does not evaporate but remains intact. This process gives a mechanism for constantly maintaining an active cathode surface. Thermionic emission measurements made on these materials show the rare-earth metal borides to be superior to the others. The highest emission was obtained from lanthanum boride. Its emission constants for the Dushman equation were $\Phi = 2.66$ v and $A = 29$ amp/cm^2/deg K^2.

EP6. The Adsorption of Sr Metal on Tungsten. H. W. ALLISON, AND GEORGE E. MOORE, *Bell Telephone Laboratories.* —Monatomic films of Sr metal were deposited on clean tungsten ribbons by producing the Sr in a controlled chemical reaction between SrO and tungsten in an adjacent filament. X-ray tests have shown that the (100) crystal face is predominantly exposed on the flat surface of these rolled ribbons. By combining radioactive tracer and thermionic techniques, the amount of Sr in a monolayer was measured directly. The amount found, 0.073 ± 0.010 microgram cm^{-2} agrees with the value predicted for a (100) tungsten surface (lattice spacing $= 3.15$A) populated on alternate lattice sites with Sr atoms. This determination, along with thermionic measurements of the work function of the monolayer, indicated an effective dipole moment per adsorbed Sr atom in a monolayer of 1.22×10^{-18} esu. From the relative average rates of evaporation at different temperatures the use of the Clapeyron equation indicates an approximate heat of adsorption of 86,000 cal/mole or 3.74 ev/atom for coverage between 1 layer and 0.5 layer. The heat of adsorption increases as the surface density of Sr decreases.

EP7. Conductivity and Hall Effect in Barium Oxide Films. D. A. WRIGHT, *M. O. Valve Company at the G.E.C. Research Laboratories, Wembley, England.*—Measurements have been made of the conductivity and Hall effect in BaO films of thickness about 10^{-5} mm, formed by evaporating barium onto a magnesia base, and heating in 5×10^{-3} mm oxygen at 500°C. The conductivity σ in vacuum was 10^{-4} ohm^{-1}cm^{-1} at 1000°K; the Hall coefficient was 10^5 cm^3/coulomb. The plot of logσ against $1/T$ was linear from 600 to 1100°K, with slope 2 to 2.5 ev. After evaporating Ba onto the oxide, heating to 750 to 800°K established a state with $\sigma = 2.5 \times 10^{-3}$ at 800°K, and slopes of 0.2 ev below 800°K, and 0.7 ev above 800°K. The low slope conductivity is attributable to residual surface Ba. It was destroyed at 850 to 900°K; here σ fell slightly, and on cooling, the slope was 0.7 ev down to 530°K. The Hall coefficient was 2.5×10^4 cm^3/coulomb at 800°K, indicating 3×10^{14} electrons/cm^3, which denotes a donor concentration near 10^{18} centers/cm^3. The mobility was 65 cm^2/volt-sec, and the free path 1.5×10^{-6} cm. Raising the temperature above 950°K caused a gradual loss of donor centers, σ falling to its initial value 10^{-4} at 1000°K, with the high slope. The whole cycle was repeated many times, with good reproducibility. The results are considered free from confusion by emission processes.

EP8. Diffusion of Barium in Barium Oxide. R. W. REDINGTON, *Cornell University.*—The diffusion of barium in barium oxide was measured to provide the information necessary to determine the role of barium in conductivity and ac-

tivation in barium oxide. Barium 140, a radioactive isotope, in the form of barium oxide was evaporated onto the surface of a crystal of barium oxide. The distribution of radioactive barium in the crystal after heat treatment was determined by sectioning the crystal with a microtome. In the temperature range from 1350° to 1500°K and in quenched crystals, two diffusion mechanisms were present, one of which transported charge. In this temperature range from 1350° to 1500°K, the diffusion constant for the neutral process was about 20 times the diffusion constant for the charge transporting process, and varied from 10^{-11} to more than 10^{-8} cm^2/sec. In the temperature range from 600° to 1300°K, in annealed crystals only the neutral process was detected, and this diffusion constant varied from 10^{-13} to 10^{-11} cm^2/sec. In quenched crystals, the charge transporting process also appeared, with a similar temperature dependence. In these quenched crystals, the magnitudes of both diffusion constants depended on the temperature from which the crystal had been quenched.

EP9. Diffusion of Magnesium Through Nickel. G. F. ROUSE AND R. FORMAN, *National Bureau of Standards.*—By means of an evaporation apparatus, operating under very good vacuum conditions, a magnesium nickel system is formed consisting of a thin layer of magnesium sandwiched between a relatively thick sheet of pure electrolytic nickel and a much thinner layer of the same nickel. When this system is held at a temperature above the melting point of magnesium, the magnesium diffuses through the thin nickel layer and evaporates from its surface. Thus, a zero magnesium concentration is maintained at the surface. This behavior, together with the known initial concentration distribution of magnesium, makes it possible to describe the process mathematically with the diffusion constant as a parameter. The fractional amount of magnesium evaporated and the corresponding time appear in the equation and are measurable quantities. Properly distributed experimental values of these latter quantities make it possible to establish a value for the diffusion constant. Preliminary data indicate that the diffusion constant for a temperature of 720°C is greater than 10^{-9} cm^2/sec. Steps to acquire sufficient data to fix the value of the constant more exactly are underway.

EP10. Initial Emission and Life of a Planar-Type Diode as Related to the Effective Reducing Agent Content of the Cathode Nickel. H. E. KERN AND R. T. LYNCH, *Bell Telephone Laboratories* (Introduced by J. A. BURTON).—A description of the Bell Laboratories planar-type diode will be given, as well as a brief outline of the method of determining cathode emission and the conditions of life testing the diode. A method will be described for calculating the effective reducing agent content of a cathode nickel based on the following factors: 1. The chemical composition of the nickel. 2. The equations of the chemical reactions between the reducing agents in the nickel and the oxide coating. 3. The thickness of the nickel directly beneath the oxide coating. A correlation will be shown to exist between this effective reducing agent figure and both initial cathode emission and tube life. In general, as the effective reducing agent content of the nickel is increased the initial emission also increases, but not without limit. Increase of the reducing agent content above a certain level causes no further increase in initial emission. The relationship between tube life and effective reducing agent content indicates that a maximum tube life is obtained over a very narrow range of effective reducing agent values and that this maximum is apparently limited to a region in which the effective reducing agent content is approximately chemically equivalent to the total oxide coating content.

EP11. Thermionic Emission from Zirconium with Gases in Solution. ARTHUR WAHL, *Princeton University** (Intro-

duced by G. E. Moore).—In 1945, Rentschler and Henry reported† that the gases oxygen, nitrogen, and hydrogen in solution in the element zirconium caused its photoelectric threshold to shift toward the longer wavelengths. Thermionic investigation of these phenomena showed that nitrogen has no significant effect, but oxygen, in solution in quantities of from ten to twenty atom percent, approximately doubles the magnitude of the emission at the high filament temperatures and increases the emission by ten times or more at lower temperatures. This increase in emission is not destroyed by positive ion bombardment. Pure zirconium with no gas in solution and cleaned by standard procedures before and during tube evacuation was found to have a work function of 4.21 volts and an A coefficient of 1260. After this, zirconium was also cleaned by bombardment of positive ions of an inert gas such as argon, the work function became 3.78 volts and the A coefficient 120. Zirconium with about 17 atom percent of oxygen and cleaned by standard procedures plus bombardment showed a thermionic work function of 3.57 volts and an A coefficient of 40. Emission efficiencies at practical operating temperatures are quite low.

* Now with Bell Telephone Laboratories.
† J. Electrochem. Soc. **87**, 289–298 (1945).

EP12. Electron Emission from Alkaline-Earth Metals.
C. H. Killian, *Brooklyn, New York.*—Ives and Stillwell (J. Opt. Soc. Am. **28**, 223 (1938)) reported that high speed hydrogen canal rays showed displacements, for certain accelerating voltages, which were not in accord with the usual theory. These discordances were attributed to perturbation shifts by spectral lines of molecular hydrogen. Irregularities in the progression of the spectral lines of recognized chief series of mercury, copper, aluminum, the alkali metals, and the alkaline-earth metals are known; and these irregularities are commonly explained, by modern theories, as mutual perturbations by terms of closely related spectral series. The most marked irregularities appear in the spectra of the alkaline-earth metals, aluminum, and copper. These are the metals used extensively in rectifiers, electrolytic condensers, and oxide cathodes. The mentioned perturbations are commonly explained as a sort of resonance phenomenon and are an indication of the storing of energy which can be released by the phenomenon of "auto-ionization" (Wentzel and Shenstone, Phys. Rev. **38**, 873 (1931)), or by radiation. This view of energy storage and emission appears to be experimentally confirmed by Stillwell and Ives, and hence is a valuable viewpoint for explaining the copious emission of electrons by the alkaline-earth oxide cathode, and perhaps also for explaining rectification.

EP13. High Voltage Breakdown due to Field Emission Processes.*
Daniel H. Goodman and David H. Sloan, *University of California* (Introduced by L. C. Marshall).—The fields at which breakdown occurs between coplanar cold metal surfaces in vacua have been studied. The experiments were performed with a 200-ohm, 200-kilovolt, 1-microsecond pulse line, and with copper, aluminum, molybdenum, nickel, and stainless steel electrodes. The results indicate that field-emitted electrons are the initiating factor in breakdown and that the field required for breakdown is proportional to the square root of the resistivity of the metal. A considerable mass of metal was transferred from the anode to the cathode. It is proposed that breakdown is dependent on the occurrence of four distinct processes: (1) emission of pure field electrons from the cathode; (2) production of ions from gas atoms or anode surface film due to bombardment by high velocity electrons; (3) further extraction of electrons from the cathode by (a) production of many secondary electrons by ion bombardment, (b) atomically close approach of an ion to the cathode, (c) fields about atoms which are splashed out of the cathode and

are intermittently ionized and neutralized without traveling far; (4) liberation of atoms by tremendous currents that heat the anode, which may be ionized as they leave the anode surface, leading to breakdown into a metallic arc.

* This work was supported by the Air Materiel Command, U. S. Air Force, Contract No. W-33-038 ac-16649.

EP14. Field Electron Emission from Sodium Chloride.
R. T. K. Murray and Alexander Mackenzie, *Long Island University.*—The field electron emission from dielectrics previously reported* has been extended to single crystal sodium chloride. The cathode consisting of a 3.5-mm plane parallel plate of sodium chloride ground and polished in the (1, 0, 0) plane was supported from above by a brass plate and placed over the aperture of a counter. For a given gap distance linear log current against reciprocal potential characteristics were obtained for currents up to 100 electrons per second. From the experimental current-potential curves from the same emitting surface taken at different gap distances identical values of the field for the same current could be obtained only if calculated from an expression that allows for a steady-state negative surface charge less than the equilibrium polarization one. This decrease in the negative surface charge has the effect of increasing the field in the dielectric and decreasing the field at the surface in order that in the steady state the conduction current will equal the emission current. Assigning values for the parameters of sodium chloride in Poole's law and the Fowler-Nordheim equation, a connection between the dielectric and surface fields is obtained.

* R. T. K. Murray and A. Mackenzie, Phys. Rev. **78**, 350 (1950).

EP15. High Density Field Emission from Single Tungsten Crystals,*
W. P. Dyke and J. K. Trolan, *Linfield College.*—Field emission of large current densities from single tungsten crystals has been studied, using pulse techniques. Observed current densities agree within an order of magnitude with values predicted by the image force corrected theory of Fowler and Nordheim, up to a current density of 10^8 amp/cm^2 and an electric field of 10^8 v/cm. The vacuum arc occurs at a slightly higher value of the electric field under the conditions which follow. Field currents of 0.1 amp, with potentials up to 17 kv at pulse lengths of a few microseconds, have been drawn from electrolytically etched emitters whose surface approximated a hemisphere of radius of the order of 10^{-5} cm. Emitters were pulsed in a Müller projection tube; emission patterns for each pulse were recorded photographically. Current density, electric field, and emitting area were calculated with the help of emitter geometry obtained from its shadow cast in a conventional electron microscope. The work function was taken as the accepted value for clean tungsten. The variation of the current density across the emitting area was obtained by photometric methods. Emission patterns from clean tungsten at high current densities are similar to patterns observed previously at low densities.

* Sponsored by the ONR and by Research Corporation.

EP16. Migration of W Atoms on the Surface of a W Single Crystal as a Function of Temperature and Electric Field Strength.
J. A. Becker, *Bell Telephone Laboratories.*—A field-emission electron microscope is used to observe the density of field-emission electrons from an approximately hemispherical surface of a W single crystal at the end of a W point.* If the point is flashed at 2400°K, a reproducible pattern is observed. This pattern shows that 15 percent of the surface consists of (110), (211), and (100) planes. Glowing below 1000°K produces no changes. At 1000°K the pattern changes slowly: (211) planes enlarge and (111) zones form step structures. At 1200°K changes occur more rapidly and

(100) planes enlarge; when a steady state prevails the areas of (211) and (100) planes are four times as large as originally. At still higher temperatures the rates are higher. When electric fields of 45 million volts/cm are applied while the point is at 1000°K, changes occur more rapidly and are more pronounced than without the field. At 1400°K and 41 million volts/cm, pronounced changes occur in 1 minute; in 20 minutes, (211) planes grow until they meet (110) planes. Subsequent glowing at 1000°K or higher with zero field decreases the area of (211) and (110) planes.

* Mueller, Z. Physik 126, 642–665 (1949).

EP17. High Speed Ten-Volt Effect. R. M. MATHESON AND L. S. NERGAARD, RCA Laboratories.

—In 1935, H. Nelson* observed that tubes with oxide-coated cathodes operating under space-charge limited conditions show a small deviation from the Child-Langmuir law for anode voltages exceeding ten volts. Recent measurements confirm his observations. The effect is stable and is independent of frequency for all frequencies for which the electron transit time may be neglected. Measurements made on triodes, rotating anode diodes, and diodes with cathode probes indicate that the effect is not caused directly by the cathode. Observations on diodes in which the anode temperature could be varied associate the effect with the anode. It is shown that an increase of space charge by secondary and reflected electrons from the anode can account for the deviation. The required secondary emission ratios are in substantial agreement with those reported for BaO.

* H. Nelson, unpublished research.

EP18. Origin of Bombardment-Enhanced Thermionic Current. J. B. JOHNSON, Bell Telephone Laboratories.

—Cathodes of (BaSr)O, bombarded by electrons, emit three categories of electron current: thermionic electrons, secondary electrons, and a component that on a microsecond scale rises during and persists after the bombardment.* The last has been considered of thermionic origin and called bombardment-enhanced thermionic emission. Measurements now show the initial energies of the enhanced component resemble those of the thermionic current, not the much higher ones of secondary electrons, adding proof of the thermionic origin. Calculations support the view that this current arises from increased concentration of free electrons in the emitter. Reasonable assumptions are made that primary electrons create an electron-hole pair for each 10 ev of their initial energy with mobility of the carriers $\mu = 1$ cm²/volt sec. Experimental evidence points to lifetime of the carriers of the order $\tau = 10$ μsec. Neglecting surface recombination, the density of holes and electrons within the diffusion distance from the surface should, on this simple basis, rise during the pulse by a calculable amount. This exceeds by a factor of the order 10 the amount obtained from the observed enhancement and reasonable estimates of the original density. The assumed mechanism could therefore account amply for the enhancement.

* J. B. Johnson, Phys. Rev. 73, 1058 (1948).

EP19. Extension of Wooldridge's Theory of Secondary Emission.* A. VAN DER ZIEL, University of Minnesota.

—Wooldridge's[1] formula (32) for the rate of increase of the number of secondary electrons with time can be rewritten as

$$\frac{1}{\Omega}\frac{dN\rho}{dt} = 4\pi e^4\rho_1(k)J_p\frac{|b\rho(k)|^2(2R_0/K)\rho}{|E(k')-E(k)|^2}.$$

This formula is more general than Wooldridge's, for it can be shown that it also holds for insulators. The formula may be applied to the calculation of the most probable energy loss of the primary electrons in the collision process. The result fits closely with Ruthemann's[2] and Lang's[3] experimental data, but differs considerably from Wooldridge's average energy loss E_0.

* Work being supported by the United States Signal Corps.
[1] D. E. Wooldridge, Phys. Rev. 56, 562 (1939).
[2] G. Ruthemann, Ann. Physik Leipzig. 6th Series 2, 113 (1948).
[3] W. Lang, Optik 3, 233 (1948).

EP20. Optical Interference Effects in the Photoelectric Emission from F-Centers in RbBr. E. TAFT AND L. APKER, General Electric Research Laboratory.

—Photoelectric emission from F-centers in RbBr was measured by methods previously used on KI.* (RbBr is of interest because it is transparent throughout the easily accessible ultraviolet.) When salt films of sufficient uniformity were deposited on metal mirrors, optical interference produced pronounced fluctuations in the frequency variation of the photoelectric yield. In a typical case, a film $\sim$4000A thick exhibited four maxima between $\lambda = 4500$ and $\lambda = 2300$A. The yields at these points were four times higher than at the intermediate minima. The phase shift on reflection at the metal surface appeared to be $\sim$170° instead of 180°. The data indicate that the photoelectrons originate within 10^{-5} cm of the surface or less, a result consistent with Hebb's calculations.† Electron bombardment appears to roughen the films, as noticed previously by I. Estermann. The possibility of these interference effects must be recognized in the interpretation of photoelectric data on transparent materials.

* L. Apker and E. Taft, Phys. Rev. 79, 964 (1950).
† Malcolm H. Hebb, Phys. Rev. 81, 321 (1951).

EP21. The Enhanced Photoelectric Emission Effect in Barium Oxide Cathodes. B. D. McNARY, University of Missouri.

—An enhanced activation of BaO cathodes for photoelectric emission has been accomplished by prolonged irradiation with wavelengths from 2537 to 7000A. The photoelectric response is increased for all wavelengths with the greater increase in response in the long wavelength region. Increases in yield of a thousandfold have been produced. This increase in response decays with time and is temperature dependent. The rate of decay also depends upon the wavelength used in studying the decay, the rate being higher for the longer wavelengths at which the greater enhancement was produced. No simple first- or second-order reaction law has been found to fit the complete decay curves, but the assumption that the initial decay depends on a Boltzman factor yields an activation energy of about 1 ev.

EP22. Photoconductivity of Composite Photoemissive Surfaces. S. PAKSWER AND W. O. REED, Rauland Corporation.

—It is still questionable whether photoelectrons in composite photoemissive surfaces are emitted from alkali metal atoms adsorbed on the surface, whether they are formed in the top layers of the sensitized coating, or whether they are produced as a volume effect inside the coating. To contribute to the problem of the mechanism of photoemission, measurements of photoconductivity in semitransparent cathodes with $Ag-Cs_2O-Cs$, $Sb-Cs$ and caesiated $Pb-O-S$ layers were attempted. It was observed that most of the current between the conductivity strips was due to "skimming" electrons, and this current was reduced in our experiments by the introduction of $\frac{1}{2}$ atmos of He. The spectral distribution of the remaining very small conduction current shows a shift to longer wavelengths in the case of $Sb-Cs$ coating as compared to remaining photoemissive current. Nonphotoemissive $Pb-O-S$ cells having infrared photoconductivity lose photoconductivity and acquire photoemissivity to short wave radiation. Some effects suggesting quenching by short wave radiation were observed on $Ag-Cs_2O-Cs$ cathodes.