Abstracts of Technical Articles from Bell System Sources

The Emission of Secondary Electrons from Tungsten.[1]   A. J. AHEARN. An apparatus is described for investigating critical potentials in the emission of secondary electrons from tungsten.   Measurements on the velocity distribution in the primary beam show that secondary electrons from the electron gun are absent.   Tube characteristics which might introduce spurious critical potentials in the secondary emission from tungsten appear to be absent.   By heat treating the tungsten and cleaning up residual gases, maxima and critical slope changes were developed below 40 volts.   With sensitive methods of measuring and plotting the data, critical potentials within the range from 40 to 500 volts were observed only at the following uncorrected voltages: 70, 108, 208, 297 volts.   All but the 70-volt effect disappeared eventually after heat treatments of the tungsten target.   Thus when the tungsten surface is most free from contamination, critical potentials persisted only at the following uncorrected voltages: maxima at about 3.5 and 8 volts and slope increases at 24, 33 and 70 volts.   The phenomena may be associated with the diffraction of electrons or the production and absorption of characteristic soft x-rays.   Regardless of the mechanism operating at the critical potentials, their decrease or elimination beyond 40 volts points strongly to effects of surface contamination rather than to characteristics of tungsten.

Electrolytic Phenomena in Oxide Coated Filaments.[2]   J. A. BECKER. A critical survey of the literature shows that the current through the oxides in oxide coated filaments is carried by electrons, negative oxygen ions, and positive barium ions.   The proportion of current carried by each depends upon the exact composition and method of preparation of the oxide coating, on the heat treatment and on previous electrolytic effects.   Presumably the conductivity is greatly affected by barium and oxygen dispersed through the oxide.   New experimental results show:

1. For a particular BaO + SrO filament, the conductivity C was given by

$$1.71 \times 10^4 \frac{1.73 \times 10^4}{T} + 5.55 \times 10^{-3} \frac{0.62 \times 10^4}{T} .$$

[1] *Phys. Rev.*, November 15, 1931.
[2] *Trans. Electrochem. Soc.*, Vol. LIX, 1931.

2. The current is proportional to the voltage only so long as the current is small; otherwise the products of electrolysis alter the conductivity.

3. Polarization currents are caused by the Ba and O which are produced by electrolysis. These currents decrease rapidly even at temperatures near 500° K., thus showing that Ba and O diffuse at low temperatures.

Some Observations of the Behavior of Earth Currents and their Correlation with Magnetic Disturbances and Radio Transmission.[3] ISABEL S. BEMIS. This paper presents correlations between the abnormal earth currents noted during magnetic storms and transoceanic radio transmission on both long and short waves. The radio transmission data were collected on the telephone circuits operating between New York and London and between New York and Buenos Aires. The earth current data were collected on two Bell System lines extending approximately a hundred miles north and west from New York. The results of this work establish facts which have been known in a general way for some time.

The direction of flow of abnormal earth currents in the neighborhood of New York seems to be along a northwest-southeast line. Coincident with such abnormal currents are periods of poor short-wave radio transmission. However, on long waves, daylight transmission over transatlantic distances is improved. On the short-wave circuit to Buenos Aires, transmission is adversely affected but only to a moderate extent.

The Propagation of Short Radio Waves over the North Atlantic.[4] C. R. BURROWS. Transmission conditions for each season are shown by "surfaces" giving the received field strength as a function of time of day and frequency. These show that frequencies near 18 mc are best for daytime transmission. In summer the best frequencies for nighttime transmission are those near 9 mc. In winter an additional frequency near 6 mc is required during the middle of the night. A frequency (such as 14 mc) intermediate between the day and night frequency is useful during the transition period between total daylight and total darkness over the path. Day-to-day variations change the periods of usefulness of these frequencies. In particular the period of usefulness on 14 mc sometimes extends so that it is the best daytime frequency.

Transmission conditions on undisturbed days were found to be the

[3] *Proc. I. R. E.*, November, 1931.
[4] *Proc. I. R. E.*, September, 1931.

same for the same time of year on different years. These undisturbed transmission conditions are presented by "normal" surfaces. Comparison of these surfaces shows that the higher frequencies are less attenuated in winter. Reception on the highest frequency, 27 mc was best in winter; in summer this frequency was never heard.

The effect of solar disturbances on short-wave transmission is to reduce reception on all frequencies. Sometimes the higher frequencies are the more adversely affected. Some of the possible causes of these disturbances are discussed.

From the measurements made on "static" at New Southgate, data on the variation of its field strength as a function of frequency, time of day, and season are given.

Methods of High Temperature Treatment.[5] PAUL P. CIOFFI. The object of this paper is to describe methods which have been developed in this laboratory for treating metals, chiefly iron and its alloys, at all temperatures up to about 1700° C., considerably above the melting point of iron, and in any atmosphere ranging in pressure from 10^{-8} mm. of mercury to 20 or more atmospheres. The methods of heating, and the forms of the materials heated fall into three rather well-defined groups: (1) Long wires and tapes heated to any temperature up to a few degrees below the melting point by passing currents through them in the presence of a gas (*a*) under a pressure of one atmosphere or less, or (*b*) under a pressure up to 20 atmospheres. (2) Toroids heated by induction in a gas atmosphere, with the gas pressure ranging from 10^{-8} mm. to one atmosphere. (3) Any shape of specimen heated up to about 1700° C. in a molybdenum wound furnace in a gas pressure ranging from 10^{-3} mm. to 20 atmospheres.

In investigations dealing with the effect of heat treatment on the properties of materials, the temperature range covered, often limited by the lack of suitable facilities, is likely to obscure important or interesting effects produced by heat treatments at high temperatures. The new high values of the magnetic permeability of iron recently reported were made possible by employing the methods here described; in fact, these methods were all developed in connection with the investigation of the magnetic properties of materials as dependent upon temperature and time of heat treatment and rate of cooling in any atmosphere. These methods are also applicable to other metals which can be shaped into long wires or tapes or toroids.

[5] *Jour. Franklin Institute*, November, 1931.

Methods for Measuring Interfering Noises.[6] LLOYD ESPENSCHIED. This paper outlines various methods of measuring interference, particularly in radio telephony, which have been found useful in the Bell System.

Reverberation Time Measurements in Coupled Rooms.[7] CARL F. EYRING. The decay of residual sound in simple reverberant enclosures has been the subject of much study. Out of these investigations along with other important developments formulæ have emerged which may be used to calculate the reverberation time of enclosed rooms, the one proposed by Sabine being applicable to live rooms, but a more general one being necessary if applied to dead rooms. These formulæ may be used in the study of simple enclosures in which the sound is diffuse, the absorbing material is well distributed, and the decay of the residual sound is exponential in time. They may not be applied indiscriminately to complex structures for the author has shown that the curves illustrating the decay of the residual sound intensity level may not be straight under certain conditions for coupled rooms of different natural reverberation times or even for a single room with no sound diffusing scheme and non-uniformly distributed absorption.

The present paper presents further data on acoustically coupled rooms and offers a theoretical study and formulæ applicable to such complex structures. Somewhat similar studies have been made by Buckingham and Davis in the investigation of sound transmission through partitions. But before the coupled room formulæ which are based on certain idealizations can be applied in general to auditoriums with various types of balconies and under-balcony spaces, they must be carefully checked by a thorough experimental study of typical theatres. Thus it is expected that empirical formulæ, based on theory and experiment, may be evolved for each type of complex structure.

Recently developed instrumental methods of measuring reverberation time, especially those methods that measure the decay history of the residual sound, give promise of being the tools needed in this study. The results recorded in this paper were made on a meter described by Wente and Bedell in their paper "Chronographic Method of Measuring Reverberation Time" and by the author. This instrument plots almost automatically the intensity level of the residual sound measured in db and the time.

[6] *Proc. I. R. E.*, November, 1931.
[7] *Jour. Acous. Soc. Amer.*, October, 1931.

When the sound source is cut off there will not only be a decay of sound due to the absorption of the walls, fixtures, etc., but the interference pattern will continually shift causing the actual rate of decay of the sound intensity level at a point to fluctuate about the rate of decay caused only by absorption. This fluctuation may be very pronounced and actually changes from point to point in the room, but may be minimized by the use of a warble tone and if necessary by the proper placement of the transmitter. With these precautions, and they are used in all the reverberation time measurements presented in this paper, the effect of interference is greatly reduced. The average rate or rates of decay δ (db per second) of the sound intensity level can at once be obtained from the slope of the straight line or lines which best fit the series of experimental points. The reverberation times T (time per 60 db) used in this paper have been calculated using the relation

$$T = \frac{60}{\delta}.$$

The Effect of Exposure and Development on the Quality of Variable Width Photographic Sound Recording.[8] DONALD FOSTER. This paper deals with the dependence of the quality of variable width recording on the conditions of exposure and development. When the widths of the images employed in recording or reproducing are comparable with the wave-length of the record the exposed portion of the record is not uniformly exposed. The record is attenuated in amplitude as the frequency is increased, and harmonics are introduced whose relative intensities depend on the contrast of development and on the frequency. When the exposure of the record occupies the linear range of the H & D curve, and when the product of the gammas of the negative and the positive is equal to unity, the record is practically free from spurious harmonics. The amount of non-linear distortion is calculated for the case when the over-all gamma is equal to two; and it is shown that Cook's analysis of the aperture effect gives a superior limit to the distortion obtainable by overexposure or by over or underdevelopment. The effect of the unavoidable non-uniform illumination of the images is considered.

The Vectorial Photoelectric Effect in Thin Films of Alkali Metals.[9] HERBERT E. IVES. It is assumed that the photoelectric effect exhibited by thin films of alkali metals on specular platinum surfaces is proportional at any wave-length to the electric intensity just above

[8] *Jour. S. M. P. E.*, November, 1931.
[9] *Phys. Rev.*, September 15, 1931.

the platinum. This electric intensity is found, using the optical constants of platinum, by computing the intensities of the wave patterns formed by the interference of the reflected and incident beams. These computations are made for various angles of incidence and for light polarized in and at right angles to the plane of incidence. The intensities thus found exhibit very large ratios of value for the two planes of polarization, in striking agreement with the characteristics of the vectorial photoelectric effect. The changes of amplitude of the perpendicular electric vector on entering the alkali metal film, as computed from the optical constants of the alkali metal, account for the experimentally found low values of the emission ratios at long, and their high values, at short wave-lengths.

The Photoelectric Effect from Thin Films of Alkali Metal on Silver.[10] HERBERT E. IVES and H. B. BRIGGS. The thin films of alkali metals which spontaneously deposit in vacuo on other metals have long been known to exhibit photoelectric effects which vary in amount and character, depending on the underlying material, but the exact nature of this dependence has been obscure. Silver, because of its region of exceedingly low reflecting power in the ultraviolet and the accompanying variation of optical constants, is exceptionally well suited for studying the influence of the underlying metal. It is found that the region of low reflecting power profoundly affects the photoemission, but in a manner not to be explained simply by reduction of light reflected back through the alkali metal film or by the absorption of light by the silver. The results obtained are very satisfactorily explained upon computing, from the optical constants, the intensity at the surface, of the interference pattern formed by reflection just above the silver surface. The positions of the maxima and minima of photoemission, and their variations with angle of illumination and plane of polarization are accurately indicated.

The Applicability of Photoelectric Cells to Colorimetry.[11] HERBERT E. IVES and E. F. KINGSBURY. It is the purpose of this paper to consider critically the requirements for a precision physical colorimeter, and to estimate, in the light of a large body of experimental data on the new types of photoelectric cells, to what degree the requirements for physical colorimetry may be met at the present time. The paper is intended to be very specifically limited to the problems of precision color measurement, and it is assumed that the reader is already acquainted with the principal facts relating to photoelectric cells and

[10] *Phys. Rev.*, October 15, 1931.
[11] *Jour. Optical Soc. America*, September, 1931.

their use in ordinary photometric measurements, in which no pronounced color differences are faced. Our study does not concern itself with certain problems of sorting and selection, commonly spoken of as "color" measurement, in which the nature of the colors concerned and their range of deviation from certain standards are known in advance, thereby greatly simplifying the problem.

A Moving Coil Microphone for High Quality Sound Reproduction.[12] W. C. Jones and L. W. Giles. A microphone is described in this paper which retains all of the inherent advantages of the moving-coil type of structure but unlike the earlier forms of this microphone responds uniformly to a wide range of frequencies. It is more efficient than the conventional form of condenser microphone and its transmission characteristics are unaffected by the changes in temperature, humidity and barometric pressure encountered in its use. Unlike the condenser microphone the moving-coil microphone may be set up at a distance from the associated amplifier and efficient operation obtained. Owing to its higher efficiency and lower impedance it is less subject to interference from nearby circuits. It is of rugged construction and when used in exposed positions is less subject to wind noise.

The Shot Effect in Photoelectric Currents.[13] B. A. Kingsbury. The shot effect, as it occurs in a photoelectric current, has been used to secure an evaluation of the electron charge. A new and original method of amplifier calibration, which involved the use of a modulated light beam, simplified the measurements and the computation of the result. In the absence of space charge, the experimental value of the electron charge was 1.61×10^{-19} coulombs for a thermionic current, and about 25 per cent greater for a photoelectric current. It was found that the shot effect is enormously increased in photoelectric currents which are amplified by collision ionization. Statistical variations which might be expected to occur in a beam of radiant energy could not be detected, since, within the limits of experimental accuracy, the shot effect in photoelectric currents was found to be independent of the frequency of the light producing electron emission.

Some Acoustical Problems of Sound Picture Engineering.[14] W. A. MacNair. The purpose of this paper is to point out that many advances in acoustical engineering have been necessary in order to understand and control adequately the conditions under which modern

[12] *Projection Engineering*, October, 1931.
[13] *Phys. Rev.*, October 15, 1931.
[14] *Proc. I. R. E.*, September, 1931.

sound pictures are recorded and reproduced. To illustrate this point, some of the acoustical problems encountered at Bell Telephone Laboratories are discussed. The sudden and successive changes in sound intensity level to be expected in a room during the growth and decay of sound from an intermittent source are pointed out. The necessity of using the more general reverberation time formula, which was developed over a year ago, when dealing with comparatively "dead" rooms, is indicated. One type of acoustical distortion which is due to interference is discussed together with the measures necessary to minimize it in sound pick-up work. These phases of acoustical engineering have been selected for discussion from many which confront the engineer in this field.

An Interpretation of the Selective Photoelectric Effect from Two-Component Cathodes.[15] A. R. OLPIN. Evidence is produced to support the view that photoelectrically selective, two component cathodic surfaces are crystalline in nature. Then, assuming that Fowler's equation for the energy of electrons selectively transmitted through a single potential valley $[W = (n^2h^2/8md^2)]$ is equally valid for the energy of electrons selectively transmitted through the periodic sequence of valleys characteristic of the potential field within a crystal, and that all of the energy of photoelectrons is acquired from the incident light quanta, the wave-lengths of light to which such a surface should respond selectively can be computed. Such computations have been made with d equal to the internuclear distance between electro-positive ions in the lattice structure of alkali metal hydride, oxide and sulphide crystals. The hydride crystals belong to the sodium chloride type and the oxide and sulphide crystals are supposedly of the calcium-fluoride type. The correlation between these computed values and the positions of the observed selective maxima is exceptionally good. Moreover, the fact that the alkali metal hydrides exhibit but one selective maximum and the oxides two or three maxima is in keeping with the geometry of their respective crystalline types.

Some Physical Concepts in Theories of Plastic Flow.[16] R. L. PEEK, JR., and D. A. McLEAN. A review is given of the considerations involved in the development of theories of deformation applicable to the flow of soft solids in capillary tubes and under similar steady state conditions. It is pointed out that the limitation to special test conditions (particularly to steady states) makes it impossible to

[15] *Phys. Rev.*, November 1, 1931.
[16] *Jour. Rheology*, October, 1931.

distinguish in all cases between the results of different physical hypotheses as to the mechanism of flow resistance. A review is given of the physical distinctions which can be determined by such experiments. It is noted that the criterion that the results from different capillary tubes can be expressed in the form $Q/R^3 = F(PR/2L)$ serves to distinguish those types of flow in which the resistance is dependent only on the rate and not on the extent of the deformation, except when slip occurs. This last can be distinguished from quasi-laminar flow (in which the resistance depends on the amount of deformation) by tests made with capillaries of common radius but of different lengths.

The other important physical distinction that can be observed is between those materials which show a yield value and those that do not. For those that do, a new type of equation is obtained, of which the Bingham-Buckingham equation is a special case. In this new general form the relation postulates an initial shear stress which must be exceeded before flow takes place, and a lower constant stress which is effective in opposing flow once the latter has commenced.

For cases of flow in which no yield value is observed, another new form is given which is based on the physical concept, common to most theories of such flow, of an effective viscosity varying with the stress intensity between upper and lower limits. It is shown that the character of this relation is similar to that given by the empirical formula $Q/R^3 = K \left(\dfrac{PR}{2L} \right)^n$. The use of this equation in expressing and interpreting experimental results is discussed.

Intercontinental Radiotelephone Service from the United States.[17] J. J. PILLIOD. Radiotelephone service between the United States and Europe was established January 7, 1927 with one circuit and with service to limited areas. Facilities and service have been greatly improved and extended and rates have been reduced. Present scope of service is described and reference made to consistent increases in transatlantic telephone messages handled. This increase indicates that this service is being found of increasing value by the public.

Extent of ship-to-shore radiotelephone service from the United States is outlined. Arrangements for service to Buenos Aires and Rio de Janeiro are described, these differing from arrangements used for service to Europe in that operation to these two cities was planned on a part time basis. Proposed short-wave system for operation with

[17] Presented at Pacific Coast Convention of A. I. E. E., Lake Tahoe, Calif., August, 1931. Published in abridged form in Elec. Engg., September, 1931.

Bermuda and proposed new long-wave system to supplement existing facilities to Europe are mentioned.

A description of the new radiotelephone transmitting and receiving stations now being erected at Dixon and Point Reyes, Calif., respectively, is given. These stations will be connected to a terminal office at San Francisco and the system used for the establishment of radiotelephone service to the Hawaiian Islands and later on, to other transpacific points as may be required.

High-Frequency Atmospheric Noise.[18] R. K. POTTER. A method which has been employed in the measurement of high-frequency atmospheric noise is described. Using this method measurements of noise over the range from 5 to 20 megacycles made in different parts of the United States and at different times of the year, show a distinct diurnal change in intensity similar to that for long-range high-frequency signal transmission. Except during periods of severe local disturbance noise on the lower frequencies is high during the night while on the higher frequencies the maximum occurs during the day. Simultaneous observation of crashes on different frequencies also suggests that the received atmospherics are largely transmitted by overhead paths. The variation in high-frequency atmospheric noise intensity during the passage of local electrical disturbance centers is shown. It is suggested that the intensity of atmospheric noise generated by these centers of electrical disturbance is inversely proportional to frequency. Measurement data are included showing the effect of sunrise and sunset, an eclipse of the sun, and disturbances in the earth's magnetic field upon the intensity of high-frequency atmospheric noise. Diurnal characteristics of high-frequency atmospheric noise on directive antennas facing England and South America and the noise reduction obtained by these arrays are illustrated. The possible location of distant centralized noise sources is discussed briefly.

The Grounded Condenser Antenna Radiation Formula.[19] W. HOWARD WISE. Exact formulas for the wave function and vertical electric field at the surface of the ground are derived for a vertical dipole of zero height.

[18] *Proc. I. R. E.*, October, 1931.
[19] *Proc. I. R. E.*, September, 1931.