Abstracts of Technical Articles from Bell System Sources.

The Effect of Temperature on the Emission of Electron Field Currents from Tungsten and Molybdenum.[1] A. J. AHEARN. Electron field currents from the central portion of long molybdenum and tungsten filaments about 2.7×10^{-3} cm. in diameter have been studied. The field currents were first made stable to about 5 per cent by long-continued conditioning treatments of temperature and high voltage under high vacuum conditions. Thermionic emission measurements gave the values 4.32 and 4.58 volts for the work function of the molybdenum and tungsten, respectively, in good agreement with the accepted values for the clean metals. Emission measurements were then made at fields varying from about 5×10^5 volts/cm. to about 1×10^6 volts/cm. and at temperatures varying from 300° K. to about 2000° K. Down to about 1600° K. the thermionic currents completely masked the field currents. Thermionic emission values below 1600° K. were obtained by extrapolation. Thus the field currents at the lower temperatures were separated from the thermionic currents. Where necessary, corrections were made for the decrease in the voltage gradient accompanying the thermal expansion of the filament. The field currents were found to be independent of temperature to within 5 per cent from 300° K. to 1400° K. At temperatures higher than 1400° K. the data are consistent with the assumption that the current consists of a thermionic current plus a current which is independent of temperature. However, because of the exponential change of thermionic current with temperature a small effect of temperature on the field current could not be distinguished at temperatures higher than 1400° K. From the theory of Fowler and Nordheim, β, a factor introduced by surface irregularities, is found to be 120 for the tungsten cathode and 47 for the molybdenum one. Thus for tungsten, Houston's theory of the temperature effect is in approximate agreement with the negative results of these experiments.

Measurement of Transmission Loss Through Partition Walls.[2] E. H. BEDELL and K. D. SWARTZEL, JR. This paper reviews the theory and describes the method used at Bell Telephone Laboratories of measuring the transmission loss through partition walls. The partition to be

[1] *Phys. Rev.*, August 15, 1933.
[2] *Jour. Acous. Soc. Amer.*, July, 1933.

tested is built into an opening between two adjacent but structurally isolated rooms. A loud speaker acts as a source of sound in one room and a portion of the sound energy is transmitted into the second room through the test partition. The transmission loss is taken as

$$TL = L_1 - L_2 - 0 \log_{10} (\alpha_2/A),$$

where L_1 and L_2 are the intensity levels in the source and test room respectively, expressed in db, α_2 is the absorption in the test room and A is the area of the partition. The levels L_1 and L_2 are measured and plotted with a moving coil microphone and an automatic level recorder, and a beat frequency oscillator is used as a source of tone so that the frequency may be varied continuously. Measurements with a continuous variation in frequency enable resonances in the partition to be much more easily and quickly detected than is possible when measurements are made at discrete frequency intervals. Both pure and frequency modulated tones have been used for the measurements. Results of measurements on a few partitions are given.

The Optical Behavior of the Ground for Short Radio Waves.[3] C. B. FELDMAN. The rôle of the ground in radio transmission is first considered generally. In short-wave propagation taking place via the Kennelly-Heaviside layer only the ground in the vicinity of the antennas is involved, and its effect may be included in antenna directivity. The utility of so ascribing the ground effect exclusively to the terminals of a radio circuit rests on the applicability of simple wave reflection theory in which the distance between the terminals does not appear. For this purpose reflection equations, similar to Fresnel's equations for a nonconducting dielectric, are employed with a complex index of refraction.

The paper describes experiments undertaken to determine the limits of applicability of these optical reflection equations and discusses the results. Particular emphasis is placed on the identification of direct and reflected waves. The existence of a surface wave, foreign to simple reflection theory, is recognized with vertical antennas, when the incident wave is not sufficiently plane. At angles of incidence between grazing and the pseudo-Brewster value the requirements of planeness are severe. The relation of optics to Sommerfeld's theory is discussed. The experiments include tests made with the aid of an airplane.

For short-wave communication via the Kennelly-Heaviside layer, use of the modified Fresnel equations is shown to be justified. These

[3] *Proc. I.R.E.*, June, 1933.

equations fail only at substantially grazing incidence and then merge into the Sommerfeld ground wave solution. The ground effect is always to discriminate against radiation or reception at very low angles.

Two methods of determining the electrical constants of the ground are described. One comprises measurements of the elliptical polarization of the ground wave, and is based on Sommerfeld's propagation theory. The other is a method of measuring, at radio frequencies, the conductivity and dielectric constant of samples of ground removed from the natural state. Suitable agreement between the two methods is found if the nonuniformity and stratification of natural ground is considered. The sample method is also used to determine the conductivity of ocean water.

On Minimum Audible Sound Fields.[4] L. J. SIVIAN and S. D. WHITE. The minimum audible field (M.A.F.) has been determined from data taken on 14 ears over the frequency range from 100 to 15,000 c.p.s. The observer is placed in a sound field which is substantially that of a plane progressive wave, facing the source and listening monaurally. The M.A.F. is expressed as the intensity of the free field, measured prior to the insertion of the observer. Similar data are presented for binaural hearing, over the range from 60 to 15,000 c.p.s., obtained with 13 observers. At 1000 c.p.s. the average M.A.F. observed is 1.9×10^{-16} watts per cm.^{2}, corresponding to a pressure 71 db below 1 bar. Included are data showing how the M.A.F. varies with the observer's azimuth relative to the wave front. Another type of threshold data refers to minimum audible pressures (M.A.P.) as measured at the observer's ear drum. The differences obviously to be expected between M.A.F. and M.A.P. values are due to wave motion in the ear canal and to diffraction caused by the head. The M.A.F. data are discussed in relation to the M.A.P. determinations from several sources. Some possible causes of difference between the two, which are due to experimental procedure and may add to the causes already mentioned, are pointed out.

Naturally-Occurring Ash Constituents of Cotton.[5] A. C. WALKER and M. H. QUELL. Precise information on the inorganic ash constituents which are deposited in cotton fibres during growth, and on the changes which occur in these constituents when cotton is washed with distilled water or aqueous solutions, is desirable as an aid in understanding many of the properties of this important industrial fibre. In a

[4] *Jour. Acous. Soc. Amer.*, April, 1933.
[5] *Journal of the Textile Institute*, March, 1933.

previous paper reference was made to laboratory experiments in which raw (untreated) cotton was washed with distilled water and various aqueous solutions, and sufficient analytical data were given to show the effects of changes in the ash constituents upon the electrical properties of the cotton.

It is the purpose of this paper to present a discussion of the analytical data obtained in these experiments, together with a possible distribution of the ash constituents as salts occurring in the raw cotton. This distribution is based upon a somewhat unusual consideration of the analytical data. It will be shown that ionic interchange occurs when cotton is washed in aqueous salt solutions, the principal effect being the replacement of Mg^{++} in the cotton by Ca^{++} from $CaSO_4$ solutions used in washing, or the reverse if the solutions are $MgSO_4$. Although these analytical data were secured in an investigation of the electrical properties of cotton, they are the subject of a more general discussion in this paper, since it is possible that they may be of service in the study of other properties of cotton or other forms of cellulose.

Influence of Ash Constituents on the Electrical Conduction of Cotton.[6] A. C. WALKER and M. H. QUELL. It has been shown that the electrical properties of textiles, such as cotton, silk, wool, and cellulose acetate silk, depend to a remarkable extent upon their moisture contents and chemical compositions. In addition, these properties have been considered to depend upon water-soluble, electrolytic impurities present in the fibres, since the insulation resistance of untreated cotton has been improved very greatly by water washing.

Evidence will be presented in this paper to show that the improvement in d-c. insulation resistance of cotton, secured by washing, is accompanied by a reduction in the inorganic ash content from about 1 per cent of the dry cotton weight to a value generally less than 0.3 per cent. Data will be given to show that the water-soluble salts present in raw cotton, which constitute about 70 per cent of the ash weight, are principally potassium and sodium salts, and their removal by washing is accompanied by an improvement of between 50 and 100 fold in the insulation resistance. Since these salts are largely inorganic electrolytes, this improvement in resistance is termed *electrolytic*. A *total* improvement of between 150 and 200 fold can be secured if the washed cotton is dried under certain conditions. The difference between *electrolytic* and *total* improvement is due to changes in the moisture-adsorbing properties of the textile resulting from the manner of drying, and this difference, largely reversible by subsequent ex-

[6] *Journal of the Textile Institute*, March, 1933.

posure of the cotton to high atmospheric humidities, is termed *transient* improvement.

The effects of ash constituents, other than Na and K, on the insulating properties of cotton are small, and these effects are difficult to evaluate, since they are masked by the effect of atmospheric humidity.

In this investigation, primary consideration has been given to cotton since it is the most economical material available for use in telephone apparatus insulation, and the improvements in electrical properties secured by water-washing have led to its substitution for silk to a large extent in the telephone industry.