

Abstracts of Technical Articles From Bell System Sources

*Reciprocal Theorems in Radio Communication.*¹ JOHN R. CARSON. Two reciprocal theorems, the generalized Rayleigh theorem and the Sommerfeld-Pfrang theorem, are of great theoretical importance in radio communication. A careful analysis of these theorems and their mathematical derivations shows that they are quite distinct and their practical fields of application different. In particular it shows that the Sommerfeld-Pfrang theorem labors under restrictions, implicit in its mathematical derivation, which seriously limit its field of practical applicability.

*Telephone Circuits for Program Transmission.*² F. A. COWAN. Systems of telephone circuits which are extensively used in the transmission of programs to broadcasting stations are described in this paper. Certain stages in the development of these networks are considered and the general requirements for satisfactory transmission at the present time are enumerated. The arrangements of the networks as well as the procedures used in setting up and maintaining them are discussed.

*Correlation of Directional Observations of Atmospheric with Weather Phenomena.*³ S. W. DEAN. This paper analyzes some data on the direction of arrival of static at Houlton, Maine, obtained by means of a recorder and a cathode ray radio direction finder; and points out that in certain cases there is a relation between the direction of static and the location of storm centers. Two cases are discussed in which day by day bearings showed static sources in the direction of moving storm centers.

*A Direct-Current Amplifier for Measuring Small Currents.*⁴ J. M. EGLIN. A direct-current amplifier consisting essentially of a Wheatstone bridge, having the amplifying tube in one arm and a balancing tube in another, has been described by P. I. Wold and by C. E. Wynn-Williams. This circuit has now been developed to give a constant amplification for currents in either direction up to 10,000 times the lowest measurable value. The amplification and the lowest

¹ *Proceedings of the Institute of Radio Engineers*, Vol. 10, June, 1929, pp. 952-956.

² *A. I. E. E. Journal*, July, 1929, pp. 538-542 (abridgment).

³ *Proceedings of the Institute of Radio Engineers*, Vol. 17, July, 1929, pp. 1185-1191.

⁴ *Journal of the Optical Society of America and Review of Scientific Instruments*, Vol. 18, May, 1929, pp. 393-402.

measurable current are alterable together by changing the resistance introduced between the grid and filament of the amplifying tube. With tubes of high insulation, the amplification can be made as large as 10^6 ; and the measurable current as low as 10^{-14} ampere. Some improvements of the circuit are: (1) the insertion of a resistance in series with the tube in one arm of the bridge to "compensate" for variations in plate and grid battery voltages; (2) the suspension of the tubes to protect them from mechanical vibrations; (3) the use of tubes with pure tungsten filaments to avoid changes in contact potentials, and with plates enclosing the filaments completely to lower the effects of wall charges. In a "null" method of using the circuit the values of the grid resistance and an auxiliary potential introduced in the grid-filament circuit are sufficient to determine the measured current.

*Meeting Long Distance Telephone Problems.*⁵ H. R. FRITZ and H. P. LAWTHOR, JR. There have been written many papers describing various technical and apparatus developments of value in providing long distance telephone service. Several papers have also appeared covering specific transmission or operating problems, or dealing with the advance planning of the telephone plant. Feeling that it might be of interest, particularly to the young engineering graduates, the writers have prepared this over-all sketch of the general problem of actually providing, year by year, the extensions and additions to a comprehensive network of communication channels necessary to keep pace with a growing public demand for long distance service. Since the writers are most familiar with the area served by the Southwestern Bell Telephone Company, the discussion is restricted to that territory.

*Some Measurements on the Directional Distribution of Static.*⁶ A. E. HARPER. The utility of directional data on static is shown, and two types of apparatus devised for such a directional investigation are compared. It is shown that a method which gives the direction of individual crashes is superior to integrating methods. The distribution of thunderstorms over the world is discussed, and comparisons are drawn between this distribution and the observed directional distribution of static. Probable geographical locations are assigned to the sources, based upon thunderstorm data and directional observations.

⁵ *A. I. E. E. Journal*, July, 1929, pp. 547-550 (abridgment).

⁶ *Proceedings of the Institute of Radio Engineers*, Vol. 17, July, 1929, pp. 1214-1224.

*Maximum Excursion of the Photoelectric Long Wave Limit of the Alkali Metals.*⁷ HERBERT E. IVES and A. R. OLPIN. Earlier experiments have shown that the long wave limit of photoelectric action in the case of thin films of the alkali metals varies with the thickness of the film. A maximum value is attained greater than that for the metal in bulk, which for the majority of the alkali metals lies in the infra-red. The wave-length of the maximum excursion of the long wave limit was first studied for Na, K, Rb and Cs. In each case it was found to coincide with the first line of the principal series, i.e., the resonance potential. If this relation holds for lithium, its maximum long wave limit should be greater than that of sodium. This was tested and confirmed by experiments in which red-sensitive lithium films were prepared, sensitive to 0.6708μ . It is suggested that photoelectric emission is caused when sufficient energy is given to the atom, to produce its first stage of excitation. The identity of photoelectric and thermionic work functions suggests that atomic excitation is the initial process in thermionic emission as well.

*Magnetic Testing Furnace for Toroidal Cores.*⁸ G. A. KELSALL. When making magnetic tests at high temperatures trouble is often experienced in maintaining the insulation between turns of the magnetizing and exploring windings and between the windings and the test sample.

This paper describes a magnetic testing furnace for toroidal specimens which eliminates these difficulties. By means of this furnace the test sample may be passed through a definite temperature cycle and the variation in magnetization for a constant magnetizing force determined or the temperature may be held constant while measurements are made for the B-H curve or for a hysteresis loop.

*Electrical Wave Analyzers for Power and Telephone Systems.*⁹ R. G. MCCURDY and P. W. BLYE. This paper describes two types of electrical analyzers which have been developed for the direct measurement of harmonic components of voltage and current on power and telephone systems. These devices are assembled mechanically in a form suitable for use either in the laboratory or in the field. Both instruments, which differ chiefly with respect to sensitivity and input circuit arrangement, employ multistage vacuum tube amplifiers and two duplicate interstage selective circuits.

⁷ *Physical Review*, Vol. 34, July 1, 1929, pp. 117-128.

⁸ *Journal of the Optical Society of America and Review of Scientific Instruments*, Vol. 19, July, 1929, pp. 47-49.

⁹ *A. I. E. E. Journal*, Vol. 48, June, 1929, pp. 461-464 (abridgment).

The power circuit analyzer is designed to measure harmonic voltages in the frequency range from 75 to 3000 cycles and over a voltage range from 0.5 millivolt to 50 volts. The telephone circuit analyzer operates over the same frequency range and measures harmonic currents as low as 0.05 microampere and voltages as small as 0.005 millivolt. Both analyzers are adapted to measure small harmonic voltages and currents in the presence of the fundamental component and other harmonics relatively large in magnitude.

A number of devices are described which have been adopted for eliminating various sources of error. The paper presents in detail the characteristics of both instruments with respect to selectivity, sensitivity, linearity, balance of input with respect to ground, generation of harmonics, and susceptibility to stray fields.

*Solution to a Problem in Diffusion in Employing a Non-Orthogonal Sine Series.*¹⁰ R. L. PEEK, JR. In this paper there are developed the equations applicable to diffusion through a membrane between a chamber in which a constant pressure of the diffusing material is maintained and a second closed chamber, initially evacuated, into which the material diffuses. Assuming Fick's law to apply, a solution is obtained in the form of an infinite series of a type similar to those applying to other problems in diffusion. The sine series to which the solution reduces at zero time is non-orthogonal, but it is shown that by a modification of Fourier's method the coefficients of the terms may be directly determined. There is included a proof of the convergence of the series considered.

*Telephone Transmission Networks.*¹¹ *Types and Problems of Design.* T. E. SHEA and C. E. LANE. In this paper is given a brief résumé of the nature of telephonic signals showing how the qualities of wave composition which distinguish signals from other electrical waves set the requirements on networks and provide a basis for their design. The principal functions of wave filters, equalizers, telephone transformers, line balancing networks, and artificial lines are outlined. In order that these networks may be used in conjunction with other apparatus in the telephone system they must provide efficient transmission, low distortion, good impedance balance, stoppage of longitudinal currents, stable characteristics with current variations, low external coupling, and low reflection coefficient. In addition to these

¹⁰ *Annals of Math.*, 2d Series, Vol. 30, April, 1929, pp. 265-269.

¹¹ Presented at the Regional Meeting of the South West District No. 7, of the A. I. E. E., Dallas, Texas, May 7-9, 1929. Abridgment in *A. I. E. E. Journal* of August, 1929, pp. 624-628.

requirements the network must not cross-talk into associated circuits and must have desirable impedance characteristics in the attenuation range of frequencies as well as throughout the transmission range. An illustration of the use of transmission networks in a typical three-channel carrier telephone system is given describing the functions of the line filter sets, the directional filter sets, band filters, and equalizers. Some of the engineering limitations on the design and construction of networks are discussed.

*Recent Developments in Telephone Construction Practices.*¹² B. S. WAGNER and A. C. BURROWAY. In this paper are described some recent developments in telephone cable installation and maintenance practices. The paper is divided into three sections: (1) Gas pressure testing for detecting and locating sheath defects before they result in failure. (2) Methods for reducing bowing and other movements of cable which in time cause fracture of the sheath. (3) Catenary construction for long spans, such as at river crossings.

¹² *A. I. E. E. Journal*, Vol. 48, May, 1929, pp. 366-369 (abridgment).