

Abstracts of Technical Articles from Bell System Sources

*The Manufacture of Rubber-Covered Wires for Telephone Installations.*¹ S. E. BRILLHART. Rubber-insulated wires are extensively used by the telephone companies in connecting up apparatus and equipment which is exposed to varying climatic conditions in the same fashion in which rubber-covered wires are employed by other electrical industries. In order to meet all size, strength, and electrical requirements the various wires available for use must differ widely from one another and from commercial rubber-insulated wires, in the character of insulation with which they are covered, as well as the properties of the conductors.

At one extreme this diverse group includes wires for such use as telephone drops which extend from the cable terminals to the buildings in which the stations are located. These drop wires must be capable of carrying heavy snow and ice loads in winter and also be able to withstand exposure to summer heat and strong sunlight in hot climates. They are Nos. 14 and 17 B. & S. gauge hard-drawn copper and bronze conductors with insulations of relatively high quality containing more than 30 per cent of rubber and covered with a weatherproofed cotton braid. At the other end the group contains wires for connecting up instruments within buildings. Being supported frequently and protected from exposure, they are made from No. 22 gauge conductors, insulated with a thinner wall and covered with a colored glazed cotton braid.

A plant is located at the Point Breeze Works, Baltimore, in which certain unique methods and departures from conventional methods of manufacturing rubber-covered wires have been reduced to practice on a large scale. This paper purposes to describe the plant.

*Some Recent Developments in Underground Conduit Construction in the Bell System.*² A. L. FOX. In the past the type of joint made by trowelling cement mortar around the abutting ends of multiple clay conduit has not been entirely satisfactory because in some cases it permitted infiltration of sand and silt which obstructed the ducts.

Various types of joints have been investigated, including a modified

¹ *Mech. Engg.*, June, 1932.

² *Bell Telephone Quarterly*, July, 1932.

form of the old trowelled joint, cement mortar collars molded in place, and joints made with different plastic materials such as asphalt compounds spread on a fabric backing to facilitate application and retention. None of these provided the tight seal desired.

A satisfactory joint has been developed by encasing the junction in a mortar bandage consisting of a wide band of cement mortar enclosed in cheese-cloth and held tightly against the conduit by tapes passing completely around the joint and secured on top. A separate strip of cheese-cloth is imbedded in the center of the mortar to prevent slumping. With cement mortar of proper consistency and an admixture to insure the desired plasticity sufficient cement paste comes through on the inside when the bandage is applied to provide a tight bond. A strip of paper placed in the bandage under the cheese-cloth in the outer side helps to distribute the pressure of the tying tapes and assists in retaining water in the mortar thereby aiding the hardening and increasing the strength of the joint.

The results of hydrostatic tests of these joints show that they are practically watertight. Their use is expected to effect savings in conduit construction since their high strength permits in many cases omission of the concrete base and further savings may accrue through the increased speed with which conduit can be laid and joined and the fact that the trench can be back-filled immediately without danger of injuring the joints. Other savings in the labor of rodding ducts will be realized because the new type of joint is siltproof.

*The Depth of Origin of Photoelectrons.*³ HERBERT E. IVES and H. B. BRIGGS. Previous work has shown that the photoelectrons from a silver plate covered with an equilibrium film of alkali metal follow the wave-length distribution of energy just above the silver surface, i.e., in the alkali metal. This question has been further investigated with particular references to alkali metal films in their early stages of development, where their average depth is less than one atom. Computations made on the absorption of light just within the silver surface show that there should be very definite and striking differences in the wave-length distribution of photoemission if emission occurs due to light absorption in the silver, as contrasted with emission from a film on the silver. Experimental tests made with sodium and caesium films show that in the earliest measurable state the emission exhibits characteristics peculiar to the light absorption in silver, and that as the films build up the emission becomes characteristic of the energy above the silver. It is concluded that the photoelectrons originate

³ *Phys. Rev.*, June 1, 1932.

partly in the underlying metal and partly in the alkali metal film, the relative proportions varying with the film thickness.

*The Lapel Microphone and Its Application to Public Address and Announcing Systems.*⁴ W. C. JONES and D. T. BELL. Many speakers find it difficult to use the conventional type of microphone, because of the restrictions that it imposes upon their freedom of movement. A microphone, known as the lapel microphone, designed to be attached to the speaker's clothing, has been developed for overcoming these limitations.

The vibratory structure of the lapel microphone is designed to have low mass and stiffness, and to resonate at a comparatively high frequency. The resilient support of the diaphragm adds sufficient mechanical resistance to prevent the occurrence of a prominent peak in the response at the resonance frequency. Means are provided for reducing extraneous noise to a minimum. A part of the sound reaching the microphone, due to body vibration, is rich in low frequencies and must be attenuated, otherwise the quality of transmission will be unnatural. This attenuation is accomplished in the coupling transformer, which, together with the apparatus required for suppressing clicks, for indicating when the circuit is in operation, etc., is mounted in a control cabinet. A flexible cord connects the microphone to this cabinet.

It is expected that the lapel microphone will find application in theaters, churches, convention halls, lecture and banquet rooms, and the like, where public address systems are now employed. It also can be applied in connection with other sound recording and reproducing equipment where the background noise, characteristic of carbon microphones, is not a limiting factor.

*Vacuum Tube and Photoelectric Tube Developments for Sound Picture Systems.*⁵ M. J. KELLY. This paper reviews some recent vacuum tube and photoelectric cell developments which are of interest in sound recording and reproduction systems. An indirectly heated cathode triode is described, in the output circuit of which the current components due to the a-c. power supply of the heater have been reduced approximately 20 decibels below previously obtained levels. This tube makes it possible to use an a-c. supply in amplifiers having flat frequency characteristics with over-all gains of the order of 100 decibels. The microphonic disturbances in vacuum tubes are discussed. A measuring system for evaluating the microphonic noise

⁴ *Jour. S.M.P.E.*, September, 1932.

⁵ *Jour. S.M.P.E.*, June, 1932.

currents is described, and the characteristics of a filamentary cathode tube of low microphonic noise level are given. The characteristics of a double anode, thermionic, gas-filled, rectifier tube for use in a d-c. power supply unit for the sound lamp and vacuum tube filaments of reproducing systems are given. A photoelectric cell of high sensitivity for use in sound reproduction work is described.

*Analysis and Reduction of Output Disturbances Resulting from the Alternating-Current Operation of the Heaters of Indirectly Heated Cathode Triodes.*⁶ J. O. MCNALLY. This paper discusses the disturbance currents in the output circuits of indirectly heated cathode triodes, introduced by the use of alternating current in the heaters. It indicates that the disturbance currents are introduced into the output circuit by (1) the electric field of the heater, (2) the magnetic field of the heater current, and (3) the resistance between heater and grid and between heater and plate, and the capacitance between heater and grid and heater and plate.

The outputs due to the electric field between cathode and plate are produced by the "grid" action of the heater and heater leads. The frequency of the output is chiefly that of the heater supply. The outputs are shown to be effectively reduced by electrostatically shielding the heater.

Disturbance currents of the frequency of the heater supply, and of double this frequency are shown to be produced by the magnetic field. The double-frequency component is shown experimentally to be proportional to the square of the heater current. The following means of reducing the magnetic field are discussed: (1) the adoption of a heater geometry which produces a smaller field in the space between the cathode and the plate, (2) the use of a magnetic shield around the heater system, and (3) the use of a lower current, higher voltage heater.

The ways in which disturbance currents are introduced by leakage resistances and capacitances between heater and grid and heater and plate are indicated, and experimental verification is given for the case of resistance between the grid and heater.

Use has been made of this disturbance current analysis in the development of an extremely low disturbance output tube, which is described.

*Fourier Series in Three Dimensions.*⁷ W. O. PENNELL. The classical Fourier Series represents a function in a given interval and then repeats the same values in the next and subsequent intervals. In

⁶ *Proc. I.R.E.*, August, 1932.

⁷ *Am. Math. Monthly*, May, 1932.

other words if $S(x)$ is the classical Fourier Series representing $f(x)$ in the interval $0 < x < a$ then $S(x) = f(x - na)$ where n takes on the values $n = 0, \pm 1, \pm 2, \dots$ corresponding to the various intervals $na < x < (n + 1)a$.

The author has shown how a generalized Fourier Series $S_1(x)$ may be obtained representing a function in the intervals $na < x < (n + 1)a$ as follows:

$$S_1(x) = b^n f(x - na),$$

where n takes on the values $n = 0, \pm 1, \pm 2, \dots$, and b is any real constant.

In this paper is described a still more general Fourier Series $S_{11}(x)$ representing a function in the intervals $na < x < (n + 1)a$ as follows:

$$S_{11}(x) = [b^n f(x - na)]n\psi,$$

where corresponding to the above intervals n takes on the values $n = 0, \pm 1, \pm 2, \dots$, b is any real constant, and the subponent notation $n\psi$ denotes the rotation of the plane of the curve about the X axis through an angle $n\psi$ with the XY plane.

Current Propagation in Electric Railway Propulsion Systems. JOHN RIORDAN.⁸ This paper presents a systematic method of attack, based on the superposition theorem on the problems of electric railway propulsion systems arising from the presence of tracks and other leaky conductors. The treatment is limited to systems in which the tracks and other leaky conductors may be represented with sufficient accuracy by a single conductor, but includes series and shunt discontinuities in this equivalent conductor. The general equations of current propagation in a single conductor in the presence of a conductor carrying a fixed current are taken in a form similar to the transmission equations ordinarily employed for power transmission and telephone lines, apparently due to H. Pleijel, Report to Swedish Royal Railway Administration, 1919. Though these equations are not rigorous they have been found to agree with experimental observations within engineering accuracy.

The starting point of the treatment is the development of the properties of a basic circuit consisting of a straight conductor of finite length connected at its terminals to a parallel leaky conductor or track which is continuous and infinite. The circuit involves the greatest degree of continuity in the track, subject to the connection of other

⁸ Presented at the A.I.E.E. Summer Convention, Cleveland, Ohio, June 20-24, 1932. To be published in *A.I.E.E. Transactions*.

conductors, since the only discontinuities are those involved in the connection of the conductor to the track; it is also conveniently adapted to modifications for discontinuities. The general single series discontinuity is a fundamental point of departure in the treatment of such apparatus as track booster transformers. The basic circuit modified by discontinuities as required gives directly the propulsion circuit impedances needed in the railway network impedance diagram; it may also be employed in the construction of a particular kind of cumulative induction curve for neighboring communication lines, which takes into account the distribution of current along the track.

The method of building up complex propulsion systems from basic circuits is illustrated by examples chosen for their practical importance, but the paper does not give detailed procedure for engineering application of the method and its results.

*Kennelly-Heaviside Layer Studies Employing a Rapid Method of Virtual-Height Determination.*⁹ J. P. SCHAFER and W. M. GOODALL. This paper describes a new method of determining the virtual height of the ionized regions by visual observations of the received pulse pattern on a cathode ray oscillograph tube, both for single frequencies and for two frequencies simultaneously. A résumé of the data obtained during observations of some three hundred hours is given. The frequencies used for these tests were 1604 kc, 2398 kc, 3256 kc, 4795 kc, and 6425 kc. A number of the tests included measurements made upon two frequencies in rapid rotation. The more important results may be summarized as follows:

1. On a large number of occasions during the night, a phenomenon has been observed apparently indicating an increase in the density of ionization in the lower layer. This is important because the ionization is usually assumed to decrease during the night hours.
2. Reflections are often observed simultaneously from both ionized layers. An explanation of this phenomenon is given.
3. The virtual heights of the reflecting layers are rarely duplicated from day to day for a given time and frequency.
4. Large numbers of multiple reflections are frequently obtained representing a path distance of over 5000 km. for the last reflection. This fact indicates that the multiple-hop mode of propagation is probable for long-distance transmission.

*The Principles of the Light Valve.*¹⁰ T. E. SHEA, W. HERRIOTT, and W. R. GOEHNER. The light valve has been used very widely as the

⁹ *Proc. I.R.E.*, July, 1932.

¹⁰ *Jour. S.M.P.E.*, June, 1932.

modulating device in systems of film sound recording. In this paper the principles of operation of the light valve are discussed, and those engineering factors which prescribe limitations on performance and indicate operating advantages are described in detail. The type of distortion which results when a light valve is overloaded is depicted both for single-plane and two-plane valves. Finally, a new type of light valve having advantages from the standpoints of weight, size, and stability of operation is described.

*Economic Control of Quality of Manufactured Product.*¹¹ W. A. SHEWHART. This book of 501 pages is an exposition of the technique developed within the Bell Telephone System for securing economic control of quality of manufactured product at every stage in the process of fabrication all the way from raw materials to finished product. It is divided into seven parts, the first of which is devoted to a general survey of the characteristics of a controlled quality, the scientific basis for attaining control, and the economic advantages to be derived. In the second part, after a definition of what is meant by quality, the methods of presenting data are discussed in detail, both graphically and by means of statistics such as the average, standard deviation, skewness, flatness, and correlation coefficient. Part III presents the necessary and sufficient conditions for the specification of a controlled quality. The allowable sampling fluctuations in statistics are indicated in the next part, illustrated by experiments made under conditions known to be controlled. This part constitutes a survey of the present status of sampling theory. Part V takes up the problem of specifying standard quality and indicates the important changes that should be made in many kinds of specifications in order to secure the greatest assurance of uniform quality at minimum cost. Five practical criteria for determining whether or not the quality under consideration differs from standard by more than an amount that should be left to chance are presented in Part VI. In Part VII, after a summary of the fundamental principles, consideration is given to the problem of sampling, and finally a control program is presented which shows the relation of control to research, design, development, production, and purchasing. Several appendices give the original experimental data on which some of this work was based and a bibliography. Throughout the book the fundamental principles are amply illustrated by practical examples.

¹¹ Published by D. Van Nostrand Company, New York, 1931.