Abstracts of Technical Articles from Bell System Sources

A New High Vacuum System.[1] J. A. BECKER and E. K. JAYCOX. A new high vacuum pumping system is described in which oil is used in a diffusion type pump, and a trap containing activated cocoanut charcoal replaces the usual liquid air trap. The system is capable of attaining a pressure of 2×10^{-8} mm. Hg. A high degree of vacuum can be attained at least as quickly as with a mercury diffusion pump and liquid air trap. The system is especially adapted to maintaining a low pressure for several days in apparatus which cannot conveniently be sealed off from the pumps.

Phenomena in Oxide Coated Filaments II. Origin of Enhanced Emission.[2] J. A. BECKER and R. W. SEARS. Various theories have been advanced regarding the mechanism of emission of electrons from oxide coated filaments. These theories postulate that: (1) the active layer is (*a*) at the outer oxide surface, (*b*) at the core-oxide interface; (2) the thermionic electrons come from (*a*) the adsorbed barium, (*b*) the oxide just underneath the adsorbed layer; (3) the current is carried through the oxide coating by (*a*) an entirely electrolytic process, (*b*) thermionic electrons which come from the core, diffuse through the pores of the coating and form a space charge therein, (*c*) electrolytic conduction through the oxide crystals and thermionic conduction between crystals, (*d*) electronic conduction, a small portion being carried by ions. A number of experiments were designed to test these various hypotheses. These experiments show that: (1) When barium is brought to the outer surface of the oxide, either by electrolysis or evaporation from an external source, the emission increases at first, passes through a maximum and then decreases. This change in activity is similar to that for barium on tungsten. (2) When oxygen is brought to the surface of the oxide of an activated filament, the activity decreases rapidly at first and then more slowly. (3) In these two respects, a filament with a core made of an alloy called "Konel" and consisting of nickel, cobalt, iron and titanium acts just like filaments with other cores. (4) When the oxide was stripped from a Konel core filament, the activity decreased by a factor of 6000. (5) The emission-limited current is independent of the area of the core

[1] *Rev. Sci. Instruments*, December, 1931.
[2] *Phys. Rev.*, December 15, 1931.

provided that the area of the outer oxide surface remains constant. (6) The conductivity of the oxide varies with the time of sending current through the oxide. (7) The conduction current in the oxide obeys Ohm's law and does not saturate even though its value is hundreds of times larger than the saturated emission. (8) The oxide acquires a positive potential with respect to the core regardless of whether the space current is limited by space charge or by emission. This potential varies linearly with the space current drawn to the plate and is of the order of a few tenths of a volt. (9) The emission for the optimum amount of barium on the oxide surface depends upon the previous treatment of the oxide. From these results we conclude that: (1) The active layer is at the outer oxide surface. The activity depends on the concentration of barium and oxygen on this surface and also upon the amount of metallic barium dispersed through the oxide. The core material does not directly affect the emission but it does greatly affect the ease with which free barium is produced by heat treatment or electrolysis. (2) The thermionic electrons originate in the oxide just underneath the adsorbed barium. (3) Most of the current through the oxide is conducted by electrons, a small portion being carried by barium and oxygen ions.

Barkhausen Effect: Orientation of Magnetization in Elementary Domains.[3] RICHARD M. BOZORTH. Brief mention is made of previously published work on the nature of the discontinuities in magnetization discovered by Barkhausen in 1919. Including the recent results described in this note, the experimental data now indicate that changes in the magnetization of ferromagnetic materials occur in the following way: The material is composed of small regions or "elementary domains" (of the order of 10^{-8} cm.^{3}), each of which is generally magnetized to saturation in a different direction. As the strength of the applied magnetic field increases, the magnetization in some of the domains changes suddenly from saturation in one direction to saturation in another direction associated with less potential energy. The change in each domain gives rise to a single click in the telephone receiver which terminates the apparatus usually used to observe the effect. In annealed materials in which the crystal grains are much larger than the domains, the direction of magnetization within each domain depends on the orientation of the crystal grain in which it is situated, and coincides with its direction of easy magnetization as determined by separate experiments on large single crystals.

[3] *Phys. Rev.*, January 15, 1932.

The Rapid Record Oscillograph in Sound Picture Studies.[4] A. M. CURTIS, T. E. SHEA, and C. H. RUMPEL. This paper describes a special oscillograph which was designed for making rapid records in sound picture studies. The oscillograph is briefly described, and illustrations are presented of records obtained in making the following studies: microphonic action of vacuum tubes; noise levels in amplifiers; investigations on rectifiers; studies on light valve clash; action of the biasing current of light valves as used in noiseless recording by the variable density method; acoustical studies showing the rise and decay of transients; loud speaker selection with regard to load carrying capacity and mechanical flutter investigations of reproducer sets.

Vertical Sound Records—Recent Fundamental Advances in Mechanical Records on "Wax." [5] H. A. FREDERICK. This paper describes recent progress which has been made in laboratory studies of mechanical records of sound cut on a wax disk. Both theoretical and experimental investigations indicate that a phonograph record, cut with vertical undulations instead of the more usual lateral undulations possesses fundamental advantages. The principal improvement comes from a marked increase in the volume and frequency range over which faithful reproduction may be obtained. A higher volume level can be recorded for the same groove spacing and speed. More playing time can be provided with a given size of record and volume level since, for these conditions, both the groove spacing and speed may be reduced. Improvements in methods of processing the stampers and in the record material give a large reduction in surface noise and hence a corresponding increase in the volume range. With these improvements the frequency range which can be reproduced satisfactorily can be extended nearly an octave to 8000 to 10,000 cycles. Other improvements incidental to the improvements noted above are great improvement in the quality of reproduction obtainable directly from a soft "wax" record and a great extension in the life of the hard record.

Effect of Shore Station Location Upon Signals.[6] R. A. HEISING. Experiments are described for ascertaining the attenuation suffered by the unreflected wave in traversing relatively small amounts of land between the seashore and hypothetical inland sites. The results show 8 to 12 db attenuation for 1 mile inland with greater attenuation thereafter for unfavorable terrain. Swampy ground produces small attenuation. The classical theory of wave transmission past a straight

[4] *Jour. S. M. P. E.*, January, 1932.
[5] *Jour. S. M. P. E.*, February, 1932.
[6] *Proc. I. R. E.*, January, 1932.

edge used in optics is applied to explain the reduction. Coexisting phenomena are mentioned.

Oxidation Studies of Rubber, Gutta-Percha, and Balata Hydrocarbons.[7] A. R. KEMP, W. S. BISHOP, and P. A. LASSELLE. The oxidation mechanism of rubber and gutta-percha hydrocarbons has been studied. Rubber hydrocarbon in sheet form oxidizes more slowly and less completely than precipitated gutta-percha, which is believed to be due to the smaller surface exposure of the former material. Gutta-percha hydrocarbon in finely divided form oxidizes to a fairly definite degree in oxygen at room temperature, corresponding to a weight increase of about 38 per cent. The length of the autocatalytic induction periods for rubber and gutta-percha varies over a wide range and is shortened by heating the hydrocarbon in high vacuum before oxidation and by exposure to light.

The rate of oxidation of gutta-percha in air, as compared with oxygen, is reduced in proportion to the oxygen concentration, and the induction period is correspondingly increased.

Carbon dioxide, water, formic acid, and formaldehyde are identified in the volatile oxidation products, and their relative amounts determined. Six to eight per cent of the hydrocarbons are converted to volatile oxidation products. The percentage unsaturation of both rubber and gutta-percha hydrocarbons is reduced in proportion to oxygen absorbed. The ratio of hydrogen to carbon decreases as a result of oxidation.

The solid oxidized products are of such a nature that they cannot be resolved into crystalline materials. They are amorphous acid substances, free from aldehyde and ketone groups. They contain a small amount of peroxides; and the acidity, saponification value, and other properties indicate that most of the oxygen is combined in the form of hydroxyl, carboxyl, and lactonic groups. The mechanism of oxidation of rubber and gutta-percha appears to be the same, and the possibility of a chain mechanism to explain the facts is discussed.

Modern Developments in Precision Clocks.[8] A. L. LOOMIS and W. A. MARRISON. A discussion of precision clock requirements is given in terms of the general equations of motion of an oscillator and extended specifically to the gravity pendulum and the crystal oscillator types.

One of the largest sources of error in pendulum clocks is due to

[7] *Ind. and Engg. Chem.*, December, 1931.

[8] Presented at A. I. E. E. Midwinter Convention, Jan. 25–29, 1932, New York, N. Y., as a part of the Symposium on Time and Time Services. To be published in full as *Monograph B-656, Bell Telephone System Technical Publications*, and available upon request to Bell Telephone Laboratories, New York, N. Y.

variations in amplitude. The amount of this effect is given, and the usual methods for reducing it by keeping the pendulum swing small are discussed. A method which is being used successfully by Mr. Loomis for controlling the amplitude at a fixed value is described.

The effect of atmospheric pressure on the rate is discussed and it is shown that the four chief rate controlling factors involved can be made to annul each other at a critical pressure for a given pendulum.

Factors that affect the length of a pendulum, such as temperature coefficient of the material, aging, etc., and some factors that affect the restoring forces, are discussed since they affect the period directly.

The effect of the phase of applied driving force in an oscillator is also an important factor. In the case of a pendulum the impulse should be delivered at the instant when the velocity is maximum, that is, at the center of the swing. If it is applied earlier, the rate is momentarily increased, and conversely.

A brief description is given of the Shortt clock, which has established an enviable record for timekeeping in some of the world's outstanding time observatories. The installation of three of these clocks in The Loomis Laboratory at Tuxedo Park, N. Y. is described and illustrated.

The crystal clocks used in Bell Telephone Laboratories, N. Y. City, are described briefly, as well as some of the outstanding features of their use. These "oscillators" were built primarily as a precise standard of frequency, but have been found in addition to serve exceedingly well as timekeepers.

Performance data are given for the crystal clocks, for the three Shortt clocks in The Loomis Laboratory, and for clocks in a number of representative national time observatories.

In addition a brief account is given of a continuous comparison which is being made between the crystal clocks in Bell Telephone Laboratories and the Shortt clocks in The Loomis Laboratory.

The Nature of Metals in Relation to their Properties.[9] EARLE E. SCHUMACHER. The methods of extracting metals from their ores and fabricating them constituted the art of metallurgy in the older sense, an art whose development has closely paralleled the rise of civilization. The modern science of metallurgy, on the other hand, concerns itself to a large extent with the explanation as to why metals behave as they do and in particular why the methods employed in the art produce the effects they do. This science, as distinct from the art, is of comparatively recent origin. It is, indeed, only since the development of the tools used in modern research, notably the microscope and x-ray,

[9] *Scientific Monthly*, January, 1932.

that important steps have been made toward the analysis of metallic structure. Rapid progress has been made in the last twenty years and today there is available a vast fund of information in regard to the nature of metals in relation to their properties.

Two of the most important properties of a metal are its hardness and strength. These properties are closely related and in general the magnitude of one indicates the magnitude of the other. The development of the relationship between the nature of a metal and the hardness and strength constitutes one of the most interesting chapters in the science of modern metallurgy.

Noise Measurement.[10] S. K. WOLF and G. T. STANTON. The instrumental measurement of noise presents difficulties that have in the past generally defeated its successful accomplishment. While noise exists in a physical state and certain of its quantities are susceptible to direct measurement, the magnitude of a noise is evaluated through the interpretation of the human ear. The ear is non-linear in its evaluation of the various factors of noise. The degree and nature of the ear's non-linearity to the principal factors is discussed, with respect to the chief interpretative impression, that of loudness.

Audiometric measurements approached a more proper evaluation of noise, but in addition to dependency upon human judgment, were only approximate, and represented comparisons of physiological effects of noise rather than true noise values.

An instrument is described that measures intensity expressed in terms of loudness, evaluated for frequency and duration, and which combines portions of a complex wave shape in a suitable manner. The characteristics of the meter and the ear are compared. The readings are in decibels above a zero reference point near the threshold of audibility. The selection and meaning of this scale is explained. Where it is desired to analyze the pitch or frequency of a noise, an analyzer attachment permits either band or single-frequency analysis. Some limitations in its use in making noise measurements are discussed.

[10] *Jour. S. M. P. E.*, December, 1931.