Abstracts of Technical Articles by Bell System Authors

Two papers by Reverend Thomas Bayes—A facsimile publication from the Philosophical Transactions, Vol. LIII, for the year 1763. This facsimile has been prepared under the direction of W. Edwards Deming, Senior Mathematician of the Bureau of the Census, Washington, from a copy of the Philosophical Transactions in the possession of the Naval Observatory in Washington. An interesting foreword to the volume has been supplied by Edward C. Molina of the Bell Telephone Laboratories. The volume is available at the Department of Agriculture, Washington, D. C., price $1.00.

The Subjective Sharpness of Simulated Television Images.[1] M. W. BALDWIN, JR. Small-sized motion pictures, projected out of focus in simulation of the images reproduced by home television receivers, are used in a statistical study of the appreciation of sharpness. Sharpness, in the subjective sense, is found to increase more and more slowly as the physical resolution of the image is increased. Images of present television grade are shown to be within a region of diminishing return with respect to resolution. Equality of horizontal and vertical resolutions is found to be a very uncritical requirement on the sharpness of an image, especially of a fairly sharp one.

Synchronized Frequency Modulation.[2] W. H. DOHERTY. Probably the foremost practical problem in FM transmitter design is that of stabilization of the mean or carrier frequency. Crystal stability is required, but the direct use of a crystal would necessarily give rise to a conflict between the factors which stabilize the frequency and those which are to produce the desired variation.

In Synchronized Frequency Modulation, which makes its first appearance in the 1000-Watt Western Electric 503A-1 Radio Transmitting Equipment, this problem is solved by associating the crystal indirectly with the system in a monitoring role which ignores the rapid frequency variations due to modulation and responds only to variations in the mean frequency. This is done by taking a sample of the output of the frequency-modulated electric oscillator and shrinking the spectrum down through a succession of frequency dividers to about 1/8,000th of the transmitted carrier frequency. It then consists of a strong central carrier (about 5,000 cycles) with a few degrees of phase modulation. This is then compared with a

[1] *Proc. I.R.E.*, October 1940.
[2] *Pick-Ups*, August 1940.

crystal standard (likewise about 5,000 cycles) in a device which produces a rotating magnetic field at the difference frequency. An armature which follows this field controls the tuning condenser of the original electric oscillator, coming to rest when exact synchronism is attained. The small phase vibrations accompanying modulation are not followed because of the inertia of the system.

The stability thus obtained for the mean frequency is identically that of a crystal oscillator. Since the actual control is mechanical, no sustaining voltage is required, so that failures in the control system do not result in sudden departures in frequency. Mechanical control, moreover, completely relieves the modulating elements of any connection with the stabilization of the mean frequency, so that the modulation range is not restricted. This and other refinements in design permit frequency excursions of hundreds of kilocycles with extremely low distortion.

Ultra-Short-Wave Transmission Over a 39-Mile "Optical" Path.[3] C. R. ENGLUND, A. B. CRAWFORD, and W. W. MUMFORD. Continuous records of ultra-short-wave transmission on wave-lengths of 2 and 4 meters, over a good "optical" path, have shown variations in the received signal strength. These variations can be explained as being due to wave interference; an interference which varies with the changes in the composition of the troposphere.

Some of the variations are due to changes in the dielectric-constant gradient of the atmosphere near the earth. Other variations are explicable in terms of reflections from the discontinuities at the boundaries of different air masses. The diurnal and annual meteorological factors which affect the transmission are discussed.

A Decade of Progress in the Use of Electronic Tubes. Part I—In the Field of Communication.[4] S. B. INGRAM. The dependency of the art of communication on the science of electronics is so great as to make a review of progress in electronics almost of necessity a review of the field of communications itself. While it is true that the early forms of telephone and radio communication advanced to a degree without the use of electronic devices as we know them today, the recognition of the vacuum tube as an amplifier and generator of high-frequency alternating currents in the years just preceding the first World War marked a turning point in the development of the communication art. From that day to this the progress of electronics and communications has gone hand in hand. The need of the communications engineer for new electronic tools has kept him continually

[3] *Proc. I.R.E.*, August 1940.
[4] *Electrical Engineering*, Transactions section, December 1940.

urging the electronics engineer to improve old devices and to originate new ones, and each time the efforts of the latter have been rewarded with success the fruits of his work have been immediately applied to produce new and more startling miracles of long-distance communication.

Because of the close relationship of electronics and communications it is necessary in reviewing the progress of the last decade to keep in mind that it is progress in electronics and not in communications which is our theme. It will be necessary to survey the trends in communications during the period under review, but then it will be necessary to ask to what extent the progress which has been made is due to advances in the electronic field and what advances in the electronic devices themselves have laid the foundation of this progress. There has been no attempt made to make this review comprehensive in the sense that it include all items of progress which are of individual interest. To do so would make it merely a catalog of these many advances and an index to the periodical literature of the subject. Rather the object has been to trace the most significant trends of development in the various fields and to emphasize those lines of advance which appear to be most closely related to the general direction of progress in the several fields of electrical communication.

The Location of Hysteresis Phenomena in Rochelle Salt Crystals.[5] W. P. MASON. Measurements of the elastic properties of an unplated crystal, the piezoelectric constant f_{14}, and the clamped dielectric constant of a Rochelle salt crystal show that practically all hysteresis and dissipation effects are associated with the clamped dielectric properties of the crystal. A theoretical formulation of the equations of a piezoelectric crystal has been made which takes account of the dissipation effects. The formulation is given for the polarization theory. The frequency variation of the clamped dielectric constant when interpreted by Debye's theory of dielectrics, modified to take account of hysteresis losses, indicates that there are two components, one of which has associated with it a high viscous resistance, whereas the other one does not. The non-viscous component has a dielectric constant of about 100 at 0°C and is probably due to the displacement of the ions in the lattice structure. The viscous component has a dielectric constant of about 140 at 0°C and is probably due to the dipoles of the Rochelle salt. Both components have higher dielectric constants and hysteresis between the Curie points indicating a cooperative action of the molecules for both components in this temperature region.

A New Broadcast-Transmitter Circuit Design for Frequency Modulation.[6] J. F. MORRISON. The problem of generating wide-band frequency-modu-

[5] *Phys. Rev.*, October 15, 1940.
[6] *Proc. I.R.E.*, October 1940.

lated waves is first reviewed in order to ascertain specifically the desired performance capabilities for a commercial transmitter circuit. The factors which influence or limit these performance capabilities in the two methods available for the generation of frequency-modulated waves, compensated phase modulation, and direct frequency modulation, are then explored. It is found that each method possesses desirable fundamental characteristics not present in the other, but with the circuits now generally employed with either method the modulation characteristics and carrier frequency stability are interrelated so that one has a limiting effect upon the other.

A new circuit is described in which these two important characteristics are independent of each other. Owing to this independence and to other circuit refinements the modulation capabilities are unrestricted with low distortion over an exceedingly wide range.

A balanced electric oscillator operating at one-eighth the radiated frequency is modulated by balanced reactance-control tubes and negative feedback is used to minimize amplitude modulation and harmonic distortion. A system of *frequency division* is employed together with a crystal-controlled oscillator and synchronous motor in such a manner as to control mechanically the mean frequency of the modulated wave with the same stability as that of the crystal-controlled oscillator. The carrier, or mean, frequency stability is that of a single crystal-controlled oscillator and is independent of any other circuit variations. A carrier frequency stability of 0.0025 per cent is possible without the use of temperature-controlled crystals or apparatus.

Neutron Studies of Order in Fe-Ni Alloys.[7] F. C. Nix, H. G. Beyer and J. R. Dunning. Neutron transmission measurements are used to study order in Fe-Ni alloys. The difference in neutron transmission between fully annealed and quenched alloys when plotted against the nickel content displays a broad peak around Ni_3Fe and falls to vanishingly small values near 35 atomic per cent Ni and pure Ni. The higher the degree of order the greater the neutron transmission. The substitution of 2.3 atomic per cent Mo or 4.1 atomic per cent Cr for Fe in the annealed 78 atomic per cent Fe-Ni alloy caused a decrease in the neutron transmission, relative to the annealed 78 atomic per cent Fe-Ni alloy, of 15.6 and 21.2 per cent, respectively. The cold working of an annealed binary 75 atomic per cent Ni alloy, a treatment known to produce disorder, gave rise to a decrease of 20.6 per cent in neutron transmission. These results demonstrate that neutron techniques serve as a useful tool to study order in Fe-Ni alloys, and suggest that they can be extended to study other solid state phenomena.

[7] *Phys. Rev.*, December 15, 1940.