Abstracts of Bell System Technical Papers* Not Published in This Journal

A Full Automatic Private-Line Teletypewriter Switching System. W. M. BACON[1] and G. A. LOCKE[1]. *Trans. A.I.E.E.*, **70**, Part 1, pp. 473–480, 1951. (Monograph 1837).

This paper describes a full automatic teletypewriter message switching system for use in private-line networks involving one or more switching centers and a multiplicity of local or long-distance lines, each of which may have one or more stations. This system provides fast teletypewriter communication from any station to any other station or group of stations in the network. At its point of origin a message first is perforated in tape accompanied by suitable directing and end-of-message characters, thereafter it is transmitted automatically, stored temporarily in perforated tape at a switching office, and then routed at high speed to its point or points of destination. Important features are the arrangements provided to permit efficient use of long full duplex transmission lines, the full automatic handling of multiple-address messages with only a single originating transmission, and the various guards and alarms which are provided to protect against loss of messages in case of trouble.

Operational Study of a Highway Mobile Telephone System. L. A. DORFF[1]. *Trans. A.I.E.E.*, **70**, Part 1, pp. 31–37, 1951. (Monograph 1838).

The Dynamics of the Middle Ear and Its Relation to the Acuity of Hearing. H. FLETCHER[1]. *J. Acoust. Soc. Am.*, **24**, pp. 129–131, March, 1952.

The transformer action of the middle ear as measured by Bekésy is shown to be the principal cause for the low acuity of hearing for low frequencies. Because of the very low mechanical impedance across the basilar membrane at low frequencies, large acoustical pressures in front of the ear drum produce appreciable acoustical pressures across the basilar membrane. For example, at 100 cps this pressure is thirty times and at 6000 cps it is one-tenth that created across the basilar membrane.

Diffusion of Donor and Acceptor Elements Into Germanium. C. S. FULLER[1]. *Phys. Rev.*, **86**, pp. 136–137, April 1, 1952.

* Certain of these papers are available as Bell System Monographs and may be obtained on request to the Publication Department, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y. For papers available in this form, the monograph number is given in parentheses following the date of publication, and this number should be given in all requests.

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A Submarine Telephone Cable with Submerged Repeaters. J. J. GILBERT[1]. *Trans. A.I.E.E.*, **70**, Part 1, pp. 564–572, 1951. (Monograph 1815).

Physical Structure and Magnetic Anisotropy of Alnico 5. Part I. R. D. HEIDENREICH[1] and E. A. NESBITT[1]. *Jl. Appl. Phys.*, **23**, pp. 352–371, March, 1952. (Monograph 1976).

It is concluded from electron metallographic results that the high coercive force and anisotropy of Alnico 5 are caused by a very finely divided precipitate produced by the permanent magnet heat treatment. This precipitate is a transition structure rich in cobalt and is face-centered cubic with a_0 = 10A and appears as rods growing along the [100] directions of the matrix crystal when no magnetic field is applied during heat treatment. The size of the precipitate rods at optimum properties is approximately 75–100A by 400A long. The spacing between rows of rods is about 200A. The rods are not distinctly resolved in the electron images unless they are grown by aging at 800°C. Their orientation and structure is clearly evident in the electron diffraction patterns at all stages of growth. The precipitate responds to a magnetic field applied during heat-treatment both by suppression of nuclei making an angle greater than about 70° with the field and by the forcing of the rods off the [100] direction into that of the field. The precipitate rods tend to scatter in direction about the field vector when the field is off the [100] but are aligned accurately when the field is along [100].

Energy of a Bloch Wall on the Band Picture. I. Spiral Approach. C. HERRING[1]. *Phys. Rev.*, **85**, pp. 1003–1011, March 15, 1952.

It is shown that the band or itinerant electron model of a solid is capable of accounting for the "exchange stiffness" which determines the properties of the transition region, known as the Bloch wall, which separates adjacent ferromagnetic domains with different directions of magnetization. In this treatment the constant spin function usually assigned to each running electron wave is replaced by a variable spin function. At each point of space the spin of a moving electron is inclined at a small velocity-dependent angle to the mean spin direction of the other electrons, and this gives rise to an exchange torque which makes the spin direction of the given electron precess as it moves through the transition region, the precession rate being just sufficient to keep it in approximate alignment with the macroscopic magnetization. Physical insight into the mechanisms involved is provided by a rigorous solution of the wall problem for a ferromagnetic free electron gas in the Slater-Fock approximation, although it is known that the free electron gas is not likely to be ferromagnetic in higher approximations. Rough upper limits to the exchange stiffness constants for actual ferromagnetic metals can be calculated without using any empirical constants other than the saturation moment and the lattice constant. The results are only a few times larger than the observed values.

Elastic and Plastic Properties of Very Small Metal Specimens. C. HERRING[1] and J. K. GALT[1]. *Phys. Rev.*, **85**, pp. 1060–1061, March 15, 1952. (Monograph 1977).

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A Scanner for Rapid Measurement of Envelope Delay Distortion. L. E. HUNT[1] and W. J. ALBERSHEIM[1]. *Proc. I.R.E.*, **40**, pp. 454–459, April, 1952. (Monograph 1967).

A measuring device is described which instantaneously displays the envelope delay-frequency characteristic on a cathode-ray screen. Loop and one-way measurements of long-distance radio networks can be carried out. The frequency range extends from 60 to 80 megacycles; the limits of accuracy are 1 millimicrosecond or 2 per cent of the measured delay range. Comparison of two characteristics can be carried out by superposition of alternate scanning traces.

The device has been found useful in measuring the delay distortion of the TD-2 radio-relay system and in designing and adjusting the delay equalizers needed to correct it.

Numerical Integration Near a Singularity. E. L. KAPLAN[1]. *J. Math. Phys.*, **31**, pp. 1–28, April, 1952. (Monograph 1980).

Measurement of Diffusion in Semiconductors by a Capacitance Method. K. B. MCAFEE[1], W. SHOCKLEY[1] and M. SPARKS[1]. *Phys. Rev.*, **86**, pp. 137–138, April, 1952.

Probing the Space Charge Layer in a p-n Junction. G. L. PEARSON[1], W. T. READ[1] and W. SHOCKLEY[1]. *Phys. Rev.*, **85**, pp. 1055–1057, March 15, 1952.

Control Methods Used in a Study of the Vowels. G. E. PETERSON[1] and H. L. BARNEY[1]. *J. Acoust. Soc. Am.*, **24**, pp. 175–184, March, 1952. (Monograph 1982)

Relationships between a listener's identification of a spoken vowel and its properties as revealed from acoustic measurement of its sound wave have been a subject of study by many investigators. Both the utterance and the identification of a vowel depend upon the language and dialectal backgrounds and the vocal and auditory characteristics of the individuals concerned. The purpose of this paper is to discuss some of the control methods that have been used in the evaluation of these effects in a vowel study program at Bell Telephone Laboratories. The plan of the study, calibration of recording and measuring equipment, and methods for checking the performance of both speakers and listeners are described. The methods are illustrated from results of tests involving some 76 speakers and 70 listeners.

Current Multiplication in the Type-A Transistor. W. R. SITTNER[1]. *Proc. I.R.E.*, **40**, pp. 448–454, April, 1952. (Monograph 1969).

One of the basic phenomena exhibited by transistors is current multiplication. In transistors of the point-contact type (one of these has been called the Type-A), the mechanism giving rise to this effect has been somewhat uncertain. Four

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possible mechanisms of the current multiplication process in the Type-A transistor are discussed. One of the mechanisms is based on trapping holes in the collector barrier of the semiconductor. By means of this trapping model, the effect of emitter current and temperature on the current multiplication is predicted. It is shown that these predictions are in reasonable accord with experiment. Furthermore, assuming this model to hold, the trap density and activation energy (produced by forming) may be evaluated.

Faraday Rotation of Guided Waves. H. SUHL[1] and L. R. WALKER[1]. *Phys. Rev.*, **86**, pp. 122–123, April 1, 1952.

Transistor Forming Effects in n-Type Germanium. L. B. VALDES[1]. *Proc. I.R.E.*, **40**, pp. 445–448, April, 1952. (Monograph 1969).

Some of the effects of electrical forming of the collector of an n-type germanium transistor are discussed. Evidence is presented for the existence of a region of p-type germanium underneath the formed electrode, together with some indication of the size of the formed region. These experiments lend support to the p-n hook mechanism in that they explain the observed high values of alpha in transistors. This relation is discussed.

Domain Structure of Perminvar Having a Rectangular Hysteresis Loop. H. J. WILLIAMS[1] and M. GOERTZ[1]. *Jl. Appl. Phys.*, **23**, pp. 316–323, March, 1952. (Monograph 1985).

An investigation has been made of the magnetic domain structure of Perminvar (43 per cent Ni, 34 per cent Fe, 23 per cent Co) ring specimens having rectangular hysteresis loops after heat-treatment in a magnetic field. Domain patterns obtained with colloidal magnetite showed curved domain boundaries extending completely around the rings, forming circles concentric with them. Changes in magnetization occur when an applied field causes the circular boundaries either to expand or contract so that there is a change in the relative values of clockwise and counter-clockwise flux. A nucleus of reversed magnetization was formed by making a small notch in a specimen, and this decreased the coercive force and hysteresis loss by a factor of two. It was found that in a 180° domain boundary it was possible to make the change in spin orientations, which occurs in going from one side of the boundary to the other, have either a right- or left-hand screw relation, by the application of a field of appropriate sign perpendicular to the surface. The effect of superposing an applied alternating field was also investigated, and an effective permeability of 4,000,000 was obtained.

Measuring Techniques for Broad-Band, Long-Distance Radio Relay Systems. W. J. ALBERSHEIM[1]. *Proc. I.R.E.*, **40**, pp. 548–551, May, 1952. (Monograph 1971).

Line-up and maintenance of radio relay systems require sensitive yet rapid measurements. These are obtained by scanning the systems response as functions of time, frequency, and amplitude. Parameters thus scanned include the

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transient response to step functions; frequency characteristics of gain, phase, impedance and their frequency derivatives; and amplitude characteristics of output nonlinearity and of intermodulation products.

Aluminum Die Castings—The Effect of Process Variables on Their Properties. W. BABINGTON[1] and D. H. KLEPPINGER[4]. *Proc. A.S.T.M.*, **51**, pp. 169–197, 1951.

Diffusion in Alloys and the Kirkendall Effect. J. BARDEEN[1] and C. HERRING[1]. pp. 261–288 of *Imperfections in Nearly Perfect Crystals*, Wiley N. Y., 1952, 490 p. Edited by W. Shockley, J. H., Hollomon, R. Maurer and F. Seitz. Symposium held at Pocono Manor, Oct. 12–14, 1950, by Committee on Solids, National Research Council.

Lightning Protection for Fixed Radio Stations. D. W. BODLE[1]. *Tele-Tech*, **11**, pp. 58–60, 126+, June, 1952.

Common grounds, parallel conducting paths, and discharge gaps provide three important means for avoiding equipment damage from high current surges. Protection of connecting facilities must also be considered to preserve service.

Compression Tests on Lead Alloys at Extrusion Temperatures. G. M. BOUTON[1] and G. S. PHIPPS[1]. *Proc. A.S.T.M.*, v. **51**, pp. 761–770, 1951.

Load-deflection measurements made during compression tests on lead and lead-alloy cylinders at various temperatures show the effects of alloying ingredients on the force required to produce deformation. The curves also furnish clues as to changes taking place in the materials during the course of the test. The load, P, to produce definite small deformation in pure lead at various temperatures, T, are shown to follow the relationship $P = Ae^{-BT}$, where A and B are constants for the material. This is the same relationship found by others in extrusion studies. The elements added to lead were those most commonly used in the manufacture of cable sheath, namely, antimony, arsenic, bismuth, silver, tellurium, and tin. The results show that the stronger alloys now used for cable sheathing deform less readily at extrusion temperatures than pure lead or the weaker alloys.

RF Phase Control in Pulsed Magnetrons. E. E. DAVID, JR[1]. *Proc. I.R.E.*, **40**, pp. 669–685, June, 1952.

This paper describes the behavior of a magnetron oscillator started in the presence of an externally applied rf exciting signal whose frequency is not greatly different from the unperturbed steady-state frequency of the magnetron.

Effect of Prior Strain at Low Temperatures on the Properties of Some Close-Packed Metals at Room Temperature. W. C. ELLIS[1] and E. S. GREINER[1]. *J. Metals*, **4**, pp. 648–651, June, 1952. (Monograph 1966).

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[4] Frankford Arsenal, Philadelphia, Pa.

The Fatigue Test as Applied to Lead Cable Sheath. G. R. GOHN[1] and W. C. ELLIS[1]. *Proc. A.S.T.M.*, **51**, pp. 721–740, 1951.

This paper discusses the more important factors affecting the design of laboratory test methods suitable for obtaining significant fatigue data from reversed bending tests on cantilever-beam specimens of lead cable sheathing alloys. Data are presented to show the effect of cycling rate, temperature, shape of specimen, alloy additions, and aging on fatigue life. The close correlation between bending fatigue tests on strip specimens and full size sections of cable is demonstrated. The fatigue data are analyzed in terms of (1) cycle life versus deflection, (2) cycle life versus strain, and (3) cycle life versus stress. Photomicrographs illustrating representative laboratory and field failures are included.

Thermal Conductivity of Germanium. A. GRIECO[1] and H. C. MONTGOMERY[1]. *Phys. Rev.*, **86**, p. 570, May 15, 1952.

Bell System Cable Sheath Problems and Designs. F. W. HORN[1] and R. B. RAMSEY[1]. *Trans. A.I.E.E.*, **70**, Part 2, pp. 1811–1816, 1951. (Monograph 1917).

Powdered Standards for Spectrochemical Analysis. E. K. JAYCOX[1]. *Applied Spectroscopy*, **6**, pp. 17–19, May, 1952. (Monograph 1978).

Engineering for Low Product Cost and High Product Quality at the Western Electric Company. A. C. JONES[3]. *Ind. Quality Control*, **8**, pp. 53–59, May, 1952.

The Approximation with Rational Functions of Prescribed Magnitude and Phase Characteristics. J. G. LINVILL[1]. References. *Proc. I.R.E.*, **40**, pp. 711–721, June, 1952.

A successive-approximations method is applied to the selection of network functions having desired magnitude and phase variation with frequency. The first approximation, the first set of pole and zero locations, can be selected on the basis of known solutions to similar problems or through use of a set of curves. In succeeding approximations the pole and zero locations are adjusted to decrease the deviation of the earlier approximations from the desired characteristics. The process adjusts the magnitude and phase characteristics simultaneously. Its flexibility permits accommodation of practical constraints not possible with other methods.

The Magnetic Structure of Alnico 5. E. A. NESBITT[1] and R. D. HEIDENREICH[1]. *Elec. Eng.*, **71**, pp. 530–534, June, 1952. (Monograph 1981).

In the investigation of Alnico 5, two problems arose. What is the mechanism which enables the alloy to respond to heat treatment in a magnetic field? What causes the alloy to have a high coercive force of 600 oersteds? The first problem has been solved and progress has been made toward solving the second.

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[3] Western Electric Company

Single-Frequency Signaling System for Supervision and Dialing Over Long-Distance Telephone Trunks. N. A. NEWELL[1] and A. WEAVER[1]. *Trans. A.I.E.E.*, **70**, Part 1, pp. 489–494, 1951. (Monograph 1841).

The single-frequency signaling system for long-distance telephone trunks frees dial calls from the range and other limitations imposed by dc signaling methods. It uses alternating currents in the voice range as the signaling medium and so can be used with any trunk of any length or type of line facility which meets voice-transmission requirements. The signaling requirements, design problems, main features of the circuit and equipment arrangements, and the operation of this system are outlined in this paper. The system described is the first practical arrangement of its type satisfactorily to meet all the conditions of telephone service in the Bell Telephone System.

Experimental Information on Slip Lines. W. T. READ, JR[1]. pp. 129–151 of *Imperfections in Nearly Perfect Crystals*, Wiley, N. Y., 1952, 490 p. Edited by W. Shockley, J. H. Hollomon, R. Maurer and F. Seitz. Symposium held at Pocono Manor, Oct. 12–14, 1950, by Committee on Solids, National Research Council.

On the Geometry of Dislocations. W. T. READ, JR.[1] and W. SHOCKLEY[1]. pp. 77–94 of *Imperfections in Nearly Perfect Crystals*, Wiley, N. Y., 1952, 490 p. Edited by W. Shockley, J. H. Hollomon, R. Maurer and F. Seitz. Symposium held at Pocono Manor, Oct. 12–14, 1950, by Committee on Solids, National Research Council.

A Servo System for Heterodyne Oscillators. T. SLONCZEWSKI[1]. *Trans. A.I.E.E.*, **70**, Part 1, pp. 1070–1072, 1951. (Monograph 1883).

A constant rate of progression of frequency of a motor-driven heterodyne oscillator is obtained by comparing its output with a frequency standard. The result is fed into a servo loop which drives the motor at the proper speed. When used in connection with a level recorder a linear frequency scale is obtained which is more accurate than the static calibration of the oscillator.

Metallic Rectifiers in Telephone Power Plants. D. E. TRUCKSESS[1]. *Trans. A.I.E.E.*, **70**, Part 2, pp 1464–1467, 1951. (Monograph 1987).

Metallic rectifiers are a comparatively new means of converting power from alternating current to direct current. Most of the component apparatus used in the Telephone Systems operates with direct current while the normal power source is alternating current. Therefore a static device without expendable parts which is obtainable in small and large current capacity lends itself as a means for power conversion in telephone power plants.

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