3

N-72545-186 [indep only]

362p.

Newell

LITERATURE SEARCH NO. 186

MAGNETISM AND MAGNETIC PROPERTIES.

(NASA CR-51027)

B

N63 84658

Code-5

(NASA Contract NASw-6)

Dorothy I. Switzer **JANUARY 1960** 362 p 1915 refs

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena

National Aeronautics and Space Administration
Contract No. NASw-6

(1) **ASTRONAUTICS INFORMATION**

(JPL LITERATURE SEARCH ~~No.~~ 186)

(2) THEORY OF MAGNETISM, MAGNETIC PROPERTIES OF MATERIALS AND USE OF MAGNETIC MATERIALS IN INSTRUMENTATION

Dorothy I. Sweitzer

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
January 1960

Copyright © 1960
Jet Propulsion Laboratory
California Institute of Technology

FOREWORD

Theories concerning magnetism are not new, nor is the study of magnetic properties of materials. However, the development of electronic computers, with the use of magnetic materials as storage or memory devices, has instigated an upswing in magnetic research. Within the last few years a special interest has been shown in the magnetic properties of thin films and the possible use of such films as super-memory devices.

This bibliography was compiled in October 1959, in response to a request by Jet Propulsion Laboratory (JPL) engineering personnel. It is presented in this form for the use of other agencies working in the field. The compilation is limited mainly to works published within the last five years; a few earlier articles are included for background material.*

No effort was made to cover the subjects of electromagnetic wave phenomena, magnetic field measurement, magnetohydrodynamics, low-temperature magnetic effects, or nuclear- and paramagnetic-resonance studies. It is true, however, that certain of the references deal with these subjects, particularly in the category of general theory of magnetism. It is suggested that readers obtain copies from JPL of the following published *Astronautics Information Literature Searches*: No. 149, "Meissner Effect, Penetration Depth, and Residual Magnetism in Superconductors"; No. 183, "Plasma Physics and Magneto-Fluid-Dynamics"; and No. 195, "Methods of Measuring Magnetic Fields."

In the present bibliography, an effort was put forth to reference work in the study of materials, including basic magnetism, domain structure, magnetostriction, magneto-electrical properties, magneto-optical properties and ferromagnetic resonance. A number of the references deal with the effects of magnetism on general physical

*Publisher's Note: Entry numbers 737, 738, 919 and 1717 have been deleted from this compilation.

properties. Instrumentation using magnetic materials is certainly not covered; however, those articles found on the subject of thin film memories are referenced, and a sampling of other applications of magnetic material is given.

Division of the bibliography is arbitrary. As many papers deal with both experimental and theoretical studies of the magnetic properties of a specified material or materials, and perhaps also the applications of such materials, the bibliography would be too bulky if references were listed in every applicable division. Therefore, each article is referenced in one, and usually only one, of the pertinent categories. Theoretical studies of specific materials are likely to appear in material categories. The section on ferrous metals and alloys includes silicon–iron and carbon–iron and all alloys which contain iron, even though that metal is a minor constituent. Within each subject category, references are listed chronologically by year and month of publication.

The references were obtained from: *Physics Abstracts (PA)*; *Engineering Index (EI); Computers and Automation (C and A); The Journal of Applied Physics;* JPL Library Additions; JPL Source Files; and Miscellaneous Reference Lists.

PREFACE

The technical staff of the Jet Propulsion Laboratory library is engaged in an extensive literature searching program covering subjects selected by the Laboratory engineers and designed to meet their individual needs. Searches considered to be of interest to persons working in the field of astronautics will be published for distribution to interested organizations.

CONTENTS

I. Conferences on Magnetic Phenomena 1
II. Theory of Magnetic Phenomena 10
A. Films, Thin Layers, Particles, Whiskers and Wires 10
B. General 17
III. Magnetic Properties of General Materials and Methods of Study 84
A. Films, Thin Layers, Particles, Whiskers and Wires 84
B. General 88
IV. Magnetic Properties of Ferrous Metals and Alloys 112
A. Films, Thin Layers, Particles, Whiskers and Wires 112
B. General 125
V. Magnetic Properties of Ferrous Metal Compounds 164
A. Films, Thin Layers, Particles, Whiskers and Wires 164
B. General 171
VI. Magnetic Properties of Non-ferrous Metals and Alloys 223
A. Films, Thin Layers, Particles, Whiskers and Wires 223
B. General 240
VII. Magnetic Properties of Non-ferrous Metal Compounds 288
A. Films, Thin Layers, Particles, Whiskers and Wires 288
B. General 290
VIII. Magnetic Properties of Non-metallic Materials 317
IX. The Use of Magnetic Materials in Instrumentation 319
A. Films, Thin Layers, Particles, Whiskers and Wires 319
B. General 324
Author Index 341

I. CONFERENCES ON MAGNETIC PHENOMENA

1. COLLECTION OF PAPERS PRESENTED AT THE CONFERENCE ON FERROMAGNETISM AND ANTIFERROMAGNETISM AT GRENOBLE, FRANCE, 4 JULY 1950

***Journal de physique et le Radium*, v. 12, pp. 153–506, March 1951**

2. CONFERENCE ON FERRITES, FEBRUARY 1–5, 1954

***Academy of Sciences, USSR, Physics Series Bulletin*, v. 18, no. 3–4, 1954**

Columbia Technical Translations, N. Y., 1955

Compilation of 26 Conference Papers on Ferrites, Ferromagnetism and Related Subjects, Translated from *Akademiya Nauk, SSSR, Izvestiya, Seriya Fizicheskaya.* (*EI*, 1956)

3. CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS (Papers presented at Conference, Pittsburgh, Pa., June 14–16, 1955)

American Institute of Electrical Engineers, N. Y.

T78, October 1955

"Magnetism and Electronic Structure," H. Brooks; "Process of Magnetization," C. P. Bean; "Double Exchange," P. W. Anderson, H. Hasegawa; "Role of Covalence in Oxides Containing Manganese," J. B. Goodenough; "Collective Electron Model for Magnetization in Alloys," B. R. Coles, J. E. Goldman; "Two-Level Approach to Cooperative Phenomena," J. Rothstein; "Magnetic Properties of Beta–UH_3," S. T. Lin, A. R. Kaufmann; "Ultrasonic Absorption in Superconducting and Normal Conducting Tin at Low Temperatures," H. E. Bommel; "Susceptibility Measurements on Paramagnetic Metals and Spinels at Low Temperatures," A. Arrott, J. E. Goldman; "Saturation Magnetic Moments in Fe-Al Alloys," M. T. Pigott; "Spin Wave Resonance in Ferromagnetic Metals," G. T. Rado, J. R. Weertman; "Frequency Dependence of g Values in Ferrites," T. R. McGuire; "Magnetic Susceptibility of Impurity Trapped Electrons and Holes in Semiconductors," E. Mooser; "Powder Susceptibility of Antiferromagnets," J. R. Tessman; "Magnetic Moment Arrangements and Magnetocrystalline Deformations in Antiferromagnetic Compounds," Y. Y. Li; "Strong Field Magnetization of $CrCl_3$ and CrF_3 at Low Temperatures," W. E. Henry, M. Griffel, W. N. Hansen; "Domain Walls in Antiferromagnetics and Weak Ferromagnetism of Alpha Fe_2O_3," Y. Y. Li; "Magnetic Susceptibilities of Complexes of Transition Elements," M. Wolfsberg, N. Elliott; "Low Temperature Heat Capacities of Some Normal Spinels," S. A. Friedberg, D. L. Burk; "Diamagnetism of Free Electrons in Aromatic Lattices," H. T. Pinnick; "Static and Dynamic Magnetization Characteristics of Magnetic Amplifier Core Materials," E. Both; "Metallurgy and Magnetic Materials," J. F. Libsch, G. P. Connard; "Study of Ferrous Ternary Diagrams in Relation to Magnetic Interactions: Fe-Ni-Al System," U. Roesler; "Domain Configurations and Crystallographic Orientation in Grain Oriented Iron-Silicon Alloy," T. G. Nilan, W. S. Paxton; "Effect of Plastic and Elastic Stresses on Losses and Domain Configurations of Grain Oriented 3% Si-Fe," P. W. Neurath; "Low Temperature Precipitation in Commercial Oriented 3% Silicon Steel," F. S. Gardner; "Magnetostriction of Iron and Some Silicon Iron Alloys in High Fields," B. A. Calhoun, W. J. Carr, Jr.; "Deformation and Recrystallization of Silicon Iron," G. Wiener, R. Corcoran; "Some Notes on Ferromagnetic Properties of Alloys With Superlattice," H. Sato; "Dislocation Movements in Stress-Relief Anneal and Their Relation to Magnetic Recovery," C. G. Dunn; "Powder Metallurgy for Research Into Ferromagnetic Materials," C. E. Richards, E. V. Walker, A. C. Lynch; "Use of Powder Metallurgy in Production of Soft Magnetic Materials," H. Evans, C. G. Smith, D. K. Worn; "Recent Advances in Field of Permanent Magnets," K. J. Sixtus; "Electron Microscopy of Submicron Iron Particles," J. H. L. Watson, M. W. Freeman; "Effect of Shape Anisotropy on Coercive Force of Elongated Single Magnetic Domain Iron Particles," T. O. Paine, L. I. Mendelsohn, F. E. Luborsky; "Approach to Elongated Fine Particle Magnets," I. S.

Jacobs, C. P. Bean; "Permanent-Magnet Properties of Elongated Single Domain Iron Particles," L. I. Mendelsohn, F. E. Luborsky, T. O. Paine; "Preferred Orientations and Magnetic Properties of Rolled and Annealed Permanent Magnet Alloys," W. R. Hibbard, Jr.; "BiMn 'Spire' Growth Induced by Magnetic Field," B. W. Roberts; "Observation of Magnetic Domains and Domain Wall in BiMn by Kerr Magneto-optic Effect," B. W. Roberts; "Anomalous Behavior of Alnico V in Sub-Curie Temperature Region of 1000 F Through 1450 F," J. R. Hansen; "New Facts Concerning Permanent Magnet Alloy, Alnico 5," E. A. Nesbitt, H. J. Williams; "Noise Problem in Coincident Current Memory Matrix," J. D. Childress; "Influence of Pulsed Magnetic Fields on Reversal of Magnetization in Square-Loop Metallic Tapes," D. S. Rodbell, C. P. Bean; "Relation of D-C Magnetic Properties of Oriented 48% Nickel Iron to Magnetic Amplifier Performance," C. E. Ward, M. F. Littmann; "Soft Magnetic Materials With Rectangular Hysteresis Loops," N. I. Ananthanarayanan; "Magnetostriction in Ferrites Possessing Square Hysteresis Loop," P. K. Baltzer; "Anomalous Rotational Damping in Ferromagnetic Sheets," T. L. Gilbert, J. M. Kelly; "Dynamax, New Crystal and Domain Oriented Magnetic Core Material," G. H. Howe; "Topics in Microwave Applications of Ferrites," J. Cacheris, G. Jones, R. van Wolfe; "Ferromagnetics and Ferroelectrics," A. von Hippel; "Applications of Ferrites," V. C. Wilson; "Recent Developments in Microwave Ferrite Devices," S. Weisbaum; "Ionic Distributions in Ferrites," H. B. Callen, S. E. Harrison, C. J. Kriessman; "Initial Permeability as Function of Temperature for Certain Ni-Zn Ferrites," J. M. Blank, N. Schwartz; "Magnetic Anisotropy of Cobalt Ferrite and Nickel Ferrite," H. Shenker; "Initial Permeability in Ferrimagnetic Spinels," R. S. Weisz; "High Resistivity Nickel Ferrites—Effect of Minor Additions of Manganese or Cobalt," L. G. Van Uitert; "Interrelation of Manufacture, Magnetic Properties, and Engineering Design of Magnetic Apparatus," F. J. Murrin; "Magnetic Effects of Compressional Stress at Low Field Intensities," R. E. Fischell; "Effect of Fringing on Air Gap in Hipersil Cores," A. S. Poulsen; "New Low Field Magnetometer for Measuring H of Small Soft Magnetic Specimens," R. D. Robinson, P. G. Frischmann; "Effect of Temperature on Permeability and Core Loss of Electrical Steels," J. J. Clark; "Stability Characteristics of Molybdenum Permalloy Powder Cores," C. D. Owens; "Accurate Electronic Tracer for Dynamic Characteristics of Magnetic Materials," E. Kittl; "Synthalyzer System: Automatic AC B-H Loop Recorder," E. R. Czerlinsky, R. A. MacMillan; "Vibrating-Coil Magnetometer and Its Application to Study of Curie Point of Magnetite," D. O. Smith; "Radio Frequency B-H Tracer and Power Measurements of Ferrites," B. Christensen. (*EI*, 1955)

4. CONFERENCE ON CRYOGENIC MAGNETISM, JULY 1–3, 1954

***Academy of Sciences, USSR, Physics Series Bulletin*, v. 19, no. 4, pp. 346–441, 1955**
Columbia Technical Translation, N. Y., 1956

"Conference on Magnetism at Low Temperatures–Introduction," S. V. Vonsovski; "On Oscillations of Thermodynamic Parameters of Degenerate Fermi Gas at Low Temperatures," I. M. Liefshits, A. M. Kosevich; "Oscillation Effects in Magnetic Fields," G. E. Zilberman; "Anisotropy of Magnetic Properties of Zinc Single Crystals at Low Temperatures," B. I. Verkin, I. M. Dmitrenko; "Galvanometric Effects and Properties of Conduction Electrons in Metals," E. S. Borovik; "Photo-Magnetoelectric Effect in Cuprous Oxide at Low Temperatures," A. P. Komar, et al; "Certain Problems Relating to Quantum-Mechanical Theory of Crystals at Low Temperatures," S. V. Vonsovski; "Relaxation Processes in Ferromagnetic Metals at Low Temperatures," E. A. Turov; "Electric Conductivity of Ferromagnetic Metals at Low Temperatures," E. A. Turov; "Anisotropy of Susceptibility and Magnetocaloric Effect in Antiferromagnetic Materials," K. B. Vlasov. (*EI*, 1956)

5. SUMMARIZED PROCEEDINGS OF A SYMPOSIUM ON MAGNETISM—LONDON, SEPTEMBER, 1955

Lynch, A. C. and Watkins, J.
***British Journal of Applied Physics*, v. 7, no. 7, pp. 236–242, July 1956**

An informal symposium on recent developments in magnetism held by the Electronics Group of The Institute of Physics. The subjects discussed ranged from some latest advances in theoretical studies, to the application of magnetic materials to computer systems. (*PA*, 1956)

6. CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS (Papers presented at Conference, Boston, Mass., October 16–18, 1956) American Institute of Electrical Engineers, T-91, February 1957

"Ferromagnetic Anisotropy," J. H. Van Vleck; "New Magnetic Anisotropy," W. H. Meiklejohn, C. P. Bean; "Controlled Crystal Anisotropy of Mixed Ferrites," C. M. Van der Burgst; "Anisotropy in Antiferromagnetic Crystals," A. L. Loeb, J. B. Goodenough; "Magnetic Annealing," R. M. Bozorth; "Magnetic Domain Patterns on Films," R. C. Sherwood, H. J. Williams; "Magnetization of Ni Films at Low Temperatures," R. W. Hoffman, A. M. Eich; "Magnetocrystalline Anisotropy Constants From Torque Measurements," J. S. Kouvel, C. D. Graham, Jr; "Fine Particle Magnets," T. O. Paine; "Properties of Fe and Oxide Micropowders," R. B. Campbell, et al; "Orientation in Elongated Particles in Single Domain Range," R. B. Campbell; "Reproducing Properties of Alnico Alloys With Co-Fe Particles," F. E. Luborsky, et al; "Anisotropy and Hysteresis in Fine Particle Magnets," I. S. Jacobs, F. E. Luborsky; "Properties and Morphology of Submicron FE Particles," M. W. Freeman, J. H. I. Watson; "Magnet Alloys of Fe-Co-Ni-Al Type," A. J. J. Koch, et al; "Nucleation Experiments on Alnico 5," E. A. Nesbitt, A. J. Williams; "Processing and Properties of Co-Pt Magnet Alloys," D. L. Martin; "Effects of Temperature on Remanence of Magnets," R. K. Tenzer; "Stress Corrosion in Magnets of Anisotropic Powdered MnBi," E. Adams; "d-Shell vs d-Band Models," C. Zener, R. R. Heikes; "Structures and Magnetic Properties of BiMn," B. W. Roberts; "Magnetic Structure of Annealed Fe_3Al," R. Nathans, et al; "X-Ray Data on Fe-Rich Fe-Al Alloys," A. Taylor, R. M. Jones; "Effect of Atomic Ordering on Magnetic Properties of 10-17 wt% Al-Fe Alloys," D. Pavlovic, K. Foster; "Heat Treatment for High Initial Permeability in Binary and Complex Ni-Fe Alloys," R. E. S. Walters; "Magnetostriction Measurements on Fe-Pt Alloys," E. Klokholm, F. J. Donahoe; "Magnetic Measurements of Ni-Au Alloy," A. E. Berkowitz, P. J. Flanders; "Magnetization of Cr-Rich Fe-Cr Alloys," A. Arrott; "Measurement of Precipitate Particle Sizes in Cu-Co Alloy," J. J. Becker; "Magnetic Properties of UMn_2," A. R. Kaufmann, S. T. Lin; "Studies of Ferro-, Ferri-, and Antiferromagnetics," W. E. Henry; "Magnetoabsorption," W. E. Bell; "Calorimeter Core Loss Measurements," E. R. Czerlinsky, R. A. MacMillan; "Magnetic Moment and Hysteresis Measurements," P. J. Flanders; "Leakage Factors for Magnetic Circuits," R. K. Tenzer; "Magnetostriction at Low Alternating Field Intensities in Si-Fe," D. A. Wycklendt; "Measurement of Magnetostriction at Low Alternating Field Intensities," C. W. Little, Jr.; "Measurement of Core Losses in Ferromagnetic Materials," I. C. Cooter, W. P. Harris; "Ferroresonance Combination for Static Control Devices," A. T. Balint; "Recording Hysteresigraph," R. E. Tompkins, J. D. Young; "Torque Balance for Determination of Anisotropy," R. F. Penoyer; "Losses in Magnetic Materials," J. B. Goodenough; "Effect of Impurities etc. on Losses in Si-Fe," G. W. Wiener; "Effect of Plastic Deformation on Core Loss of Oriented Si-Steel," J. K. Stanley; "Domain Wall Observations in Si-Fe," C. D. Graham, Jr.; "Determination of Preferred Orientations in Magnetic Al-Fe Alloys by Etch Pit Domain Pattern Techniques," P. A. Albert; "Magnetostriction of Al-Fe Single Crystals in Region of 6-30 At% Tl," R. C. Hall; "Effect of Aging on Time Decay of Permeability in 3% Si-Fe," E. S. Anolick; "Sendust Flake, New Magnetic Material," W. M. Hubbard, et al; "Effect of Nuclear Irradiation on Magnetic Materials," R. S. Sery, et al; "Why Present Evaluation Methods for Magnetic Strip Materials Are Inadequate," P. W. Neurath; "New Class of Oxide Ferromagnetic Materials With Hexagonal Structures," G. H. Jonker, et al; "Domain-Wall Relaxation in Ferrites," D. J. Epstein; "Remanent State in Ferrites," E. H. Frei, S. Shtrikman; "Perminvar Characteristics in Ferrites," C. E. Kool; "Susceptibility of Normal Spinels," A. Arrott, J. E. Goldman; "Growth of Ferrite Single Crystals," S. K. Dickinson, W. G. Field; "Preparation of Ferrites by Atomizing Burner Technique," J. V. Wenckus, W. Z. Leavitt; "Ferrite Accelerating Cavities for 25 Bev Proton Synchrotron," M. Plotkin; "Magnetic Resonance in Ferrites," N. Bloembergen; "Ferromagnetic Resonance in Highly Anisotropic Single Crystal Metals," J. O. Artman; "Single Crystal Intrinsic Permeabilities of Ferrites," E. G. Spencer, et al; "Domain Structure Effects in Anomalous Ferrimagnetic Resonance of Ferrites," R. C. LeCraw, E. G. Spencer; "Reversible Properties of Ferromagnets," D. M. Grimes; "Microwave Properties of Ferrites," C. I. Hogan; "Interference Effect Associated With Faraday Rotation—Application to Switching," J. A. Weiss; "High Intensity Pulsed Magnetic Fields," S. Foner, H. H. Kolm; "Microwave Susceptibility of Polycrystalline Ferrites in D-C Fields," E. Schlomann; "H-F Effects in Magnetic Films," R. L. Conger; "Magnetic-Core Switching Time and Width of Ferromagnetic Resonance Peaks," R. P. Coleman; "Magnetic Relaxation in Films," D. O.

Smith; "Switching Properties of Square Loop Ferrites," E. M. Gyorgy, J. L. Rogers; "Magnetic Viscosity in 4-79 Moly Permalloy," O. J. Van Sant; "Ferractor," T. H. Bonn; "Crossed Fields Magnetic Transducer," E. H. Frei, D. Treves; "Ferrite Bead, New Memory Device," D. H. Looney; "Memory Array in Sheet of Ferrite," R. H. Meinken; "Supermendur, New Rectangular Loop Magnetic Material," H. L. B. Gould, D. H. Wenny. (*EI*, 1957)

7. FERRITES AND ELECTRONIC CORE SESSION (Proceedings 13th Annual Meeting, Chicago, April 30–May 1, 1957) Metal Powder Association, N.Y.

"How To Take Advantage of Magnetic Core Materials," J. A. Roberts, A. Schmeckenbecher, G. Ludewig; "Magnetic Cores in Miniature Electronic Circuits," D. M. Hodgin; "Characteristics and Application of Ceramic Permanent Magnets," C. A. Maynard; "Characteristics and Present Requirements of Ferrites," R. D. Harrington; "Latest Developments in Magnetic Storage and Switching Applications," J. W. Schallerer; "Thermal Expansion of Ferrite Materials at Temperatures Near Curie Point," W. R. Buessem, A. Dorf. (*EI*, 1957)

8. CONVENTION ON FERRITES, OCTOBER–NOVEMBER, 1956

***Proceedings of the Institution of Electrical Engineers*, v. 104, Part B, Supplement No. 5, pp. 127–266, 1957**

"Introductory Lecture," W. Jackson; "Chemistry and Crystal Structure of Ferrites and Other Magnetic Oxides," A. J. E. Welch; "Structural and Magnetic Properties of Solid Solutions of Lithium Ferrite With Cadmium Ferrite and With Lithium Aluminate," A. E. Carter, P. A. Miles, A. J. E. Welch; "Physical and Chemical Properties of Some Nickel Zinc Ferrite Compounds," N. C. Tombs, J. Watkins; "Crystal Formation in Metallic Oxides," L. R. Maxwell, S. J. Pickart; "Ferrite Materials for Faraday Rotation at Wavelengths of 2.6 and 10 cm," P. E. L. Jung; "Preparation of Magnesium Manganese Ferrite for Microwave Applications," A. E. Robinson; "Properties of Manganese Zinc Ferrites and Physical Processes Governing Them," C. Guillaud; "Magnetic Spectra," J. B. Birks; "Losses in Ferrites: Single-Crystal Studies," J. K. Galt; "Effect of Magnetocrystalline Anisotropy on Magnetic Spectra of Mg-Fe Ferrites," G. T. Rado, V. J. Folen, W. H. Emerson; "Ferrimagnetic Resonance in Magnesium Manganese Ferrite," K. J. Standley, J. Peters; "Complex Susceptibility of High Resistivity Ferrites," P. M. Prache, B. Chiron; "Neutron Diffraction Studies of Manganese-Magnesium Ferrite System," R. Nathans, S. J. Pickart, S. E. Harrison, C. J. Kriessman; "Magnetic Exchange Mechanisms in Magnesium Manganese Ferrites," W. P. Osmond; "Heat Changes Accompanying Magnetization Processes in Ferrites," L. F. Bates, D. A. Christoffel; "Magnetocrystalline Anisotropy in Cobalt Substituted Magnetite Single Crystals," L. R. Bickford, J. M. Brownlow, R. F. Penoyer; "New Class of Oxidic Ferromagnetic Materials With Hexagonal Crystal Structures," G. H. Jonker, H. P. Wijn, P. B. Braun; "Saturation Magnetization of Some Ferrimagnetic Oxides With Hexagonal Crystal Structures," E. W. Gorter; "Crystalline Structure and Magnetic Properties of Ferrites Having General Formula 5 Fe_2O_3 $3M_2O_3$," F. Bertaut, R. Pauthenet. (*EI*, 1957)

9. CONVENTION ON FERRITES, OCTOBER–NOVEMBER, 1956

***Proceedings of the Institution of Electrical Engineers*, v. 104, Part B, Supplement No. 6, pp. 267–398 1957**

"Survey of Theory and Applications of Ferrites at Microwave Frequencies," P. J. B. Clarricoats, A. G. Hayes, A. F. Harvey; "Properties of Circular Waveguides Containing Ferrites," P. J. B. Clarricoats; "Measurement of Complex Permittivity, and Complex Tensor Permeability of Ferrite Materials at Microwave Frequencies," I. G. MacBean; "Theory of Measurement of Elements of Permeability Tensor of Ferrite by Means of Resonant Cavity," R. A. Waldron; "Non-Reciprocal Network Theory Applied to Ferrite Microwave Devices," H. J. Carlin; "Microwave Faraday Effect and Conductivity in Nickel Ferrites and Ferrite-Aluminates," R. Derry, M. S. Wills; "Properties and Applications of Ferrites at 3 cm Wavelength," S. Boronski; "Measurement of Ferrite Properties in Rectangular Cavity at 10,000 Mc/s," J. Roberts, C. M. Srivastava; "Quantum Theory of Spontaneous Magnetization of Ferrites at Low Temperatures," E. I. Kondorskii; "Ferrite Structures for Millimetre Wavelengths," A. F. Harvey; "Applications of Ferrites at 3 cm Wavelength," R. M. Godfrey, B. L. Humphreys, P. E. V. Allin, G. Mott; "Development of Rotation Isolator for 6 cm Wavelength," P. E. L. Jung; "Resonance Absorption Isolator in Microstrip for 4 Gc/s," L. Lewin; "Microwave Ferromagnetics Research," A. G. Fox; "Measurements and Applications

of Microwave Properties of Magnesium-Manganese Ferrite in 8-9 mm Waveband," E. Laverick, A. Rivett-Carnac; "45° Faraday-Rotation Ferrite Isolator," A. L. Morris; "Applications of Ferrites to Microwave Directional Couplers, Switches, and Cavity Filters," E. Strumwasser. (*EI*, 1957)

10. CONVENTION ON FERRITES, OCTOBER–NOVEMBER, 1956

***Proceedings of the Institution of Electrical Engineers*, v. 104, Part B, Supplement No. 7, pp. 399–570, 1957**

"Introduction," J. H. Richards; "Influence of Chemistry on B H Loop Shape, Coercivity and Flux-Reversal Time in Ferrites," J. B. Goodenough; "Ordering in Cobalt-Ferrous Ferrites," H. P. J. Wijn, H. van der Heide, J. F. Fast; "Square-Loop Ferrites Obtained by Magnetic Annealing of New Compositions," E. W. Gorter, C. J. Esveldt; "Pulse-Response Properties of Rectangular-Loop Ferrites," H. P. J. Wijin, H. van der Heide; "Ferrites With Constricted Loops and Thermal Magnetic Treatment," O. Eckert; "Magnetic-Core Matrix Store With Direct Selection Using Magnetic-Core Switch Matrix," W. Renwick; "Magnetic Cell: New Circuit-Element," D. S. Ridler, R. Grimmond; "Matrix Store for Data Rate Conversion," C. J. Quartly, A. L. Cain, R. W. Clarke; "Ferrite-Core Switch-Matrix for Magnetic-Recording-Head Selection," D. W. Willis; "1000-Channel Neutron-Velocity Spectrometer Using Ferrite Data Storage," F. H. Wells, J. G. Page; "Digital Computer Based on Magnetic Circuits," B. Bambrough; "Application of Square-Loop Ferrite Cores in Telecommunication Switching Circuits," W. Six, R. A. Koolhof; "Application of Square-Loop Ferrite Material in Data-Processing Systems," E. P. G. Wright; "Core-Transistor Logical Element," D. Eldridge, P. F. Dorey; "Current and Future Applications for Ferrite Components in Radio and Television Receivers," V. A. Jones, G. Campbell; "Application of Soft Magnetic Ferrites in Television-Receiver Line-Scanning Circuits," R. H. C. Morgan; "Ferrites Applied to Carrier-Frequency Equipment," W. G. Glover, S. E. Buckley; "Ferrites for Magnetic and Piezomagnetic Filter Elements With Temperature-Independent Permeability and Elasticity," G. M. van der Burgt; "Practical Applications and Measurements on Ferrite Electromechanical Transducers," G. Bradfield; "Examples of Electric Wave Filters Using Ferrite Inductors," W. Saraga. (*EI*, 1957)

11. RENDICONTI DEL IV CORSO CHE NELLA VILLA MONASTERO A VARENNA (Proceedings of the 4th Course, July 15–August 4, 1956, Varenna, Italy)

***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 805–1237, 1957**

"Paramagnetism in Crystals," M. H. L. Pryce; "Magnetic Properties of Metals," J. H. Van Vleck; "Paramagnetic Relaxation," C. J. Gorter; "Ferromagnetism," C. Kittel; "Antiferromagnetism," C. J. Gorter;" Metamagnetics of Antiferromagnetic Substances," L. Néel (in French); "Nuclear Magnetism and Nuclear Relaxation," E. M. Purcell; "Line Breadths and Theory of Magnetism," J. H. Van Vleck; "Influence of Electrons in Resonance of Resonance of Nuclear Spins in Diamagnetic Substances," A. Abragam (in French); "Stochastic Theory of Magnetic Resonance," R. Kubo; "Concept of Temperature in Magnetism," J. H. Van Vleck; "Magnetism at Very Low Temperatures and Nuclear Orientation," N. Kurti; "Cyclotron Resonance in Crystals," C. Kittel; "Optical Methods of Herzian Resonance," A. Kastler (in French); "Magnetic Properties of Superconductors," C. J. Gorter; "Hall Effect in Ferromagnetics," J. Smit; "Critical Scattering of Neutrons from Ferromagnetics," W. Marshall; "Influence of Apparatus on Nuclear Magnetic Resonance," H. Pfeifer; "Statistical Theory of Ferro- and Antiferromagnetism," J. Van Kranendonk; "Nuclear Relaxation in Magnetic Materials," J. Van Kranendonk; "Study of Chemical Exchange Reaction by Nuclear Magnetic Resonance," S. Meiboom; "Paramagnetic Resonance of Impurities in Semiconductor," A. Abragam, J. Combrisson (in French); "Nuclear Magnetic Relaxation in Mixtures of Liquids," L. Giulotto, G. Lanzi, L. Tosca; "Magnetic After-Effect and Internal Friction at High Temperatures in Iron and Some Iron Alloys," A. Ferro, G. Montalenti; "Roentgenographic and Paramagnetic Experiments With (Gd-La)AlO_2 Mixed Crystals," H. Graenicher, K. A. Mueller; "Electric Analogue to Antiferromagnetism: Antiferro-electricity," H. Graenicher; "Magnetic Susceptibility of Electrons in Periodic Fields," C. P. Enz; "Proton Spin Relaxation in Gaseous and Liquid Hydrogen," M. Bloom; "Production of Very Uniform Magnetic Fields," E. M. Purcell (Abstract); "Antiferromagnetic State in Chrome Alums," J. H. Van Vleck (Abstract); "Magnetic Susceptibility of Oxygen in Clathrate Compound," J. H. Van Vleck; "Dependence of Nuclear Magnetic Resonance Absorption in Metals on Specimen Shape and Size," P. Rhodes. (*EI*, 1958)

12. 3RD CONFERENCE ON PHYSICS OF MAGNETIC PHENOMENA, MOSCOW, 23–31, MAY 1956

Academy of Sciences, USSR, Physics Series Bulletin, v. 21, no. 6, pp. 789–906; no. 8, pp. 1043–1202; no. 9, pp. 1205–1322, 1957

Columbia Technical Translations, N. Y., 1958

"De Haas–Van Alphen Effect," D. Shoenberg; "Influence of Pressure on Galvanomagnetic Properties of Bismuth," N. E. Alekseevskii, N. B. Brandt, T. I. Kostina; "On Determination of Individual Components of Magnetic Susceptibility of Semiconductor," Ia. G. Dorfman; "On Transverse Photomagnetic Effect in n- and p-Type Germanium," I. K. Kikoin, Iu. A. Bykovskii; "Towards Theory of Ferromagnetism in Nonideal Lattice," V. L. Bonchbruevich; "Paramagnetic Behavior of Some Salts of Iron Group of Elements," A. Bose; "Magnetochemistry of Diamagnetic Compounds and Role of Polarizing Paramagnetism," Ia. G. Dorfman; "Cyclotron and Plasma Resonance in Solids," A. F. Kip; "Hyperfine Structure of Paramagnetic Resonance in Supercooled Solutions of Salts of Iron Group," N. S. Garifianov; "Electron Paramagnetic Resonance in Electrolyte Solutions," B. M. Kozyrev; "Thermodynamic Theory of Relaxation and Resonance Effects in Two-Spin Systems," G. V. Skrotskii, L. V. Kurbatov; "Resonance Paramagnetic Absorption of Ultrasound in Some Salts of Rare Earth Elements," S. A. Altshuler, M. M. Zaripov, L. Ia Shekun; "Approximate Method of Second Quantization in Quantum Theory of Magnetism," N. N. Bogoliubov, S. V. Tiablikov; "Quantum Mechanical Treatment of Ferromagnetism in Metals of Transition Groups," S. V. Vonsovskii; "Some Remarks Concerning Bloch Spin Wave Theory," Z. Semadeni; "Dispersion Formula for Spin Waves in Ferrimagnets," G. Czofta; "Ferromagnetism of Conduction Electrons," G. S. Krinchik; "Towards Theory of Spontaneous Magnetization of Thin Films," L. Valenta, "On Temperature and Field Dependence of Magnetic Anisotropy Constants of Cubic Crystal," A. A. Gusev, S. V. Tiablikov; "Concerning Spectrum of Elementary Excitations and Some Kinetic Processes in Ferromagnetic Crystals," E. A. Turov; "Phase Transitions and Phase Diagrams in Rhombic Antiferromagnetic Crystal," C. J. Gorter, T. van Peskitinbergen; "Metamagnets or Antiferromagnetic Substances with Threshold Field," N. Néel; "New Form of Ferromagnetic Material, Rare Earth Ferrites of Garnet Type," L. Néel, F. Berteau, F. Forra, R. Pothene; "Influence of Structural Characteristics of Ferromagnets of Temperature Dependence of Spontaneous Magnetization," K. P. Belov, A. N. Goriaga; "Investigation of Magnetization of Ferrites in Vicinity of Curie Point," K. P. Belov, K. M. Bolshova, T. A. Elkina; "Temperature Dependence of Differential Susceptibility of Cobalt in Strong Magnetic Fields," L. Pal, T. Tarnotsi; "Application of Paramagnetic Resonance to Determination of Structure of Rochelle Salt and Epoxy Resins," A. Loesche; "Recent Developments in Field of Paramagnetic Relaxation," C. J. Gorter; "Temperature Dependence of Magnetic Anisotropy Energy in Nickel," I. M. Puzel; "Superstructure and Temperature Dependence of Magnetic Anisotropy Energy of Nickel-Iron Alloys," I. M. Puzei; "Temperature Dependence of Some Magnetic Properties of Nickel," L. V. Kirenskii, R. S. Nosova, N. V. Reshetnikova; "Temperature Dependence of Magnetic Susceptibility of Nickel Base Alloys," D. I. Volkov, V. I. Chechernikov; "Correlation Between Electric and Magnetic Properties of Chromium Sulphides," N. P. Grazhdankina, I. G. Fakidov; "Low-Temperature Resistivity of Nickel Alloys and Its Variation in Magnetic Fields," E. I. Kondorskii, O. S. Galkina, L. A. Chernikova; "Resistivity and Effect of Strong Magnetic Field on Resistivity of Iron-Nickel Alloys at Low Temperatures (14–77 °K)," E. I. Kondorskii, I. E. Ozhigov; "Investigation of Magnetostriction and Other Even Effects in Region of Approach to Saturation," G. P. Diakov; "Some Aspects of Theory of Elastic Ferromagnetic (Magnetostrictive) Media," K. B. Vlasov; "Some New Experiments With Bitter Figures," L. F. Bates; "One Role of Closure Domain in Technical Magnetization Processes," Ia. S. Shur, V. R. Abels, V. A. Zaikova; "Dynamic Behavior of Domain Structure in Silicon-Iron Crystals," L. V. Kirenskii, V. D. Dylgerov, M. K. Savchenko; "Domain Structure of Ferromagnets at High Temperatures," J. Kaczer; "Contribution to Theory of Coercive Force in Thin Sheets," J. Kaczer; "Direct Observations of Domains in Ferromagnet by Means of Secondary Emission Electron Microscope and Electron Mirror," G. V. Spivak, N. G. Kanavina, I. S. Sbitnikova, I. N. Prilezhaeva, T. N. Dombrovskaia, V. K. Azovtsev; "Nature of Ferromagnetic Domain Walls," C. P. Bean; "Thermal Changes Associated With Magnetization," L. F. Bates; "Report on Some Recent Progress in Field of Magnetic Investigations in Tokyo," R. Kubo; "Anisotropic Magnetic Cores," P. Denes; "Characteristics of Technical Magnetization in Grain-Oriented Fine

Powder Specimens," Ia. S. Shur, E. V. Shtolts, G. S. Kandaurova; "Investigation of Dissociation in Ni-Be Alloy," N. N. Buinov, L. I. Podrezov, M. F. Komarova; "Changes in Structure and Properties of Nickel Solid Solutions During Heat Treatment," B. G. Livshits; "Structure of Fe-Ni-Al Alloys in High Coercivity State," B. G. Livshits, V. S. Lvov; "Magnetic Investigation of Ordering in Ni_3Mn-Base Alloys," B. G. Livshits, B. V. Molotilov; "Kinetics of Superstructure Transformations of Fe_3Al Alloy," V. E. Rodi; "Magnetic Properties of Ordered Fe_3 Al Alloy," V. I. Ivanovskii; "Residual Magnetization of Nickel and Its Stability," Ia. S. Shur, I. E. Startseva; "Influence of Plastic Deformation on Barkhausen Effect," K. Wotruba; "Investigation of Reversal of Magnetism (Barkhausen) Jumps in Ferromagnets," V. F. Ivlev, V. L. Iliushenko, L. I. Aseeva; "On Structure of Family of Symmetrical Hysteresis Loops of Ferromagnets," R. I. Ianus, V. P. Kartashev; "Temperature and Rotational Hysteresis in Ferromagnets," L. V. Kirenski, A. Ia. Vlasov, N. I. Vtiurin, A. I. Drokin, V. F. Ivlev, R. I. Tukalov; "Hysteresis Losses in Rotating Magnetic Fields in Magnetic Single Crystal Before and After Phase Transition," N. L. Brukhatov; "Influence of Elastic Stresses and Thermochemical Treatment on Magnetic Properties of High Coercivity Alloys," Ia. S. Shur, M. G. Luzhinskaia, L. A. Shubina; "Magnetization Viscosity of Ni-Zn Ferrites With Free Variation of Magnetization," I. A. Lednev, R. V. Telesnin; "On Decay of Magnetic Permeability in Silicon Iron," Iu. S. Vail; "Some Magneto-Optical Effects at Microwave Frequencies," N. N. Nepremerov; "Magneto-Optical Properties of Ferromagnets in Infrared Region," G. S. Krinchik; "Contribution to Theory of Kerr and Faraday Effects at Radiofrequencies," G. V. Skrotskii, V. F. Zakharchenko; "Measurement of Initial Permeability of Ferromagnets in Microwave Region," G. S. Sanyal; "Radiofrequency Magnetic Spectra of Mixed Ferrites," L. A. Fomenko; "Magnetic Spectra of Magnetodielectrics of Alsifer Type," L. A. Fomenko; "Ferroprobe Magnetometer for Investigating Properties of Small Samples of Magnetically Soft Materials," V. I. Drozhzhina, L. A. Fridman; "Magnetic Moments and Curie Constants of Ferromagnetic Alloys," F. M. Galperin; "Investigation of Magnetic Susceptibility of Iron and Nickel Base Solid Solutions," V. V. Parfenov; "Influence of Elastic Deformation on Paraprocess Susceptibility," V. V. Parfenov, V. P. Voroshilov. (*EI*, 1958)

13. PROCEEDINGS OF CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, WASHINGTON, D. C., NOVEMBER 18–21, 1957

***Journal of Applied Physics*, v. 29, no. 3, pp. 237–548, March 1958 (see also *AIEE* Publication T-103, 1958)**

"Masers," C. H. Townes; "Time Decrease of Permeability in Iron," G. W. Rathenau; "Electrical Resistivity of Ferro-Magnetic Metals at Low Temperatures," E. Kondorsky, O. S. Galkina, L. A. Tchernikova; "Structure and Ferrimagnetism of Ilmenite Compound MnNiO," E. F. Bertaut, F. Forrat; "Analogy Between Directional Ordering and Magnetic Diffusion Aftereffect," P. Brissonneau; "Uniaxial Magnetic Anisotropy Induced in Fe-Ni Alloys by Magnetic Anneal," E. T. Ferguson; "Spontaneous Magnetization of Some Garnet Ferrites and Aluminum Substituted Garnet Ferrites," R. Pauthenet; "Paramagnetic Faraday Effect," J. Soutif-Guicherd; "Magnetic Resonance of Ferrites With Compensation Temperature," J. Pauleve; "Static and Dynamic Behavior of Thin Permalloy Films," D. O. Smith; "Flux Reversal in Thin Films of 82% Ni, 18% Fe," C. D. Olson, A. V. Pohm; "Rotational Model of Flux Reversal in Square Loop Soft Ferromagnets," E. M. Gyorgy; "Transverse Flux Change in Soft Ferromagnetics," F. B. Humphrey; "Effects of Heat Treatment of Thin Ferromagnetic Films at Intermediate Temperatures," E. N. Mitchell; "Reversible Rotation in Magnetic Films," R. M. Sanders, T. R. Rossing; "Steady-State and Pulse Measurement Techniques for Thin Magnetic Films in Vhf-uhf Range," D. O. Smith, G. P. Weiss; "Ferromagnetic Resonance in Ultra-Thin Films," M. H. Seavey, Jr., P. E. Tannenwald; "Domain-Wall Structure in Permalloy Films," E. E. Huber, Jr., D. O. Smith, J. B. Goodenough; "Motion Pictures of Magnetic Writing on Thin Films of MnBi," H. J. Williams, R. C. Sherwood; "Some Results of Electron Microscopical Study of Metallographic Structure of Two Alloys for Permanent Magnets (Ticonal G and Ticonal X)," J. J. de Jong, J. M. G. Smeets, H. B. Haanstra; "Relation Between Colloid Pattern and Permanent Magnet Precipitate During Magnetization Reversal in Alnico V," K. J. Kronenberg, R. K. Tenzer; "Phase Analysis of Alnico V Based on Temperature Effects," R. K. Tenzer, K. J. Kronenberg; "Physical and Magnetic Properties of Elongated Single-Domain Iron and Iron-Cobalt Permanent Magnets," R. C. Lever, E. J. Yamartino, R. B. Falk; "Effects of Magnetic Fields Upon

Anisotropic Iron Crystals," J. H. L. Watson, A. Arrott, M. W. Freeman; "Loss of Exchange Coupling in Surface Layers of Ferromagnetic Particles," F. E. Luborsky; "Study of Precipitate Particles in Cu-Co Employing Ferromagnetic Resonance," D. S. Rodbell; "Shape Distribution of Single Domain Powders," C. E. Johnson, Jr., W. F. Brown, Jr.; "Measurements on Precipitating Systems," A. E. Berkowitz, P. J. Flanders; "Precipitation and Magnetic Annealing in Cu-Co Alloy," J. J. Becker; "Resonant Modes of Ferromagnetic Spheroids," L. R. Walker; "Multiplicities of Uniform Precessional Mode in Ferrimagnetic Resonance," I. H. Solt, Jr., R. L. White, J. E. Mercereau; "Ferromagnetic Resonance and Nonlinear Effects in Y-Fe Garnet," R. C. LeCraw, E. G. Spencer, C. S. Porter; "Low Temperature Spin-Wave Resonance at 3000 and 4000 Mc in Permalloy Having Nearly Zero Magnetocrystalline Anisotropy," J. R. Weertman, G. T. Rado; "Effect of Electronic Mean Free Path on Spin-Wave Resonance in Ferromagnetic Metal," G. T. Rado; "Ferromagnetic Dynamical Response," H. B. Callen; "Inhomogeneous Broadening of Magnetic Resonance Lines," A. M. Clogston; "Origin of Ferromagnetic Resonance Line Broadening in Mn-Rich Mn Ferrites," S. E. Harrison, H. S. Belson, C. J. Kriessman; "Resonance in Uniaxial Polycrystalline Materials," C. A. Morrison, N. Karayianis; "Resonance in Nickel Ferrite Aluminate," E. Schloemann, J. R. Zeender; "Damping and Dispersion Relations in Antiferromagnetic Resonance," E. S. Dayhoff; "Magnetic Anisotropy Induced by Magnetic Annealing and Cold Working of Ni_3Fe Crystal," S. Chikazumi; "Effect of Sample Thickness on Field Annealing of 6.5% Si-Fe," P. A. Albert; "Recrystallization of MnBi Induced by Magnetic Field," O. L. Boothby, D. H. Wenny, E. E. Thomas; "Effects of Composition and Processing Variables on Magnetic Properties of 50% Ni-Fe Alloy," M. J. Savitski; "Orientation Study of Ultra-Thin Molybdenum Permalloy Tape," P. K. Koh; "Development of Preferred Orientations in Silicon Iron," J. R. Brown; "(110) (001) Secondary Recrystallization Texture in 3% Silicon-Iron," H. C. Fiedler; "Magnetic Properties of Cube Textured Silicon-Iron Magnetic Sheet," J. L. Walter, W. R. Hibbard, H. C. Fiedler, H. E. Grenoble, R. H. Pry, P. G. Frischmann; "Cube Texture in Body Centered Magnetic Alloys," G. Wiener, P. A. Albert, R. H. Trapp, M. F. Littmann; "Low Residual Induction in High Al-Fe Alloys," D. Pavlovic, K. Foster; "Effect of Elastic Bending on Magnetic Properties of Oriented Silicon Iron," R. W. Cole; "Effect of Hydrostatic Pressure and Temperature on Properties of Ni-Zn Ferrite," G. Q. Adams, C. M. Davis, Jr.; "Preferential Volatilization of Cations from Ferrites During Sintering," J. M. Brownlow; "Quenched Mg Ferrites," D. J. Epstein, B. Frackiewicz; "Ionic Valences in Mn-Fe Spinels," A. H. Eschenfelder; "Substitution for Fe in Ferrimagnetic Y-Fe Garnet," M. A. Gilleo, S. Geller; "Some Ferrimagnetic Properties of System $Li_x\ Ni_{1-x}O$," J. B. Goodenough, D. G. Wickham, W. J. Croft; "Effect of Thermal History on Antiferromagnetic Transition in Zn Ferrite," D. N. Grimes, E. F. Westrum, Jr.; "Magnetic Germanates Isostructural with Garnet," A. Tauber, E. Banks, H. H. Kedesdy; "Some Magnetic and Crystallographic Properties of System $LaMn_{1-x}\ Ni_xO_3 + \lambda$," A. Wold, R. J. Arnott, J. B. Goodenough; "Growth of Magnetic Garnet Crystals," J. W. Nielsen; "Antiferromagnetic Structures of MnS_2, $MnSe_3$, and $MnTe_3$," L. M. Corliss, N. Elliott, J. M. Hastings; "Measurements of Losses of Magnetic Materials at High Inductions at Frequencies up to 100 Mc," I. Bady; "Measurement of Properties of Various Ferrites Used in Magnetically Tuned Resonant Circuits in 2.5–45 Mc Region," P. P. Lombardini, R. F. Schwartz, R. J. Doviak; "Behavior of TE Modes in Ferrite Loaded Waveguide in Region of Ferrimagnetic Resonance," W. J. Crowe; "Energy Distribution in Partially Ferrite-Filled Wave Guides," J. E. Tompkins; "Miniaturized Resonant Antenna Using Ferrites," D. M. Grimes; "Appraisal of Permanent Magnet Materials for Magnetic Focusing of Electron Beams," M. S. Glass; "Performance of Permanent Magnets at Elevated Temperatures," W. H. Roberts; "Microuniformity of Permanent Magnets," L. I. Mendelsohn; "Understanding and Predicting Permanent Magnet Performance by Electrical Analog Methods," R. J. Parker; "Method for Measuring Saturation Magnetization in Ring Samples," C. D. Graham, Jr.; "Some Aspects of Tempering 3¼% Silicon Steel as Followed by Time Decay of Permeability," E. S. Anolic, J. Singer; "Factors Limiting Magnetic Suspension System," J. B. Breazeale, C. G. McIlwraith, E. N. Dacus; "Origin and Use of Instabilities in Ferromagnetic Resonance," H. Suhl; "Solid-State Microwave Amplifier and Oscillator Using Ferrite," M. T. Weiss; "New Type of Ferromagnetic Amplifier," C. L. Hogan, R. L. Jepsen, P. H. Vartanian; "Microwave Frequency Conversion Studies in Magnetized Ferrites," E. N. Skomal, M. A.

Medina; "Spin-Lattice Relaxation Time in Y-Fe Garnet," R. T. Farrar; "Resonance in Gd-Fe Garnet," B. A. Calhoun, W. V. Smith, J. Overmeyer; "Resonance in Y-Fe Garnet at Low Frequencies," E. G. Spencer, R. C. LeCraw, C. S. Porter; "Microwave Properties of Polycrystalline Rare Earth Garnets," M. H. Sirvetz, J. E. Zneimer; "Ferrimagnetic Resonance in Single Crystals of Rare Earth Garnet Materials," R. V. Jones, G. P. Rodrigue, W. P. Wolf; "Temperature Dependence of Ferromagnetic Anisotropy," W. J. Carr, Jr.; "Magnetocrystalline Anisotropy of Mg-Fe Ferrites: Temperature Dependence, Ionic Distribution Effects, etc.," V. J. Folen, G. T. Rado; "Effect of Cation Vacancies on Magnetic Annealing of Co Substituted Magnetite," L. R. Bickford, Jr., J. M. Brownlow, R. F. Penoyer; "Magnetization Processes in Heat-Treated Single Crystal Co Ferrite," S. Foner, J. O. Artman; "Crystallographic and Magnetic Studies of System $(NiFe_2O_4)_{1-x} + (NiMn_2O_4)_x$," P. K. Baltzer, J. G. White; "Origin of Magnetic Anisotropy in $Co_xFe_{3-x}O_4$," J. C. Slonczewski; "Theory of Magnetostriction and g Factor in Ferrites," N. Tsuya; "Relationship Between Single Crystal and Effective Polycrystalline Anisotropy Constants in Ferrites," C. J. Kriessman, S. E. Harrison, H. S. Belson; "Exchange Anisotropy in Iron–Iron Oxide System," W. H. Meiklejohn; "Magnetostriction and Elastic Properties of Ferromagnetic Substances at High Magnetic Fields," H. Sato; "Domain Wall Motion in Metals," R. W. DeBlois; Preparation and Properties of Crystal-Oriented Ferroxplana Samples," A. L. Stuijts, H. P. J. Wijn; "Rigorous Approach to Theory of Ferromagnetic Microstructure," W. F. Brown, Jr.; "Model for Nonlinear Flux Reversals of Square-Loop Polycrystalline Magnetic Cores," M. K. Haynes; "Temperature Dependence of Microwave Permeabilities for Polycrystalline Ferrite and Garnet Materials," J. Nemarich, J. C. Cacheris; "Effect of Cobalt on Relaxation Frequency of Ni-Zn Ferrite," F. J. Schnettler, F. R. Monforte; "Switching Properties of Permalloy Cores of Varying Coercivity," T. D. Rossing, V. J. Korkowski; "Temperature Dependence of Absorption of Ultrasound in Nickel Single Crystal from 77 to 650°K," F. G. West; "Magnetic Fluctuations in Molybdenum Permalloy," J. J. Brophy; "New Concept in Large-Size Memory Arrays–Twistor," A. H. Bobeck; "Operating Range of Memory Using Two Ferrite Plate Apertures per Bit," M. M. Kaufman, V. L. Newhouse; "Recent Advances in Design of High-Field d-c Solenoid Magnets," H. H. Kolm; "Further Development of Vibrating-Coil Magnetometer," K. Dwight, N. Menyuk, D. Smith; "Improved Torque Magnetometer," W. S. Byrnes, R. G. Crawford; "Transparent Ferromagnetic Light Modulator Using Yttrium Iron Garnet," C. S. Porter, E. G. Spencer, R. C. LeCraw; "Design of Optimum Inductors Using Magnetically Hard Ferrites in Combination With Magnetically Soft Materials," J. T. Ludwig; "Pulse Generator Based on High Shock Demagnetization of Ferromagnetic Material," R. W. Kulterman, F. W. Neilson, W. B. Benedick; "New Magnetic Core Loss Comparator," R. E. Tompkins, L. H. Stauffer, A. Kaplan; "Casting of Alnico VII With Improved Physical Properties," D. H. Wenny, K. M. Olsen; "Skullcap Method for Magnetizing Bowl-Shaped Magnetron Magnets," F. X. MacDonough; "Magnetometallurgy—Applications etc.," A. Arrott; "Role of Wave-Function Symmetry in Transition Metals and Their Alloys," J. B. Goodenough; "Transitions From Ferromagnetism to Antiferromagnetism in Fe-Al Alloys," H. Sato, A. Arrott; "Unusual Magnetic Behavior of Disordered Ni_3Mn," J. S. Kouvel, C. D. Graham, Jr., J. J. Becker; "Magnetic Properties of Dilute Magnetic Alloys and Rare Earth Metals," G. W. Pratt, Jr.; "Magnetic and X-Ray Diffraction Studies on Fe-Rich Fe-Al Alloys," A. Taylor, R. M. Jones; "Magnetic Moments and Apparent Molecular Fields in Rare Earth Metals and Compounds," W. E. Henry; "Magnetic Domain Patterns on Fe Whiskers," R. V. Colemann, G. G. Scott; "Domain Observations on Fe Whiskers," R. W. DeBlois, C. D. Graham, Jr.; "Magnetization Reversal by Rotation," P. R. Gillette, K. Oshima; "Energy Loss in Magnetic Sheet Materials," R. H. Pry, C. P. Bean; "Growth of MnBi Crystals and Evidence for Subgrains," W. C. Ellis, H. J. Williams, R. C. Sherwood; "Antiferromagnetic Domain Walls and Magnetization in α-Fe_2O_3," I. S. Jacobs, C. P. Bean; "Optical Properties of Ferrimagnetic Garnets," J. F. Dillon, Jr.; "Size Dependence of Wall Characteristics in Two-Domain Fe Particle," H. Amar; "Constraint Principle in Domain Theory," L. Gold. (*EI*, 1958)

14. PROCEEDINGS OF THE FOURTH SYMPOSIUM ON MAGNETISM AND MAGNETIC MATERIALS
(Supplement to the *Journal of Applied Physics*, v. 30, 1959)
American Institute of Physics, McGraw-Hill Book Company, Inc., N.Y., 1959

II. THEORY OF MAGNETIC PHENOMENA

A. *Films, Thin Layers, Particles, Whiskers and Wires*

15. **THEORY OF THE STRUCTURE OF FERROMAGNETIC DOMAINS IN FILMS AND SMALL PARTICLES**
Kittel, C.
The Physical Review, v. 70, pp. 965–971, 1946

16. **PARTICOLARI ASPETTI DELLA MAGNETIZZAZIONE DI SOTTILI PELLICOLE FERROMAGNETICHE**
Drigo, A. and Pizzo, M.
Il Nuovo Cimento, v. 5, pp. 1–11, 1948

17. **DOMAIN THEORY AND THE DEPENDENCE OF THE COERCIVE FORCE OF FINE FERROMAGNETIC POWDERS ON PARTICLE SIZE**
Kittel, C.
The Physical Review, v. 73, p. 810, 1948

18. **THIN FERROMAGNETIC FILMS**
Klein, M. J. and Smith, R. S.
The Physical Review, v. 81, no. 3, pp. 378–380, February 1, 1951

19. **A THEORY OF MAGNETIC-DOMAIN CREATION AND FLUX REVERSAL IN POLYCRYSTALLINE, FERROMAGNETIC MATERIALS**
Goodenough, J. B. and Menyuk, N.
Massachusetts Institute of Technology, Lincoln Laboratory, Report TR-40, November 6, 1953

Films are considered.

20. **THE MAGNETIC FLUX SET UP BY A DIPOLE INSIDE A CIRCULAR FERROMAGNETIC WIRE**
Rȳtov, S. M.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 27, no. 3(9), pp. 307–312, 1954 (in Russian)

A general expression is obtained for the flux induced by a magnetic dipole inside an infinite circular ferromagnetic wire. The flux is calculated for a circular area with the centre on the axis of the wire and perpendicular to it. An approximate formula is given for the case that the radii of the wire and area considered are small against the distance of the latter from the dipole. This problem has a special bearing on experiments in which the e.m.f. pulse set up by the remagnetization of a single domain is measured by a ballistic method. Such a single domain may be represented by a magnetic dipole in any case in which the distance of the point considered from the dipole is large compared with the actual dimensions of the domain. The problem of the magnetic dipole may, in turn, reduce to that of a "point charge." The solving expression involves Bessel functions of a complex argument and Macdonald functions, the approximate solution taking a very simple exponential form. (*PA*, 1955, #4799)

21. **THE THEORY OF DRY MAGNETIC MINERAL DRESSING OF FINELY DISPERSED STRONGLY MAGNETIC MATERIAL**
Laurila, E.
Annales Academiae Scientiarum Fennicae, Series A.I., Paper 171, 1954 (in German)

Gives an account of the magnetostatic principles applied to the properties of magnetic powders in steady and in rotating magnetic fields, and applies the results to the design of a magnetic separator of use in mineral dressing. (*PA*, 1955, #1037)

22. **BLOCH WALL ENERGY OF THIN FILMS**
Néel, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 241, no. 6, pp. 533–536, August 8, 1955 (in French)

Shows that the wall energy increases as the film width decreases, reaches a maximum (about 10 γ_0 at a width of about 100 Å for iron) and finally decreases to the normal value γ_0 for a bulk metal as the width tends to zero. (*PA*, 1955 #458)

23. **THE EFFECT OF PARTICLE INTERACTION ON THE COERCIVE FORCE OF FERROMAGNETIC MICROPOWDERS**
Wohlfarth, E. P.
Proceedings of the Royal Society of London, Series A, v. 232, pp. 208–227, October 25, 1955

Previous theoretical work by Stoner and Wohlfarth on the magnetic properties of single domain ferromagnetic

particles is extended to take some account of the interaction between the particles. Earlier theoretical considerations of the interaction problem are critically discussed, and the experimental results for micropowder materials under different degrees of compression are reviewed. A general relation for the magnetic interaction energy of two prolate spheroidal particles is derived. The magnetic properties of assemblies of parallel particles (two particles, linear chains, two- and three-dimensional assemblies) are discussed, and relations are derived for the coercivity change due to the interaction. Results are similarly derived for two nonparallel particles and for ordered assemblies of such particles.

The two principal effects of interaction which have been covered are an interaction-dependence of the effective shape anisotropy coefficient, and a mutual magnetization change due to an interaction-dependent rotation of the magnetization vectors. Both these effects are in general present and as a result the coercive force H_c depends on the interaction, being given by the general relation $H_c(p) = H_c(O) - I_o(Ap + Bp^{\frac{5}{3}} + \cdots)$, where p is the packing factor and I_o the saturation magnetization. The coefficients, particularly A, may depend critically on the orientations and the geometrical arrangement of the particles. This formula is contrasted with those obtained previously, based on an "effective field" treatment. (*PA*, 1955, #9761)

24. INFLUENCE OF PULSED MAGNETIC FIELDS ON THE REVERSAL OF MAGNETIZATION IN SQUARE-LOOP METALLIC TAPES

Rodbell, D. S. and Bean, C. P.

***Journal of Applied Physics*, v. 26, no. 11, pp. 1318–1324, November 1955**

Reversal of magnetization in square-loop metallic tapes is described in terms of the domain geometry and the dependence of this geometry upon the applied magnetic field wave shape. For a steady field whose amplitude is slightly greater than the coercive force, the reversal is accomplished by growth of a single axial domain originating at the thin tape edge. For steady fields of much greater amplitude, the reversal domain grows in from all tape surfaces. Because of the finite nucleation time required to establish the reversal domain, short duration, high-amplitude field pulses can be used to investigate the mechanism of nucleation of the high field reversal domain configuration. A model which accounts for the nucleation process is suggested. The compatibility of this model with various experimental results is presented. From these results an understanding of the high field reversal-domain configurations and the kinetics of the nucleation and growth of these domains in lamellar materials is obtained. An auxiliary result obtained is the value of the "intrinsic mobility" of a domain wall which for a 65 Permalloy specimen is determined to be about 100 cm.sec^{-1}oersted. (*PA*, 1956, #4515)

25. THEORY OF REMAGNETIZATION OF THIN TAPES

Ekstein, H.

***Journal of Applied Physics*, v. 26, no. 11, pp. 1342–1344, November 1955**

Analysis which assumes that velocity of domain wall is proportional to difference between magnetic field intensity at wall and coercive force; local magnetic field, which is not equal to external field, is calculated from eddy-current equations; rate of change of magnetic flux as function of time is determined; total switching time is expressed in terms of two phenomenological constants, retardation constant and delay time. (*EI*, 1956)

26. HYSTERESIS LOOPS OF MIXTURES OF FERROMAGNETIC MICROPOWDERS

Bean, C. P.

***Journal of Applied Physics*, v. 26, no. 11, pp. 1381–1384, November 1955**

A treatment is given of the hysteresis loops of dilute mixtures of various sizes of ferromagnetic particles. Three ranges of particle size are considered: very small particles called "super-paramagnetic" which are single domain and equilibrate resulting from thermal vibrations, single domain particles which are large enough not to equilibrate, and particles large enough to contain many domains in equilibrium. The results are compared with experiment. (*PA*, 1956, #492)

27. AN APPROACH TO ELONGATED FINE-PARTICLE MAGNETS

Jacobs, I. S. and Bean, C. P.

***The Physical Review*, v. 100, no. 4, pp. 1060–1067, November 15, 1955**

The coercive force predicted by theory for single-domain particles with shape anisotropy frequently far

exceeds the observed value. From an examination of the results of Paine, Mendelsohn and Luborsky on elongated iron particles, several approximate models are suggested which may exist in certain experimental situations. Detailed calculations are presented for a "chain-of-spheres" model remagnetizing by several mechanisms. Comparison with experiment on certain single-domain particles of known elongation favours the chain-of-spheres model as a suitable description of their magnetic behaviour. A successful calculation is made of the coercive force of material prepared by several earlier workers. A comparison of the new models with the older ones indicates a direction for experimental advance. (*PA*, 1956, #2336)

28. REMARKS ON THE THEORY OF THE MAGNETIC PROPERTIES OF THIN LAYERS AND FINE GRAINS (International colloquium on thin films)
Néel, L.
***Journal de physique et le Radium*, v. 17, no. 13, pp. 250–255, March 1956 (in French)**

The author shows, first, that in the case of powdered iron, the variation of the coercitive field against the grain size, is correctly interpreted by supposing that the energy spent during a hysteresis cycle is only used for the irreversible production of the system of "walls" (produced twice in a cycle in the region where the resulting magnetization nears zero). Agreement with theory is already less good for magnetite and becomes very bad for Mn–Bi: for the latter, and generally for the substances with only one direction of easy magnetization, the coercitive field is rather determined by the difficulties in forming the nuclei of inversion of the magnetization. No satisfactory theory is now available for these phenomena of "nucleation": serious theoretical objections can be raised in fact against the theory proposed by Kittel. In the second part, the author deals again with the theory of the coercitive field of thin continuous layers, and shows that the superficial energy of Bloch's "walls" has no constant value but increases as soon as the thickness of the wall is not negligible when compared with the thickness of the layer: let 0.1 μ be the thickness of an iron layer, the "wall" energy is 7 erg/cm^2, the normal value being 1.4 erg/cm^2. It is perhaps an explanation of the increase of the coercitive field of thin layers when their thickness decreases. (*PA*, 1956, #6766)

29. THE DE HAAS–VAN ALPHEN EFFECT IN THIN METAL LAYERS
Kosevich, A. M. and Lifshits, I. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 2, no. 4, pp. 646–649, July 1956 (in Russian)**
(English translation in *Soviet Physics–JETP*, N. Y., vol. 2, no. 4, pp. 646–649, July 1956)

The magnetic properties of electrons in thin metal layers are discussed for an arbitrary law of dispersion. The energy levels of quasi-particles with an arbitrary law of dispersion in a magnetic field in the presence of a transverse potential field are determined. The oscillating part of the magnetic moment of a gas of such quasi-particles is calculated and general formulae are used for investigating the de Haas–van Alphen effect in thin metal layers. It is shown that the periods and amplitudes of the oscillations are determined by the form of the limiting Fermi surface and depend appreciably on the ratio of the thickness of the layer to the "radius of the classical orbits" of the quasi-particles. (*PA*, 1956, #8858)

30. A CONTRIBUTION TO THE THEORY OF THE COERCIVE FORCE OF THIN SHEETS
Kaczér, J.
***Czechoslovak Journal of Physics*, v. 6, no. 4, pp. 310–320, August 1956 (in Russian)**

On the basis of the known model of the Bloch wall the magnetostatic energy density of the surface charges produced by the intersection of the wall with the surface of a single crystal is calculated. It is shown that this energy is not negligible as compared to the other energies (energy of exchange and anisotropy) and that it has to be taken into account in the case of thin sheets. As a consequence of this the energy density γ of the sheet is larger than in the unbounded crystal. It is also shown that the thickness of the Bloch wall is a function of the thickness of the sheet. An expression is calculated for the coercive force of thin sheets as a function of the thickness of the sheet which, in the case of single crystal sheets, is in very good agreement with experiment. For polycrystalline sheets, however, only qualitative agreement is obtained, the values calculated being smaller than those measured. It is shown, however, that agreement can also be obtained if a constant magnetostatic surface energy is assumed which is probably due to additional charges on the surfaces of the sheet. The experimental value of the energy of these charges for polycrystalline silicon iron sheet is about 4 erg/cm^2. (*PA*, 1957, #3430)

31. ON THE MINIMUM OF MAGNETIZATION REVERSAL TIME

Kikuchi, R.

***Journal of Applied Physics*, v. 27, no. 11, pp. 1352–1357, November 1956**

A modified Landau–Lifshitz equation is solved for a single-domain sphere and an infinitely-wide thin single-domain sheet of ferromagnetic material neglecting anisotropy. The external magnetic field is switched from one direction to its opposite instantaneously at the initial time and the behaviour of the magnetization vector is investigated thereafter. It is shown that there is a critical value of the damping constant corresponding to the minimum value of the (repetitive) magnetization reversal time. If the damping constant is larger than the critical value, the magnetization vector moves slower; if it is smaller, the magnetization vector moves faster but oscillates so that it takes longer time until it comes to a rest at the final position. The critical values of the Landau–Lifshitz damping constant λ and γM for the sphere and $0.013\gamma M$ for the thin sheet, where γ and M are the gyromagnetic ratio and the magnetization, respectively. The computed minimum switching time for the thin sheet of 4–79 molybdenum permalloy is of the order of 10^{-9} sec. (*PA*, 1957, #1456)

32. RESONANCE AND REVERSAL PHENOMENA IN FERROMAGNETIC FILMS

Conger, R. L. and Essig, F. C.

***The Physical Review*, v. 104, no. 4, pp. 915–923, November 15, 1956**

For fields several times the coercive force, magnetization reversal in thin films takes place by domain rotation. A phenomenological theory based on a modification of the Landau–Lifshitz equation of motion shows that the reversal time for this type of magnetization reversal will be proportional to the damping constant of the modified equation of motion. This damping constant is in turn proportional to the ferromagnetic resonance absorption line width. Experimental measurements on evaporated films of three different alloy compositions demonstrate this predicted proportionality of the reversal time and the resonance line width. The shift in the value of the resonant field strength at constant frequency as a function of film thickness was also investigated. This shift can be attributed to a decrease in the saturation magnetization, $4\pi M_0$. The results indicate that the saturation magnetization remains reasonably constant down to a film thickness of about 10^{-3} cm, and then decreases rapidly. The resonance line widths of the thickest and the thinnest films tested of a given composition were about the same. (*PA*, 1957, #2399)

33. STRUCTURES GRANULAIRES FERROMAGNETIQUES

Prache, P. M.

***Cables & Transmission*, v. 11, no. 1, pp. 32–65 January 2, 1957; pp. 128-166, April 1957**

Ferromagnetic granular structures; in compact structures with grain diameter of about ten microns, there probably does not exist any systematic wall formation between domains; theory of ferromagnetic phenomena which assumes that domains are constituted by grains themselves; effects of propagation of electromagnetic waves in grains. Summary in English. (*EI*, 1957)

34. ON THE THEORY OF THE SPONTANEOUS MAGNETIZATION OF THIN FILMS

Valenta, L.

***Czechoslovak Journal of Physics*, v. 7, no. 2, pp. 127–135, 1957 (in Russian with English summary)**

Treats the atomic planes in a thin film as effective magnetic sublattices and thus calculates statistically the temperature dependence of the magnetization, which is given by a hyperbolic tangent law. This result is equivalent to that derived on the basis of a molecular field treatment. (*PA*, 1959, #8303)

35. ON THE THEORY OF THE SPONTANEOUS MAGNETIZATION OF THIN FILMS, II

Valenta, L.

***Czechoslovak Journal of Physics*, v. 7, no. 2, pp. 136–151, 1957 (in Russian with English summary)**

The equations of the molecular field treatment are solved, and application is made to Fe, Co and Ni films whose Curie temperatures are also discussed on this basis. The agreement with experiment is only fair, and reasons for this are proposed. (*PA*, 1959, #8304)

36. EFFECT OF A CAVITY ON A SINGLE-DOMAIN MAGNETIC PARTICLE

Brown, W. F., Jr. and Morrish, A. H.
***The Physical Review*, v. 105, no. 4, pp. 1198–1201, February 15, 1957**

It has been suggested that the observed low coercive forces of some ferromagnetic powders, as compared with predictions of single-domain-particle theory, may be due to cavities in the particles. Here this possibility is investigated theoretically. Some general formulae are established for a particle of arbitrary shape and for an ellipsoidal particle containing an ellipsoidal cavity; attention is then turned to the case in which both ellipsoids are spheroids, the particle prolate, the cavity either prolate or oblate. Several special cases are studied. In some cases the cavity increases the coercive force, in others it decreases it; for an originally large coercive force, the usual effect is a decrease. It is concluded that the proposed mechanism is capable of accounting, at least in part, for the observed decrease. (*PA*, 1957, #4526)

37. CRITERION FOR UNIFORM MICRO-MAGNETIZATION

Brown, W. F., Jr.
***The Physical Review*, v. 105, no. 5, pp. 1479–1482, March 1, 1957**

Current theories of "single-domain" ferromagnetic particles compare the free energy in a state of uniform magnetization with that in an arbitrarily chosen state of nonuniform magnetization. In this paper, the comparison is between an initial uniform state and all neighboring states, uniform or nonuniform, as an initially large applied field decreases. The initial state becomes unstable when, for some choice of the varied magnetization, the second variation of the free energy changes from positive to negative. This instability criterion leads to a boundary-value problem; the relative magnitudes of certain eigenvalues determine whether the deviation from the initial state occurs by uniform rotation or by development of nonuniform magnetization. Formulae for the critical radius are found in simple cases; they agree, except for a numerical factor, with formulae of Kondorskii. (*PA*, 1957, #4555)

38. EVALUATION OF SOME NONLOCAL THEORIES FOR A THIN SUPERCONDUCTING FILM

Schrieffer, J. R.
***The Physical Review*, v. 106, no. 1, pp. 47–50, April 1, 1957**

The magnetic susceptibility of a thin superconducting film has been evaluated as a function of film thickness on the basis of nonlocal theories proposed by Pippard, Bardeen and Schafroth and Blatt. Two limiting boundary conditions corresponding to specular reflection and random scattering of the electrons at the surface have been applied, and the susceptiblity appears to be insensitive to the boundary condition. Deviations from the London theory occur for a thickness less than twice the penetration depth and give a susceptibility smaller than the London value. Largest deviation is found for the Pippard theory and least for the Schafroth–Blatt version. The experimental data of Lock are inconclusive with regard to the validity of the nonlocal theories. (*PA*, 1957, #5352)

39. FERROMAGNETIC RESONANCE IN WIRE SHAPED SPECIMENS

Zehler, V.
***Zeitschrift für Naturforschung*, v. 12a, no. 5, pp. 433–437, May 1957 (in German)**

The influence of a magnetic field on the resonance frequency and Q factor of a resonant cavity with ferromagnetic walls is calculated including the effect of a ferromagnetic damping term. The construction of a coaxial resonant cavity suitable for investigating the damping of ferromagnetic resonance in wire specimens is described. (*PA*, 1959, #4809)

40. ON THE DOMAIN STRUCTURE OF THIN FERROMAGNETIC FILMS

Kaczér, J.
***Czechoslovak Journal of Physics*, v. 7, No. 5, pp. 557–567, 1957**

The energy of Bloch walls is calculated with respect to the demagnetizing energy of a Bloch wall. A model of the stability of the domain structure in thin films is proposed. (*PA*, 1959, #7160)

41. MINIMUM SATURATING FIELDS FOR FERROMAGNETIC CRYSTALS
Kouvel, J. S.
***Journal of Applied Physics*, v. 28, no. 6, pp. 704–706, June 1957**

The conditions for magnetic saturation are investigated analytically for a very thin ferromagnetic single-crystal disk or spheroid of cubic crystalline symmetry and positive magnetic anisotropy constant K_1, whose axis of revolution is perpendicular to a {100} or {110} plane. Contrary to some previous work, it is found that an external field ranging in magnitude from NI_s to $NI_s + 2K_1/I_s$ (where NI_s is the demagnetizing field) is sufficient for saturation in any direction in either of these planes. Above this field, the crystal behaves as a single magnetic domain. The applicability of the calculated minimum saturating fields to torque measurements is discussed. (*PA*, 1958, #6059)

42. ON THE WIDTH AND ENERGY OF DOMAIN WALLS IN SMALL MULTI-DOMAIN PARTICLES
Amar, H.
***Journal of Applied Physics*, v. 28, no. 6, pp. 732–733, June 1957**

A two-domain ferromagnetic particle is considered. It is shown that the inclusion of the magnetostatic energy in the derivation of the wall characteristics yields values of these characteristics considerably different from those in bulk material. (*PA*, 1958, #224)

43. SOME COMMENTS ON THE THEORY OF COERCIVE FORCE OF FINE PARTICLES
Ohoyama, T.
***Journal of the Physical Society of Japan*, v. 12, no. 7, p. 827, July 1957**

Calculation is discussed in terms of Kittel's and Néel's models. A dependence of coercive force on particle-diameter is not fully established.

44. MAGNETIZATION REVERSAL IN THIN FILMS AT LOW FIELDS
Couger, R. L. and Essig, F. C.
***Journal of Applied Physics*, v. 28, no. 8, pp. 855–858, August 1957**

A statistical theory of magnetization reversal in thin films for reversing fields less than the anisotropy field is presented in which it is assumed that reversal takes place by domain wall motion. The number of moving domain walls is determined by a simple statistical model which allows for the random nucleation of walls as the reversing field increases. Experimental data are presented in support of this theory. Two equations for the velocity of a domain wall in a thin film are presented; these arise since two alternative forms of the equation of motion of the magnetization vector are considered. (*PA*, 1958, #2414)

45. THIN FERROMAGNETIC FILMS
Glass, S. J. and Klein, M. J.
***The Physical Review*, v. 109, no. 2, pp. 228–291, January 15, 1958**

The spontaneous magnetization of thin films of ferromagnetic materials is studied by means of spin-wave theory. Results are obtained for the magnetization as a function of temperature and film thickness for body-centered and face-centered cubic materials, generalizing earlier calculations by Klein and Smith. The approximations in the theory are critically discussed, and the relevant experimental material is briefly reviewed. (*PA*, 1958, #1766)

46. STATIC AND DYNAMIC BEHAVIOR OF THIN PERMALLOY FILMS
Smith, D. O.
***Journal of Applied Physics*, v. 29, no. 3, pp. 264–273, March 1958**

Thin magnetic films (~ 1000 Å) evaporated onto a heated glass substrate in the presence of a dc magnetic field develop a uniaxial magnetic anisotropy energy of the form $E_k = K \sin^2\phi$, with ϕ measured from the deposition field. Such films promise to out-perform ferrite cores in digital-computer memory-systems by several orders of magnitude. A detailed static and dynamic theory based on the above anisotropy energy and the Landau–Lifshits dynamical equation is presented. The static theory contains the unique feature of the coercive force parallel to the easy axis being dependent on a field in the plane of the film and perpendicular to the easy axis. Experimental verification of the theory is given. The dynamic theory considers both steady-state and pulse response. The steady-state solution is well-known; the pulse solution must take very careful account of all the important

torques acting in a switching experiment, and numerical results are obtained by the use of a digital computer. Experimentally, steady-state resonance was measured from 100 to 10,000 Mc and pulse switching down to 3 mμ sec. Both types of experiment are in good agreement with each other and with the theory. (*PA*, 1959, #419)

47. MAGNETIZATION REVERSAL BY ROTATION

Gillette, P. R. and Oshima, K.

***Journal of Applied Physics*, v. 29, no. 3, pp. 529–533, March 1958**

The mechanism of magnetization reversal by simple rotation has been discussed by many authors, but a completely general analysis (applicable to a single-domain ferromagnetic body of any type of anisotropy, with an applied field in an arbitrary direction) has not been given. The purpose of this paper is to present such an analysis. General differential equations are derived which can be used to describe the rotation process in any body for which demagnetization and anisotropy factors can be written. These equations are then applied to a sphere, a cylinder, and a thin sheet. Both uniaxial and cubic anisotropy are considered for the sphere and cylinder; only uniaxial anisotropy (the kind observed in deposited films) is considered for the thin sheet. The resulting differential equations can be solved numerically to obtain output voltages, switching times, and switching constants. (*PA*, 1958, #8927)

48. ON THE THEORY OF DOUBLE BLOCH WALLS IN THIN FILMS

Kaczér, J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 569–572, March 1958**

A theory of the double Bloch walls observed by Williams and Sherwood in thin ferromagnetic films. The stability of these walls as a function of the thickness of the film and the external magnetic field is discussed. (*PA*, 1958, #8874)

49. THE REMANENT MAGNETIZATION OF SINGLE DOMAIN FERROMAGNETIC PARTICLES: II. MIXED UNIAXIAL AND CUBIC ANISOTROPIES

Tonge, D. G. and Wohlfarth, E. P.

***Philosophical Magazine*, Eighth Series, v. 3, pp. 536–537, May 1958**

A continuation of previous work, it is shown that the reduced remanence of random particles only differs appreciably from 1/2 if the ratio of the uniaxial to the cubic anisotropy coefficients is less than a constant of order one. (*PA*, 1958, #4118)

50. TEMPERATURE DEPENDENCE OF THE SPONTANEOUS MAGNETIZATION IN SMALL FERROMAGNETIC PARTICLES

Kneller, E.

***Zeitschrift für Physik*, v. 152, no. 5, pp. 574–585, 1958 (in German)**

The magnetization curve, at constant temperature, of a "superparamagnetic" alloy can be described in terms of a modified Langevin function which can be calculated on the basis of an assumed distribution of particle sizes. The Curie temperature of small ferromagnetic particles varies with temperature in a way similar to that in which the Curie temperature of thin ferromagnetic films depends upon film thickness. The reduced spontaneous magnetization of small ferromagnetic particles varies with the reduced temperature in the same way as for bulk material. Combining these effects, the temperature dependence of the magnetization of a superparamagnetic alloy can be calculated and compared with observations. (*PA*, 1959, #4789)

51. COMMENTS ON A THEORY OF DOUBLE BLOCH WALLS IN THIN FILMS

Behringer, R. E.

***Journal of Applied Physics*, v. 29, no. 9, pp. 1380–1381, September 1958**

Notes an inconsistency in Kaczér's theory. If the film is sufficiently thin for the anisotropy constant to be replaced by $2\pi I_s^2$ where I_s is the saturation magnetization of the specimen, the Néel-type wall results in a lower energy than the type of wall proposed by Kaczér. The dipole–dipole interaction energy then has the reverse sign and the resulting relation between field, film thickness and distance between walls is given. It is deduced that unwinding walls cannot exist in very thin ideal films and that nonunwinding walls can exist only when a field is applied contrary to the direction of magnetization of the central domain. (*PA*, 1959, #3629)

52. THIN FILM MAGNETIZATION REVERSAL BY COHERENT ROTATION
Gillette, P. R. and Oshima, K.
Journal of Applied Physics, v. 29, no. 10, pp. 1465–1471, October 1958

Several theoretical analyses of the process of magnetization reversal in thin films by coherent rotation of the magnetization vector were published. However, these analyses suffer from the use of questionable assumptions and from a lack of generality. This paper presents results obtained by employing an electronic digital computer to solve differential equations of greater accuracy and generality than those previously used. These results show how the optimum damping factor (which, as defined herein, differs slightly from the critical damping factor), the peak output voltage, and the reversal time vary with the magnitude and direction of a field applied to a thin ferromagnetic film with uniaxial anisotropy. The results for a particular direction of applied field show that the optimum damping factor and the peak voltage increase and the reversal time decreases with increasing magnitude of the field; and that a plot of reciprocal reversal time vs field magnitude is a parabola if the damping factor is always equal to its optimum value, but a hyperbola if the damping factor is a constant. (*PA*, 1959, #3645)

(See also references: 101, 303, 319, 320, 369, 370, 386, 390, 417, and 437)

B. General

53. L'HYPOTHESE DU CHAMP MOLECULAIRE ET LA PROPRIETE FERROMAGNETIQUE
Weiss, P.
Journal de Physique et le Radium, Series 4, v. 6, pp. 661–690, 1907

54. UBER DIE KOERZITIVKRAFT: I. TEIL. KOERZITIVKRAFT UND MECHANISCHE HARTE
Kussmann, A. and Scharnow, B.
Zeitschrift für Physik, v. 54, pp. 1–15, 1929

55. ZUR THEORIE DES FERROMAGNETISMUS
Bloch, F.
Zeitschrift für Physik, v. 61, pp. 206–219, 1930

56. ZUR THEORIE DER MAGNETISIERUNGSKURVE
Becker, R.
Zeitschrift für Physik, v. 62, pp. 253–269, 1930

57. ON INHOMOGENEITIES IN THE MAGNETIZATION OF FERROMAGNETIC MATERIALS
Bitter, F.
The Physical Review, v. 38, pp. 1903–1905, 1931

58. ZUR THEORIE DES AUSTAUSCHPROBLEMS UND DER REMANENZERSCHEINUNG DER FERROMAGNETIKA
Bloch, F.
Zeitschrift für Physik, v. 74, pp. 295–335, 1932

59. THE THEORY OF ELECTRIC AND MAGNETIC SUSCEPTIBILITIES
Van Vleck, J. H.
The Clarendon Press, Oxford, 1932

60. ELECTRICITY AND MAGNETISM
Jeans, J. H.
The University Press, Cambridge, 1933

61. PROPAGATION OF LARGE BARKHAUSEN DISCONTINUITIES. IV. REGIONS OF REVERSED MAGNETIZATION
Sixtus, K. J. and Tonks, L.
The Physical Review, v. 43, pp. 931–940, 1933

62. ELEKTRONENTHEORIE DER METALLE
Sommerfeld, A. and Bethe, H.
Handbuch der Physik, v. 24.2, pp. 333–622, 1933

63. ZUR THEORIE DES AUSTAUSCHPROBLEMS UND DES FERROMAGNETISMUS BEI TIEFEN TEMPERATUREN
Moller, C.
Zeitschrift für Physik, v. 82, pp. 559–567, 1933

64. UBER DIE HYSTERESISVERLUSTE IN FLUSSIGEN FERROMAGNETIKA (AMALGAMEN)
Antik, I. and Kubyschkina, T.
Wissenschaftliche Berichte Moskauer Staatsuniversität, v. 2, pp. 143–149, 1934

65. ON THE THEORY OF THE DISPERSION OF MAGNETIC PERMEABILITY IN FERROMAGNETIC BODIES
Landau, L. and Lifshitz, E.
Physikalische Zeitschrift der Sowjetunion, v. 8, pp. 153–169, 1935

66. ON MAGNETIC AND ELECTROSTATIC ENERGY
Guggenheim, E. A.
Proceedings of the Royal Society of London, Series A, v. 155, pp. 49–70, 1936

67. INTRODUCTION TO FERROMAGNETISM
Bitter, F.
McGraw-Hill Book Co., New York, 1937

68. ON THE NATURE OF THE COERCIVE FORCE AND IRREVERSIBLE CHANGES IN MAGNETIZATION
Kondorsky, E.
Physikalische Zeitschrift der Sowjetunion, v. 11, pp. 597–620, 1937

69. ON THE ANISOTROPY OF CUBIC FERROMAGNETIC CRYSTALS
Van Vleck, J. H.
The Physical Review, v. 52, pp. 1178–1198, December 1, 1937

70. PROBLEME DER TECHNISCHEN MAGNETISIERUNGSKURVE, ZUR DEUTUNG DER KOERZITIVKRAFT
Kersten, M.
Verlag, Julius Springer, Berlin (Reprinted J. W. Edwards Publishers, Inc., Ann Arbor, 1938)

71. REMARK ON THE FUNDAMENTAL RELATIONS OF THERMOMAGNETICS
Fokker, A. D.
Physica, v. 6, pp. 791–796, 1939

72. FERROMAGNETISMUS
Becker, R. and Doring, W.
Verlag, Julius Springer, Berlin (Reprinted J. W. Edwards Publishers, Inc., Ann Arbor, 1939)

73. THEORY OF THE APPROACH TO MAGNETIC SATURATION
Brown, W. F., Jr.
The Physical Review, v. 58, pp. 736–743, October 15, 1940

74. FERROMAGNETIC ANISOTROPY AND THE ITINERANT ELECTRON MODEL
Brooks, H.
The Physical Review, v. 58, pp. 909–918, November 15, 1940

75. GRUNDLAGEN EINER THEORIE DER FERROMAGNETISCHEN HYSTERESE UND DER KOERZITIVKRAFT
Kersten, M.
S. Hirzel, Leipzig (Reprinted J. W. Edwards Publishers, Inc., Ann Arbor, 1943)

76. NEW RESEARCHES ON MAGNETIZATION BY ROTATION AND THE GYRO MAGNETIC RATIOS OF FERROMAGNETIC SUBSTANCES
Barnett, S. J.
Proceedings of the American Academy of Sciences, v. 75, pp. 109–129, 1944

77. VIRTUES AND WEAKNESSES OF THE DOMAIN CONCEPT
Brown, W. F., Jr.
Reviews of Modern Physics, v. 17, no. 1, pp. 15–19, January 1945

78. A SURVEY OF THE THEORY OF FERROMAGNETISM
Van Vleck, J. H.
Reviews of Modern Physics, v. 17, no. 1, pp. 27–47, 1945

79. THE DEMAGNETIZING FACTORS FOR ELLIPSOIDS
Stoner, E. C.
The Philosophical Magazine, v. 36, no. 263, pp. 803–821, 1945

80. BASES D'UNE NOUVELLE THEORIE GENERALE DU CHAMP COERCITIF
Néel, L.
Annales de l'université de Grenoble, v. 22, pp. 299–343, 1946

81. QUELQUES ASPECTS DE LA THEORIE DU MAGNETISME
Van Vleck, J. H.
Annales de l'institut Henri Poincaré, v. 10, pp. 57–190, 1947

82. THEORIE DE L'ANISOTROPIE A AIMANTS TRAITES A CHAUD DANS UN CHAMP MAGNETIQUE
Néel, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 225, pp. 109–111, 1947

83. ENERGY CALCULATION FOR DOMAINS
Shockley, W.
The Physical Review, v. 73, p. 1246, 1948

84. THE APPLICATION OF THE BETHE-PEIERLS METHOD TO FERROMAGNETISM
Weiss, P. R.
The Physical Review, v. 74, pp. 1493–1504, 1948

85. A MECHANISM OF MAGNETIC HYSTERESIS IN HETEROGENEOUS ALLOYS
Stoner, E. C. and Wohlfarth, E. P.
Philosophical Transactions of the Royal Society of London, Series A, v. 240, pp. 599–644, 1948

86. MAGNETISM (4th Edition)
Stoner, E. C.
Methuen and Co., Ltd., London, 1948

87. A QUANTITATIVE EXAMINATION OF RECENT IDEAS ON DOMAIN STRUCTURES
Bates, L. F. and Neale, F. E.
Physica v. 15, ,pp. 220–224, 1949

88. PHYSICAL THEORY OF FERROMAGNETIC DOMAINS
Kittel, C.
Reviews of Modern Physics, vol. 21, no. 4, pp. 541–583, 1949

89. THEORY OF THE FORMATION OF POWDER PATTERNS ON FERROMAGNETIC CRYSTAL
Kittel, C.
The Physical Review, v. 76, p. 1527, 1949 b

90. ENERGIES AND WIDTHS OF DOMAIN BOUNDARIES IN FERROMAGNETICS
Lilley, B.
Philosophical Magazine, v. 41, p. 792, 1950

91. NOTE ON THE INERTIA AND DAMPING CONSTANT OF FERROMAGNETIC DOMAIN BOUNDARIES
Kittel, C.
The Physical Review, v. 80, no. 5, p. 918, December 1, 1950

92. FERROMAGNETISM
Bozorth, R. M.
D. Van Nostrand Co., N. Y., 1951

93. ON THE THEORY OF SPIN WAVES IN FERROMAGNETIC MEDIA
Herring, C. and Kittel, C.
The Physical Review, v. 81, no. 5, pp. 869–880, March 1, 1951

94. STRUCTURE OF METALS
Barrett, C. S.
McGraw-Hill Book Co., N. Y., 1952

95. ENERGY OF A BLOCH WALL ON THE BAND PICTURE. I. SPIRAL APPROACH
Herring, C.
The Physical Review, v. 85, no. 6, pp. 1003–1011, March 15, 1952

96. ENERGY OF A BLOCH WALL ON THE BAND PICTURE
Wohlfarth, E. P.
Proceedings of the Physical Society, London Section A, v. 65, pp. 1053–1054, 1952

97. SOME MAGNETIC PROPERTIES OF METALS. I. GENERAL INTRODUCTION, AND PROPERTIES OF LARGE SYSTEMS OF ELECTRONS
Dingle, R. B.
Proceedings of the Royal Society of London,
Series A, v. 211, pp. 500–516, 1952

A general introduction surveying the problems to be examined in a series of paper is followed by a detailed treatment of the magnetic behavior of a large system of electrons. The Schrodinger equation is solved on the assumption that the system is unbounded. An expression is obtained for the density of states and the free energy of the system found. The magnetic susceptibility, thermodynamic potential and specific heat are discussed.

98. SOME MAGNETIC PROPERTIES OF METALS. II. THE INFLUENCE OF COLLISIONS ON THE MAGNETIC BEHAVIOR OF LARGE SYSTEMS
Dingle, R. B.
Proceedings of the Royal Society of London,
Series A, v. 211, pp. 517–525, 1952

A discussion of the effect of collisions on the magnetic properties of a large system of free electrons shows that the non-periodic term in the susceptibility is hardly affected, but that the periodic terms are reduced in magnitude by a factor $\exp(-hp/\gamma\beta H)$, where p is the harmonic considered, γ is the mean collision time, and $\beta = eh/2\pi mc$.

99. MODELS OF EXCHANGE COUPLING IN FERROMAGNETIC MEDIA
Van Vleck, J. H.
***Reviews of Modern Physics,* v. 25, no. 1, pp. 220–228, January 1953.**

100. THEORY OF DISPLACEMENT OF DOMAIN BOUNDARIES
Akulov, N. S. and Krinchik, G. S.
***Doklady Akademii Nauk* SSSR,**
v. 89, pp. 809–812, 1953
NSF-Tr-106

101. SOME BOUNDARY PROBLEMS OF THE THEORY OF IMPULSIVE MAGNETIZATION
Taksar, I. M. and Plume, Z. Y.
Trudy Instituta Fjiki, Akademiya Nauk Latvia,
USSR, v. 6, pp. 21–38, 1953 (in Russian)

A study is made of the problem of longitudinal magnetization of an infinite, circularly cylindrical, conducting wire of unit radius by the application of an external magnetic field. Two cases of external field are considered: in one the field jumps from zero to unity at time $t = 0$, while in the other the value unity is approached exponentially. The problem is solved by separation of variables. (*PA*, 1956, #2249)

102. ATOMIC MAGNETIC MOMENTS OF FERROMAGNETICS
Vonsovskil, S. V. and Vlasov, K. B.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki,
v. 25, no. 3, pp. 327–340, 1953 (in Russian)

Atomic magnetic moments are calculated using a model based on a theory of interacting external 4*s*- and internal 3*d*-electrons in the crystal lattice. One consequence of this theory is that such moments have non-integral values. Discussing pure metals the authors assume the total free energy of the electrons to be the sum of the free energies of the internal and external electrons and expressions are derived for the atomic magnetic moment at temperature T and at very low temperatures. Using a general wave-function derived by Vonsovskil and the Smirnov quantum theory of alloys, the authors go on to determine for disordered alloys the equilibrium values of magnetization due to *s*- and *d*-electrons and hence to derive an expression for χ (alloy). This is an approximately parabolic relation with respect to concentration. The authors also indicate how to work out the dependence of the Curie point on concentration. Calculation of the energy spectrum of an external electron taking account of *s-d* exchange interaction for an ordered alloy shows this has the form of two non-overlapping bands. Unlike Smirnov the authors find that in a ferromagnetic alloy the breadth of these energy bands and their separation depend on the magnitude of *d*-electron magnetization and the orientation of the spin of an *s*-electron relative to this magnetization. Analysis gives the same expression for atomic magnetic moment as for disordered alloys. Qualitative agreement is stated to be found between experimental results for Fe–Ni alloys and the calculated dependence upon concentration and degree of ordered

arrangement of the alloy—roughly parabolic in form with maximum at stoichiometrical composition. [The value of the paper would be much enhanced by an additional section giving a detailed comparison of theoretical and experimental results.] (*PA*, 1955, #7179)

103. ZENER'S THEORY OF FERROMAGNETISM
Turov, E. A.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 3, pp. 352–358, 1953 (in Russian)**

Zener's theory is analyzed from the point of view of the (*s-d*)-exchange model of transition metals. The temperature dependence of spontaneous magnetization at low temperatures, as calculated in accordance with Zener's assumptions, widely differs from experimental values. Zener's theory cannot be applied to ferromagnetics, at least to those in which magnetization obeys the $T^{3/2}$ law. (*PA*, 1955, #1040)

104. APPLICATION OF THE SPHERICAL MODEL TO ANTIFERROMAGNETISM II.
Uryu, N.
***Memoirs of the Faculty of Science*, Kyusyu University, Series B, v. 1, no. 4, pp. 139–145, March, 1954**

The spherical model is applied to a f.c.c. lattice and high temperature series expansions (J/kT) are obtained for the internal energy and entropy. The model does not predict antiferromagnetism for this lattice structure. (*PA*, 1955, #2859)

105. ON THE APPROXIMATE NATURE OF THE SPHERICAL MODEL
Uryu, N.
***Memoirs of the Faculty of Science*, Kyusyu University, Series B, v. 1, no. 4, pp. 146–149, March, 1954**

The spherical and Ising model are contrasted in their applicability to ferromagnetic lattices. It is found that the partition functions for the two models have quite a different temperature dependence below the Curie point, but that there is more agreement between them above, the agreement being the closer the larger the co-ordination number. (*PA*, 1955, #2860)

106. ON A MINIMAL PRINCIPLE IN THE THEORY OF MAGNETISM
Graffi, D.
***Annali dell 'universita di Ferrara* v. 3, pp. 25–29, 1954 (in Italian)**

A treatment of the magnetic field due to steady currents in the presence of magnetizable bodies, in general ferromagnetic and anisotropic, but without hysteresis. The principle established is: in the class of all fields compatible with the currents, the actual field due to the currents in the presence of the magnetizable bodies minimizes the total complementary energy. (*PA*, 1957, #2403)

107. ON LORENTZ FORCE DUE TO INTERNAL MAGNETIC FIELD ACTING ON A CONDUCTION ELECTRON (IN METALS)
Kondo, K.
***Science Reports of the Saitama University*, Series A, v. 1, no. 3, pp. 125–127, 1954**

Shows that in the theory of the extraordinary Hall constant in ferromagnetic substances, arising from spin-orbit coupling effects, the electronic velocity should strictly be an operator. (*PA*, 1955, #1985)

108. THE MAGNETIZATION PROCESSES NECESSARY FOR THE TEMPERATURE MAGNETIC HYSTERESIS EFFECT IN FERROMAGNETICS
Baranova, N. A. and Shur, Ya. S.
***Doklady Akademii Nauk*, SSSR, v. 94, no. 5, pp. 825–827, 1954 (in Russian)**

109. QUANTUM THEORY OF THE MAGNETOSTRICTION OF FERROMAGNETIC MONOCRYSTALS
Gusey, A. A.
***Doklady Akademii Nauk*, SSSR, v. 98, no. 5, pp. 749–752, 1954 (in Russian)**

A systematic quantum-mechanical consideration of the electron system in a spontaneously deformed ferromagnetic monocrystal furnishes an explanation of the phenomenon of magnetostriction and shows its relationship

with the magnetic interaction of the electrons. The theory yields the temperature relation of the magnetostriction constants at low temperatures for hexagonal and cubic crystals which must show analogies with the anisotropy constants, as suggested by the character of the low-temperature energy spectrum. (*PA*, 1955, #7194)

110. ON THE SPIN WAVE FIELD THEORY AND ITS APPLICATION TO THE MICROWAVE RESONANCE

Tsuya, N.

***Progress of Theoretical Physics*, v. 12, no. 1, pp 1–9, July 1954**

An exact operator system describing spin systems such as the ferro-, ferri- and antiferromagnetic was obtained, in which spin S need not be equal to one half. The field operators adopted here are well known annihilation and creation operators usually used for the Bose field, with subsidiary conditions limiting the infinite space of numbers to a finite value of $2S + 1$. Exact solutions of these Hamiltonians, of course, cannot be obtained because their form is not bi-linear, but they are solved approximately in the case of low temperatures. The resonance conditions obtained by this method for ferro-, ferri- and antiferromagnetic cases are the same as those already obtained from the Heisenberg equation of motion. (*PA*, 1955, #1042)

111. INFLUENCE OF A CIRCULAR FIELD ON THE FORM OF THE LONGITUDINAL MAGNETIZATION CURVE

Ershov, R. E.

***Zhurnal Tekhnicheskoi Fiziki*, v. 24, no. 8, pp. 1508–1512, 1954 (in Russian)**

112. INVESTIGATION OF THE HYSTERESIS OF THE BALLISTIC DEMAGNETIZATION COEFFICIENT

Lyustrova, A. P. and Lipatova, V. A.

***Zhurnal Tekhnicheskoi Fiziki*, v. 24, no. 8, pp. 1513–1519, 1954 (in Russian)**

113. A THEORY OF DOMAIN CREATION AND COERCIVE FORCE IN POLYCRYSTALLINE FERROMAGNETICS

Goodenough, J. B.

***The Physical Review*, v. 95, no. 4, pp. 917–932, August 15, 1954**

114. A NOTE ON A THEORY OF THE UNIAXIAL FERROMAGNETIC ANISOTROPY INDUCED BY COLD WORK OR BY MAGNETIC ANNEALING IN CUBIC SOLID SOLUTIONS

Taniguchi, S. and Yamamoto, M.

***The Science Reports of the Research Institutes*, Tôhoku University, Series A, v. 6, no. 4, pp. 330–322, August 1954**

To explain the origin of the uniaxial ferromagnetic anisotropy induced by cold work or by magnetic annealing in cubic solid solutions, the anisotropy energy caused by an anisotropic distribution of solute atoms produced by cold work or magnetic annealing has been calculated using the same model as in Van Vleck's theory of cubic anisotropy. The results obtained concerning the order of magnitude of the uniaxial anisotropy, and its dependence on the temperature, concentration and direction of applied tensile stress or magnetic field agree well with available experimental data. (*PA*, 1955, #2016)

115. SUSCEPTIBILITIES OF ANTIFERROMAGNETIC CRYSTALS AT THE ABSOLUTE ZERO OF TEMPERATURE

van Peski-Tinbergen, T. and Gorter, C. J.

***Physica*, v. 20, no. 9, pp. 592–602, September 1954**

On the basis of the molecular field theory of antiferromagnetism, calculations are made on magnetic susceptibilities at absolute zero. Rhombic and cubic symmetries are considered with constant fields in the direction of the axes. Besides the threshold phenomena the anomalies occurring when antiferromagnetism goes over into paramagnetism are considered. (*PA*, 1955, #1043)

116. ON THE G-VALUE OF FERROMAGNETIC RESONANCE

Date, M.

***The Science Reports of the Research Institutes*, Tôhoku University, Series A, v. 6, no. 5, pp. 503–510, October 1954**

The quantum mechanical calculation of the effective g-value was performed for the three-spin system in which there exists exchange interaction among three spins of ½, of which one spin has a different g-value. The object of this paper is to analyse the simplest model of ferrimagnetic substances for which the problem of the determining of the exact g-value is unsolved. The result can be expressed as follows: When the exchange interaction is positive, the effective g-value of the three-spin-system coincides with that of the classical calculation. But when ferrimagnetic interaction exists, the effective g-value of this system is different from the result of the classical theory of ferrimagnetic resonance. This is caused by the characteristic of the three-spin wave-functions which are symmetric for the ferromagnetic ground state but show asymmetry for the ferrimagnetic state in exchanging each spin co-ordinate. If this effect can be applied in the same manner to the case of an actual ferrite, for example Ni ferrite, the effective g-value to be shown in the microwave resonance absorption must be expressed as $g^* = (2g_{Ni} + g_{Fe})/3$. The result of the classical calculation, however, shows $g^* = g_{Ni}$. Here g_{Ni} and g_{Fe} represent the g-values of Ni^{++} and Fe^{+++} ions respectively. Of course, this relation must be re-evaluated in the case of actual ferrites which have many electrons acting on one another with strong exchange interaction. But it may be pointed out that the determination of g-values in ferrites only from the classical point of view must be reconsidered. (*PA*, 1955, #1982)

117. MAGNETIZEM ENAKOMERNO NAELEKTRENE KROGLE, KI SE VRTI

Janzekovic, J.

***Elektrotehniski Vestnik*, v. 22, no. 9–10, pp. 281–287, September, October, 1954**

Magnetism of rotating sphere uniformly charged with electricity; two cases are considered: in first case sphere is uniformly charged on surface; in other case through all its inside; equations representing course of magnetic lines and equations for energy of electric and magnetic fields developed. (*EI*,1955)

118. EFFECTS OF ANISOTROPY ON THERMODYNAMIC PROPERTIES OF ANTIFERROMAGNETS

Eisele, J. A. and Keffer, F.

***The Physical Review*, v. 96, no. 4, pp. 929–933, November 15, 1954.**

In antiferromagnets, because of interplay with exchange energy, a small anisotropy can have a huge effect on thermodynamic properties. Detailed calculations are given, using spin-wave theory, of this effect on sublattice magnetization, specific heat and parallel susceptibility of a cubic or uniaxial antiferromagnet. Specific heat data is discussed and experiments are suggested on the relatively large spin specific heats of antiferromagnets with low curie points. The theory is extended to orthorhombic symmetry, and reasonable agreement found with existing experimental data on $CuCl_2 2H_2O$. (*PA*, 1955, #1045)

119. ON ANTIFERROMAGNETISM IN METALS

Tredgold, R. H.

***Proceedings of the Physical Society*, London, Section A, v. 67, pt. II, no. 419, pp. 1018–1020, November 1, 1954.**

Theoretical study showing that any material having narrow partly filled energy band and not exhibiting ferromagnetism will show antiferromagnetic properties at sufficiently low temperatures. (*EI*, 1955)

120. ON THE CONNECTION BETWEEN THE COERCIVE FORCE OF A FERROMAGNETIC AND INTERNAL STRESS

Vicena, F.

***Czechoslovak Journal of Physics*, v. 4, no. 4, pp. 419–438, November 1954 (in Russian with English summary)**

An extension of the internal stress theory of Néel. Account is taken of the spatial and angular distribution of the internal stresses, the regions of homogeneous stress being taken to be spherical and the angular distribution to be isotropic. Both boundary surface tension and internal magnetic pole effects were considered, the former effect being found to be much more important than was found by Néel, especially for iron where it predominates. With an internal stress of magnitude 30 kg mm^{-2} the observed coercive force of iron (~1 oersted) and nickel (~10 oersted) can be accounted for; minimum values due to magnetostrictive stresses may also be derived. (*PA*, 1955, #4778)

121. REVERSIBLE SUSCEPTIBILITY OF FERROMAGNETICS

Grimes, D. M. and Martin, D. W.
The Physical Review, v. 96, no. 4, pp. 889–896, November 15, 1954

An expression is given relating the magnetization dependence of the reversible susceptibility normal to the field direction to that of the parallel reversible susceptibility. Modification of these susceptibility dependences due to the trapping of domain walls in metastable positions by potential holes is considered. The macroscopic magnetization is expressed in terms of a distribution of potential holes by an argument analogous to that of a "mean free path." The desirability of further examination of this approach is discussed. The reversible susceptibilities of three ferrite specimens were measured and found to compare favourably with the theory. (*PA*, 1955, #1044)

122. MAGNETIC ANISOTROPY AT 0 °K

Tessman, J. R.
The Physical Review, v. 96, no. 5, pp. 1192–1195 December 1, 1954

The results of the spin-wave method of Holstein and Primakoff are extended to obtain approximate values for the dependence of the energy of magnetically saturated cubic crystals upon the direction of magnetization. The anisotropy at 0 °K is calculated for the cases of dipolar ferromagnetism and exchange ferromagnetism. In a nearest neighbour approximation, the results agree with those obtained by Van Vleck from a treatment of ferromagnetic anisotropy. However, in the case of dipolar interaction, the nearest neighbour approximation is not sufficient and more distant neighbours are included. For dipolar ferromagnetism, the method gives the following results: In a face-centred cubic (f.c.c.) lattice of spin S, the anisotropy constant K_1 is a maximum when there is no external field and is then given by $K_1 = -0 \cdot 11 M_0^2/S$, where M_0 is the saturation magnetization. In a body-centred cubic (b.c.c.) lattice, with no external field, $K_1 = -0 \cdot 15 M_0^2/S$. An external field must be applied to obtain saturation in a simple cubic (s.c.) lattice; $K_1 = +0.43 M_0^2/S$ when the external field $H = 0.6 M_0$. More generally, in the presence of an external field H, then $K_1 = \kappa [(M_0^2/S)(4\pi/3) + H/M_0]^{-1}$, where $\kappa = -0.46$ for an f.c.c. lattice, -0.63 for a b.c.c. lattice and $+2.06$ for an s.c. lattice. All values given are for specimens having zero demagnetizing field. (*PA*, 1955, #1060)

123. THE RELAXATION PROCESS IN FERROMAGNETIC RESONANCE ABSORPTION

Kasuya, T.
Letter in *Progress of Theoretical Physics*, v. 12, no. 6, pp. 802–803, December 1954

A theoretical treatment of relaxation times for nonmetallic ferromagnetics, e.g., ferrites, indicates that three spin wave collisions are important. These are permitted as a result of lattice imperfections and $1/\tau \sim 10^8\ \text{sec}^{-1}$ and should be proportional to T. (*PA*, 1955, #7180)

124. DEMAGNETISING ENERGIES OF UNIFORMLY MAGNETISED RECTANGULAR BLOCKS

Rhodes, P. and Rowlands, G.
Proceedings of the Leeds Philosophical and Literary Society, Scientific Section, v. 6, no. 4, pp. 191–210, December 1954

Results are given of calculations of the magnetostatic self-energies of the following structures: (1) a uniformly magnetized rectangular block, (2) a rectangular block containing an infinitely thin 180-deg domain boundary, (3) a rectangular block containing several equispaced 180-deg boundaries. The applications of the results of such calculations to specific problems are outlined. (*PA*, 1955, #6287)

125. THE RELAXATION PROCESS IN FERROMAGNETIC RESONANCE ABSORPTION

Kasuya, T.
Letter in *Progress of Theoretical Physics*, v. 12, no. 6, pp. 803–805, December 1954

A similar treatment when conduction electrons are present, indicates d electron spin/conduction electron orbital interaction to be the controlling feature governing the relaxation time of 10^{-10} sec which should be independent of T. (*PA*, 1955, #7181)

126. CLASSICAL THEORY OF THE TEMPERATURE DEPENDENCE OF MAGNETIC ANISOTROPY ENERGY

Zener, C.
The Physical Review, v. 96, no. 5, pp. 1335–1337, December 1, 1954

The consequences are analysed of the following two assumptions: (1) the effect of temperature upon magnetic anisotropy arises solely from the introduction of local deviations in the direction of magnetization; and (2) the local deviation in an elementary region is the resultant of a very large number of independent deviations. The influence of these local deviations upon the magnetic anisotropy is most conveniently expressed by representing the magnetic energy as a series of surface harmonics. The coefficient of the nth harmonic is found to vary with temperature as $\{J_s\ (T)/J_s\ (0)\}$ raised to the power $n\,(n+1)/2$. The first two exponents for cubic crystals have values of 10 and 21, respectively. The exponent 10 expresses almost precisely the observed temperature dependence of K_1 in iron. In nickel the anisotropy decreases much more rapidly than predicted. It is deduced that the above two assumptions are applicable to iron but not to nickel. (*PA*, 1955, #1980)

127. THE $T^{3/2}$ LAW FOR THE APPROACH TO SATURATION OF FERROMAGNETIC SUBSTANCES

Néel, L.

***Journal de physique et le Radium*, v. 15, no. 12, pp. 74–75, December 1954 (in French)**

Following Schafroth the relative magnetization ζ is expressed in the form $1-\zeta=\sum_{n=6}^{\infty}(-1)^n A_n\,(T/\theta^{n/4}$, where the coefficients A_n are functions of the spin quantum number S and θ is the paramagnetic Curie temperature. The formula is applied to gadolinium, and conclusions are drawn as to its temperature range of validity. The often used method of estimating values of the exchange integral from low-temperature magnetization data using the $T^{3/2}$ law is criticized. (*PA*, 1955, #2861)

128. DEMAGNETISING ENERGIES OF UNIFORMLY MAGNETISED RECTANGULAR BLOCKS

Rhodes, P., and Rowlands, G.

***Proceedings of the Leeds Philosophical and Literary Society*, Scientific Section, v. 6, pt. 4, pp. 191–210, December 1954**

Study relating to ferromagnetics; calculation of demagnetizing energies: (1) of uniformly magnetized block, as function of dimensions, (2) of block containing single boundary of negligible thickness dividing it into two oppositely magnetized domains, as function of boundary position, and (3) of block containing several equi-spaced boundaries dividing it into alternately magnetized domains, as function of number of domains. (*EI*, 1955)

129. TOPOLOGY OF STEADY CURRENT MAGNETIC FIELDS

McDonald, K. L.

***American Journal of Physics*, v. 22, no. 9, pp. 586–596, December 1954**

Discussion of misconceptions on nature of lines of force; examples show how magnetic lines of force and of induction are not generally closed curves and that line density may be made infinite in regions where field intensity is finite: systematic analysis of distribution of singular points and of linear fields in neighborhood of these points. (*EI*, 1955)

130. THE QUANTUM THEORY OF FERROMAGNETISM

Vonsovskii, S. V., Vlasov, K. B.,and Turov, E. A.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 1, pp. 37–50, 1955 (in Russian)**

The magnetic interaction of the electrons of a ferromagnetic is represented on a multi-electron quantum-mechanical crystal model. The energy spectrum of the system at low temperatures is calculated. Consideration of the magnetic interaction terms in the orginal Hamiltonian of the system leads to the emergence of energy components of quasi-classic magnetic type as well as terms of the type of anistropic (magnetic) exchange. The latter may be important, e.g., in calculating relaxation phenomena in ferromagnetics and antiferromagnetics. (*PA*, 1956, #1347)

131. FERROMAGNETIC DOMAINS

Stewart, K. H.

The University Press, Cambridge, 1954

***Cambridge Monographs in Physics* (Reviewed in *British Journal of Applied Physics*, v. 6, no. 1, p. 39, January 1955)**

132. ELECTROMAGNETIC EFFECTS OF SPIN WAVE RESONANCE IN FERROMAGNETIC METALS

Ament, W. S. and Rado, G. T.
***The Physical Review*, v. 97, no. 6, pp. 1558–1566, March 15, 1955**

It was shown experimentally by Rado and Weertman that under suitable conditions there is an observable effect of exchange interactions on the ferromagnetic resonance in metals. The present paper provides an electromagnetic theory of this "spin-wave resonance" experiment and satisfactorily explains the exchange shift as well as the width and shape of the absorption line. A combined solution is obtained of Maxwell's equations and the equation of motion of the magnetization vector **M**, the latter equation including the exchange term due to the nonuniform orientation of **M** in the skin depth. It is shown that the triple refraction caused by the exchange effect necessitates the introduction of new boundary conditions. The final result, which is checked numerically and by an approximate calculation, is an expression for the measurable surface impedance and the "equivalent isotropic permeability" derived therefrom. This result is discussed and generalized, the properties of thermal spin waves in metals are briefly considered, and previous theories of exchange effects in ferromagnetic resonance are shown to be inadequate. (*PA*, 1955, #4779)

133. STATISTICAL MODELS OF FERRIMAGNETISM

Syozi, I. and Nakano, H.
***Progress of Theoretical Physics*, v. 13, no. 1, pp. 69–78, January 1955**

The temperature-dependence of some idealized ferrimagnetic crystals is studied. The whole lattice of the crystal discussed here can be divided into two sublattices. These sublattices are generally inequivalent to each other, and any lattice points of one sublattice L_1 is nearest-neighbouring to some number of lattice points belonging to another sublattice L_1 and vice versa. Every lattice point of L_1 is occupied by a certain kind of magnetic atom A_1 and that of L_2 by another kind of magnetic atom A_2. In this configuration there exists an antiferromagnetic coupling between every pair of A_1 and A_2 nearest-neighbouring each other. A_1-atoms and A_2-atoms have their own magnetic moment generally different from each other. Without introducing any approximation, the spontaneous magnetization of such a ferrimagnetic Ising model is computed by making use of the Onsager theory and especially of the solution of the temperature-dependence of the spontaneous magnetization of the plane square lattice obtained by Yang. The exact results obtained for the magnetic behaviour of the idealized simple model are quite similar in character to those of the actual ferrimagnetic crystal computed by Néel in the Weiss approximation. (*PA*, 1955, #9758)

134. THEORY OF THE LOW TEMPERATURE PROPERTIES OF FERROMAGNETIC CRYSTALS

Van Kranendonk, J.
Letter in *Physica*, v. 21, no. 1, pp. 81, 82, January 1955

The spin-wave treatment is generalized by considering the statistical mechanical properties of the partition function of the spin-wave assembly treated as a non-ideal Bose-Einstein gas. The temperature variation of the magnetization is calculated for a simple cubic lattice, both neglecting interaction between spin waves (leading to the $T^{3/2}$ law at low temperatures) and also taking account of binary collisions. The effect of such collisions is shown to be important, and the corresponding magnetization, temperature curve is shown to be in good agreement with the experimental curve for nickel at temperatures less than about 0.15 of the Curie temperature. (*PA*, 1955, #3875)

135. ANTIFERROMAGNETISM

Nagamiya, T., Yosida, K., and Kubo, R.
***Advances in Physics*, v. 4, pp. 1–112, January 1955**

An extensive review of the following topics: I. *Fundamental facts and elementary theory.* Neutron and X-ray diffraction measurements; susceptibility and specific heat determinations (a table gives magnetic data and an extensive bibliography, 112 references, for a wide variety of substances); theory of susceptibility at low fields (molecular field approximation) and at moderately high fields (effects of anisotropy); antiferromagnetic resonance (with application to $CuCl_2$); transition to paramagnetic behaviour in high fields. II. *Indirect exchange interaction and anisotropy energy.* Superexchange and double exchange interactions (outline of quantum mechanical calculations); origins of anisotropy energy and application

of the theory of anisotropy to $CuCl_2$ and fluorides of Mn, Fe, Co. III. *Statistical theory of antiferromagnetism.* Ising model; high temperature approximations (Bethe-Peierls-Weiss); low temperature approximations (linear chain model of Bethe and Hulthen), the antiferromagnetic ground state; semi-classical and quantum-mechanical formulations of the spin-wave theory and consequences of the theory (specific heat, sublattice magnetization, susceptibility); limitations of the spin-wave theory. (*PA*, 1955, #1039)

136. NUCLEAR MAGNETISM
Bloch, F.
***American Scientist*, v. 43, no. 1, pp. 48–62, January 1955**

Explanation of phenomenon of nuclear magnetism and how it differs from ordinary or "atomic" magnetism; how nuclear magnetism is caused by amperian currents within nucleus; experiments which reveal such properties as magnetic resonance; measurement of nuclear magnetic moments. (*EI*, 1955)

137. THEORY OF FARADAY AND KERR EFFECTS IN FERROMAGNETICS
Argyres, P. N.
***The Physical Review*, v. 97, no. 2, pp. 334–345, January 15, 1955**

Analysis of first order effect of spin orbit interaction on optical properties of ferromagnetics on basis of band theory of metals; relation to order of magnitude, dispersion, and temperature dependence of Faraday and magneto-optic or polar Kerr effects. (*EI*, 1955)

138. THERMODYNAMICAL THEORY OF GALVANOMAGNETIC AND THERMOMAGNETIC PHENOMENA
Fieschi, R.
***Il Nuovo Cimento*, Supplement no. 1, pp. 1–47, no. 2, pp. 1168–1170, 1955**

Theory of irreversible processes and De Groot and Mazur's theory; derivation of reciprocal relations including those for heat conduction, diffusion, cross effects and viscosity; explicit expressions for measurable effects in isotropic metals. (*EI*, 1955)

139. PHOTO-ELECTRON EMISSION IN A FERROMAGNETIC
Veksler, A. Z.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 2, pp. 201–208, 1955 (in Russian)**

Formulae determining the velocity distribution of the photoelectrons and the temperature relation of the photocurrent near the Curie point are derived. The calculations are based on Vonsovskii's *s-d* exchange model and consider the periodic lattice potential by the method of variation of the parameters. The photocurrent is found to depend on the square of the magnetization, which agrees with Cardwell's results. (*PA*, 1956, #1375)

140. ON THE QUESTION OF THE EFFECT OF STRESSES PRODUCED DURING PRECIPITATION
Vicena, F.
***Czechoslovak Journal of Physics*, v. 5, no. 1, pp. 11–17, February 1955 (in Russian)**

It is assumed that various physical processes such as age hardening, work hardening or the presence of dislocations will affect the existence of internal stresses of various types in a ferromagnetic and that their influence on the coercive force will therefore differ. The effect of internal stress produced in the process of precipitation in the vicinity of particles of the precipitated phase on the coercive force of the ferromagnetic is investigated. The following assumptions are made: the form of the precipitated particle is regarded as isotropic (spherical), the Bloch wall is considered plane and the distance between the precipitates is considered large in comparison with their size. The character of the tension in the surroundings of the spherical precipitate was investigated by Mott and Nabarro (1940). Their explanation of the tensor of tension in the surroundings of the precipitates was taken as a basis for the present calculations. Particular attention was paid to the influence of the effect of surface tension of the Bloch wall and the effect of magnetic charges. It is shown that with spherical particles the first influence need not be considered at all, due to the symmetry existing, and that the second can be neglected in comparison with the effect of magnetic charges produced on the surface of a particle of the

precipitate on the direction of spontaneous magnetization. The conclusion is drawn that with precipitates of spherical shape (e.g. carbide of iron, Fe_3C, in iron) the internal stresses produced by them in their vicinity during precipitation do not in any marked degree influence the movement of the Bloch wall across these inclusions and thus also the coercive force. Thus the opinion held by some authors that the internal stresses influencing the coercive force (which is the subject of the "stress theory") were produced in the vicinity of the precipitates during age hardening, is not justified. (*PA*, 1955, #4806)

141. QUANTUM THEORY OF MAGNETOSTRICTION

Gusev, A. A.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 2, pp. 181–192, 1955 (in Russian)**

A consistent quantum-mechanical theory of the magnetostriction of hexagonal monocrystals, based on Bogolyubov and Tyaklikov's theory of the polar model of a metal, considering magnetic and magneto-elastic interaction of the electrons in the lattice, is presented. This shows that magnetostriction is due to the magnetic interaction of the electrons and yields the temperature relation of the magnetostriction constants, the energy spectrum at low temperatures and the free energy of the crystal. (*PA*, 1956, #1356)

142. THE THEORY OF THE NERNST EFFECT OF FERROMAGNETIC METALS

Meyer, K.

Note in *Zeitschrift für Naturforschung*, v. 10a, no. 2, p. 166, February 1955 (in German)

The ratio of the extraordinary to the ordinary Nernst coefficients is shown on the basis of a two-band model and the treatment of Karplus and Luttinger to be of the same order as the ratio of the corresponding Hall coefficients. (*PA*, 1955, #4780)

143. A THEORY OF ANTIFERROMAGNETISM. II.

Oguchi, T.

***Progress of Theoretical Physics*, v. 13, no. 2, pp. 148–159, February 1955**

General theories of ferromagnetism and antiferromagnetism based on the Heisenberg model, which are extensions of the Weiss theory, are presented. The approximation of these theories is not as good as that of the author's previous theories, but the main object of this paper is to develop simple and tractable theories which can include short-range order effects. The perpendicular susceptibility of an antiferromagnet below the Néel point is obtained, and is almost independent of temperature. The large residual entropy above the Néel point of $CuCl_2 2H_2O$ can be explained by application of the present theory. (*PA*, 1956, #457)

144. MOLECULAR FIELD IN THE SPHERICAL MODEL

Lax, M.

***The Physical Review*, v. 97, no. 3, pp. 629–640, February 1, 1955**

The Heisenberg model of ferromagnetism is replaced by a classical model in which the interaction between a pair of neighbouring atoms is $-2JS(S+1)\,\varepsilon_i, \varepsilon_j$, where S is the spin of any atom, J is the exchange integral, and the ε_i are classical unit vectors. The spherical model is then used to evaluate the molecular field acting on any atom i. This effective field is found to have the generalized Weiss form, $H + W(T)M + W'(T)M'y_i^{\pi}$, where H is the magnetic field, M the magnetization, and M' the antiferromagnetic order (in units of magnetization). The coefficient y_i^{π} changes sign from one sublattice to another. The Weiss coefficients $W(T)$ and $W'(T)$ are slowly temperature-dependent and obey $dW/dT > 0$; $dW'/dT > 0$. A phase transition is found in three dimensions, but not in one or two dimensions. For spin ½ lattices of simple cubic, body-centered cubic, and face-centered cubic type, the ferromagnetic transition temperature T_c in units kT_c/J is found to be 1.98, 2.87, and 4.45, respectively. Corresponding values for the simple cubic case due to P. R. Weiss and V. Zehler are 1.85 and 1.93 respectively. The susceptibility and the paramagnetic temperature θ are found for the three lattices. The ratio θ/T_c is found to be independent of spin with the values 1.52, 1.39, and 1.34 for the s.c.c., b.c., and f.c.c. lattices respectively. Corresponding results for the transition temperatures, susceptibility, etc., are obtained for the antiferromagnetic cubic lattices. (*PA*, 1955, #2863)

145. THERMODYNAMICAL THEORY OF MAGNETIC RELAXATION
Khutsishvili, G. R.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki,* v. 29, no. 3(9) pp. 329–333, 1955 (in Russian)**

The thermodynamical consideration of the magnetic relaxation processes is based on the use of the principle of the symmetry of the kinetic coefficients and yields the time-relation of magnetization and internal temperature of the spin system. The author considers the conditions under which internal spin-equilibrium is attained much earlier than equilibrium of the spin system with the lattice. (*PA*, 1956, #4486)

146. POSSIBILITY OF THE OBSERVATION OF EXCHANGE RESONANCE NEAR A FERRIMAGNETIC COMPENSATION POINT
Wangsness, R. K.
Letter in *The Physical Review*, v. 97, no. 3, pp. 831, 832, February 1, 1955

Shows that near a compensation point the normal resonance peak is expected to shift to lower fields (g higher) while the exchange resonance peak appears at still lower fields and coincides with the first at exact compensation. Above the compensation point the two peaks separate again. The results may also be expressed in terms of effective g values, the two branches of the curve of g as a function of temperature tending to coincide at the compensation temperature. (*PA*, 1955, #3878)

147. THE BOUNDARY CONDITIONS FOR MAGNETIC MEDIA WITH INFINITE PERMEABILITY
Durand, E.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 240, no. 11, pp. 1197–1200, March 14, 1955 (in French)**

Investigates the generality of the condition that the lines of induction are normal or tangential to the surface bounding a medium $\mu = \infty$. (*PA*, 1955, #6288)

148. ON THE DENSITY OF STATES OF THE CONDUCTION ELECTRONS IN FERROMAGNETICS
Sokolov, A. V. and Tsipis, S. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki,* v. 28, no. 3, pp. 321–325, 1955 (in Russian)**

Calculates the density of states for the s-electrons as a function of the magnetization. (*PA*, 1955, #9756)

149. BARKHAUSEN NOISE FROM A CYLINDRICAL CORE
Haneman, D.
Letter in *Journal of Applied Physics*, v. 26, no. 3, pp. 355–356, March 1955

Derives an expression for the Barkhausen noise in a ferromagnetic core under the action of a saw-tooth exciting field; this allows the application of Campbell's theorem. The expression is applied to part of the range of a sine-wave exciting field, and it is shown that the maximum noise in a frequency range Δf is proportional to f. (*PA*, 1955, #4803)

150. PARAMAGNETIC RESONANCE II.
Bowers, K. D., Owen, J.
***Reports on Progress in Physics*, v. 18, pp. 304–373, 1955**

In this report, which is complementary to that of Bleaney and Stevens in *Reports on Progress in Physics*, Volume XVI, paramagnetic resonance data are collected together for crystalline solids containing ions of the transition groups, and those parts of the theory necessary for an understanding of the results are presented in a fairly simple way. After a brief introduction, the magnetic properties of various types of compounds are considered, and a simple discussion is given of the spin Hamiltonian which is used to describe the lowest energy levels. Some details are also given of the structures of the ten crystal types which are most commonly used, and of the relation between the structure and the resonance spectrum of a single crystal. Finally, the resonance data which are available for ions of the 3*d*, 4*d*, 5*d*, 4*f* and 5*f* transition groups are tabulated. These data are expressed as values of the parameters in the appropriate spin Hamiltonian, and, where applicable, formulae are given for (1) energy levels, (2) susceptibility, (3) specific heat tail CT^2/R, in terms of these parameters. Extensive bibliography. (*PA*, 1955, #8907)

151. MAGNETOSTRICTION AND MAGNETOMECHANICAL EFFECTS

Lee, E. W.

***Reports on Progress in Physics*, v. 18, pp. 184–229, 1955.**

The energy of a ferromagnetic substance comprises three parts, the exchange, anisotropy and magneto-static (demagnetizing) energies. These all vary with the state of strain of the substance and so it will deform sponstaneously if the deformation reduces the total energy (equal to the sum of the magnetic energy and the elastic energy). This phenomenon is known as magnetostriction and the three magnetic energies respectively give rise to the volume magnetostriction, the linear magnetostriction and the form effect. The greater part of this report is taken up with the linear magnetostriction since this is the effect most easily and often observed. The formal theory as developed by Becker and others is given. The various attempts to calculate the magnetostriction constants in terms of interatomic forces are reviewed. The fact that the linear magnetostriction can interact with stress to give rise to an additional anisotropy is discussed, together with some consequences of this fact; also the volume magnetostriction and related topics which arise from the variation of the exchange energy with interatomic distance. The form effect which arises incidentally in the analysis of volume magnetostriction is treated more fully, and the only secondary effect of any importance, the ΔE effect, is also discussed. The final section describes such topics as magnetic strain analysis and the magnetostriction of ferrites and antiferromagnetics. Over 100 refs. (*PA*, 1955, #8075)

152. MAGNETIC ANISOTROPY AND VAN VLECK'S RELATION FOR ANTIFERROMAGNETICS

Niessen, K. F.

***Philips Research Reports*, v. 10, no. 2, pp. 131–140, April 1955**

For the influence of magnetic anisotropy on the susceptibility of antiferromagnetics a formula is derived which is more general than that given by Nagamiya since anisotropy coefficients are supposed to be different for the two kinds of magnetic spins and also a small difference in the spin moments is taken into account. A corresponding extension of Van Vleck's relation between the powder susceptibilities at 0°K and at the Curie temperature is given. (*PA*, 1956, #1349)

153. THE DEPENDENCE OF THE SPONTANEOUS MAGNETIZATION ON THE MAGNETIC FIELD AT LOW TEMPERATURES

Valenta, L.

***Czechoslovak Journal of Physics*, v. 5, no. 2, pp. 171–177, April 1955**

Deals with a generalization of the Bloch-Moller three-half power law to the case of the dependence of spontaneous magnetization on the temperature and the magnetic field strength at low temperatures for a simple cubic lattice. It is shown that the derivation of the relations also admits such values of H and T for which the somewhat more general law given by Holstein and Primakoff fails. (*PA*, 1955, #8086)

154. MAGNETOSTATICS WITH FERROMAGNETICS

Skobelkin, V. I. and Solomko, R. N.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 28, no. 4, pp. 385–393, 1955 (in Russian)**

The variational principle of magnetostatics with ferromagnetics in the field of electric currents is formulated, leading to a solution of the general problem which could not be obtained by integration of Maxwell's equations owing to the non-linear relation between B and H. A system of axial symmetry is first considered, and then a planar system. The authors then derive the "complete δ-system" of functions and introduce direct methods of determining the magnetic flux. (*PA*, 1955, #8085)

155. ANISOTROPY OF THE PERMEABILITY AND MAGNETO-CALORIC EFFECT IN ANTIFERROMAGNETICS

Vlasov, K. B.

***Izvestiya Akademii Nauk*, SSSR, *Seriya, Fizicheskaya*, v. 19, no. 4, pp. 481–488, 1955 (in Russian)**

The macroscopically steady magnetic state of an antiferromagnetic is determined by a minimum thermodynamic potential, e.g., minimum free energy. To calculate the free energy associated with the magnetic state of an antiferromagnetic it is necessary to consider its energy in an external magnetic field, the energy of interaction of the elementary magnetic moments and that

of the electrostatic exchange interaction. A range of field strengths is considered where external field energy is much less than exchange energy, but possibly greater than energy of interaction. (*PA*, 1956, #1348)

156. INTERACTION BETWEEN SPIN WAVES AND CONDUCTION ELECTRONS IN FERROMAGNETIC METALS.

Abrahams, E.

***The Physical Review*, v. 98, no. 2, pp. 387–390, April 15, 1955**

With a view toward understanding ferromagnetic resonance line widths in metals, the relaxation time due to the spin wave-conduction electron interaction has been calculated. The effect due to the interaction of ferromagnetic spins with conduction electron currents is much more important than that due to the interaction of ferromagnetic spins with conduction electron spins. In nickel, for temperatures between 4°K and 300°K, the former process yields a relaxation time $10^{-3}-10^{-7}$ sec, while the latter yields $10^{-3}-10^{-4}$ sec. The interactions do not appear to be strong enough to account for the observed line widths. (*PA*, 1955, #5509)

157. FERRO- UND FERRIMAGNETISCHE STOFFE BEI HOHEN FREQUENZEN

von Harlem, J.

***Elektronische Rundschau*, v. 9, no. 3, 4, pp. 98–100, March 1955, pp. 147-150, April 1955**

Ferro- and ferrimagnetic materials at high frequencies; permeability is dependent on frequency; behavior of apparent and true permeability, in absence of macroscopic influence of field displacement, described with reference to experimental investigations; various theories explaining phenomena; results obtained from theory and experiment. (*EI*, 1955)

158. THE THEORY OF ATOMIC MAGNETIC MOMENTS IN FERROMAGNETICS

Akulov, N. S.

***Doklady Akademii Nauk*, SSSR, v. 105, no. 5, pp. 935–938, 1955 (in Russian)**

Developments in the zone theory of ferromagnetism together with more recent work on the elucidation of the peculiarities in the filling of 3*d*- and 4*s*-shells of atoms have enabled the author to give a purely theoretical calculation for the atomic magnetic moments of Fe and Co at high temperatures. For this the *s–d* electron distribution is assumed to be that given by the probability of transition of electrons from *s*- to *d*-shells and vice versa. Hund's rule is also applied. Calculated values for the number of unpaired 3*d*-electrons obtained by this theory of $T > \theta_{\text{Curie}}$ are in excellent agreement with those obtained in magnetic and neutron diffraction studies for $T < \theta_{\text{Curie}}$. When attempting to develop the notions into a general theory it is found that at low temperatures the effect of exchange interactions upsets the electron distribution considered above. Further discussion of *s–d* interaction leads to the calculation of atomic magnetic moments in alloys. This is applied with special relevance to Fe–Co, Fe–Cr, Co–Ni, Ni–Cu alloys. (*PA*, 1957, #1435)

159. THE QUANTUM THEORY OF THE MAGNETOSTRICTION OF CUBIC MONOCRYSTALS OF FERROMAGNETICS AT LOW TEMPERATURES

Gusev, A. A.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki* v. 29, no. 6, pp. 895–897, 1955 (in Russian)**
English translation in *Soviet Physics–JETP*, N. Y., v. 2, no. 4, pp. 764–766, July 1956

Earlier results on crystals of hexagonal symmetry are here extended to cubic crystals. Special difficulties connected with this are discussed and finally expressions for the magnetostriction constants are obtained which show their temperature dependence. (*PA*, 1957, #1439)

160. RESONANCE FIELDS OF A SYSTEM WITH MAGNETIC SUBLATTICES (FERROMAGNETIC RESONANCE)

Dreyfus, B.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 6, pp. 552–554, August 8, 1955 (in French)**

Derives relations for the resonance field H in terms of the characteristics of the two sublattices. The conditions for zero and imaginary values of H are derived and it is shown that H can never become infinite. (*PA*, 1956, #1350)

161. METHOD OF DETERMINATION OF PARAMETERS OF FERROMAGNETIC RESONANCE FROM EXPERIMENTAL DATA

Pilshchikov, A. I.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 6, pp. 798–807, 1955 (in Russian)**

English translation in *Soviet Physics–JETP*, v. 2, no. 4, pp. 703–710, July 1956

A calculation of the conditions for the extrema of the magnetic permeabilities in the region of ferromagnetic resonance is carried out. On the basis of the results obtained, formulae are derived for the determination of the gyromagnetic ratio and the relaxation time from experimental data. In the proposed method the calculation of the parameters of ferromagnetic resonance is carried out for fields of magnitudes corresponding to extrema of the magnetic permeabilities. Consequently, the necessity of calculating the maximum value of the magnetic permeability μ_k (or ρ'), which is the source of a large error (greater than 25%) in the determination of the relaxation time, disappears. It is shown that the method of calculation of g and T for fields of the extrema is applicable in cases where it is impossible to calculate the maximum values of the permeability μ_k (or ρ'). (*PA*, 1956, #8869)

162. CORRECTION FOR FERROMAGNETIC SUSCEPTIBILITY (DUE TO FERROMAGNETIC IMPURITIES) IN MAGNETOCHEMICAL INVESTIGATIONS USING THE CYLINDER METHOD

Knappwost, A.

Note in *Naturwissenschaften*, v. 42, no. 7, p. 175, 1955 (in German)

The Honda formula is generalized to apply to field strengths below that giving ferromagnetic saturation, and the applicability of the new formula is outlined. (*PA*, 1955, #6289)

163. THEORY OF MAGNETIC SUSCEPTIBILITY OF METALS AT LOW TEMPERATURES

Lifshits, I. M. and Kosevich, A. M.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 6 (12), pp. 730–742, 1955 (in Russian)**

English translation in *Soviet Physics–JETP*, v. 2, no. 4, pp. 636–645, July 1956

The magnetic properties of electrons in a metal are investigated for the case of an arbitrary dispersion law. The energy levels are found for a quasi-particle under an arbitrary dispersion law in a magnetic field, and the magnetic moment of a gas of such quasi-particles is computed, spin paramagnetism, being taken into account. It is shown that the periods and amplitudes of the oscillations are determined by the form of the Fermi boundary surface. Knowledge of these quantities permits one to reconstruct the form of the Fermi surface and the values of the velocities on it. (*PA*, 1956 #8862)

164. DIPOLAR FERROMAGNETISM AT 0°K

Cohen, M. H. and Keffer, F.

***The Physical Review*, v. 99, no. 4, pp. 1135–1140, August 15, 1955**

A critical examination of the Holstein Primakoff spin-wave technique has yielded explicit criteria for the stability of ferromagnetic arrays. These criteria have been applied to point dipoles on the three primitive cubic lattices for the shape most favorable to ferromagnetism, that of a long, thin sample. The results are: (1) dipolar ferromagnetism cannot occur in the simple cubic lattice; (2) the ferromagnetic state can be the lowest, or at least a metastable, state on the face-centered cubic and body-centered cubic lattices. The zero-point energies of ferromagnetic states are calculated for the ⟨100⟩, ⟨011⟩ and ⟨111⟩, directions, yielding two anisotropy constants, K_1 and K_2, for each lattice. The Holstein-Primakoff Hamiltonian is shown not to be diagonal for spin waves in the pathological region, i.e., of wavelengths comparable to the dimensions of the specimens. The properties of this region are shown to be unimportant in energy considerations but may effect stability. They are of great importance in effects such as ferromagnetic resonance which involve long-wavelength spin waves. (*PA*, 1955, #8894)

165. THE THEORY OF NÉEL "SPIKES" AND OF THE COERCIVE FORCE DUE TO THE FORMATION OF CYLINDRICAL SECONDARY DOMAINS

Brenner, R.

***Zeitschrift für angewandte Physik*, v. 7, no. 8, pp. 391–397, 1955 (in German)**

The theory of Néel spikes is extended by investigating the dependence of their size on the presence of an external field and on the temperature. The condition for the formation of spikes, depending on the nature of the non-ferromagnetic inclusions, is discussed. The formation of cylindrical secondary domains during the motion of 180 deg walls past the inclusions is considered, and the lengths of the cylinders before separation from the inclusions are calculated. Earlier formulae for the coercive force are modified by this effect. (*PA*, 1955, #9757)

166. THE THEORY OF THE HALL EFFECT OF FERROMAGNETIC ALLOYS

Meyer, K.

***Zeitschrift für Naturforschung*, v. 10a, no. 8, pp. 656–657, August 1955 (in German)**

The ordinary Hall coefficient R_0 of Cu–Ni alloys varies slightly with temperature. This effect is shown to be explicable on the basis of Vonsovsky's theory of ferromagnetism. (*PA*, 1956, #8868)

167. REVERSIBLE AND IRREVERSIBLE MAGNETIZATION CHANGES ALONG THE HYSTERESIS CURVE

Kersten, M.

***Zeitschrift für angewandte Physik*, v. 7, no. 8, pp. 397–407, 1955 (in German)**

A general review of the theory of the secondary domain structure, the coercive force and the initial permeability of ferromagnetic materials. (*PA*, 1955, #9778)

168. THE SPONTANEOUS MAGNETIZATION OF A ONE-DIMENSIONAL MODEL OF A FERROMAGNETIC TOROID IN A MAGNETIC FIELD

Valenta, L.

***Czechoslovak Journal of Physics*, v. 5, no. 3, pp. 291–299, August 1955**

Deals with the derivation of the dependence of the spontaneous magnetization on the temperature and the intensity of the magnetic field for a one-dimensional model of a ferromagnetic toroid. For a chain formed of $N \leq 10H^{-\frac{1}{2}}$ particles this dependence has the form of a half-power law modified by exponential dependence on H/T for temperatures and intensities of the magnetic field for which $H/T \sim 10$. (*PA*, 1955, #9762)

169. THE NÉEL THEORY OF FERRIMAGNETISM

Smart, J. S.

***American Journal of Physics*, v. 23, no. 6, pp. 356–370, September 1955**

The Néel theory of ferrimagnetism is a molecular-field theory of magnetic ordering in systems which contain non-equivalent substructures of magnetic ions. The two principal results of the theory are: (a) the curve of reciprocal susceptibility vs. temperature above the Curie temperature is an hyperbola, and (b) the curve of spontaneous magnetization vs. temperature below the Curie temperature may have any one of a number of unusual forms. The exact form depends on the distribution of magnetic ions between the substructures and on the relative values of the molecular field coefficients. The agreement between the predictions of the Néel theory and some experimental observations on ferrites is discussed briefly. (*PA*, 1955, #8895)

170. A NOTE ON THE PARAMAGNETIC RELAXATION

Yokota, M.

***Journal of the Physical Society of Japan*, v. 10, no. 9, pp. 762–768, September 1955**

Introducing the spin-spin relaxation time in Bloch's equation simultaneously, the author has calculated the relaxation equation of paramagnetic substances. As the contribution from the spin-spin relaxation to the imaginary part of the complex susceptibility, a term proportional to $(1 - F)^2$ instead of $(1 - F)$ given by Broer has been obtained. The theory explains the experimental results obtained by Gorter et al. for the dependence of the spin-spin relaxation time on the static field strength. (*PA*, 1955, #9774)

171. DOMAIN STRUCTURES SUGGEST KEY TO ENIGMA OF MAGNETIC FORCE

Graham, C. D., Jr.

***Journal of Metals*, v. 7, no. 9, pp. 948–951, September 1955**

Ferromagnetic domain as key to behavior of magnetic materials; variables which may be approached by observa-

tion of domains are effects of textures, grain size, inclusions, internal stresses, and magnetic annealing; knowledge of effects of metallurgical structure on domain behavior should make it possible to predict in advance structure required to produce magnetic properties needed for particular application; photomicrographs. (*EI*, 1955)

172. DETERMINATION AND PROPERTIES OF ANISOTROPY IN PARAMAGNETIC RESONANCE ABSORPTION

Il Nuovo Cimento (Series 10), v. 2, no. 4, pp. 811–819, October, 1955

In order to measure the anisotropy in paramagnetic resonance absorption in single crystals, a method has been devised which does not require initial knowledge of the directions of the principal magnetic axes, and by which it is possible to determine the principal values together with the directions of the axes. It is shown that under certain assumptions the characteristic surface of g is an ellipsoid, and that thus, with a proper choice of the axes, the following equation holds: $g = g_x\alpha^2 + g_y\beta^2 + g_z\gamma^2$, where α, β, γ stand for the direction cosines of H. The method has been applied for completing previous measurements, thus rendering their interpretation possible. (*PA*, 1956, #3016)

173. ON THE MAGNETORESISTANCE EFFECT IN METALS

Coldwell-Horsfall, R. A. and ter Haar, D.
***The Philosophical Magazine*, v. 46, p. 1149, October 1955**

Derives a general formula for the magnetoresistance on the basis of a one-band model with an energy-dependent time of relaxation. (*PA*, 1956, #496)

174. ANTIFERROMAGNETISM

Marshall, W.
***Proceedings of the Royal Society of London*, Series A, v. 232, pp. 48–68, October 11, 1955**

The ground state of a lattice with one electron per atom and antiferromagnetic interactions between nearest neighbours only is examined by a variational method similar in principle to the treatments by Hulthen (1938) and Kasteleijn (1952) of the linear-chain problem. The calculation involves a statistical problem which is shown to be exactly equivalent to the Ising ferromagnetic problem. This cannot be solved exactly, except in the one-dimensional case, and so the Bethe-Peierls method is used to solve it approximately. In complete contradiction to the Kubo (1953) variational calculation it is concluded that all lattices have disordered ground states. The energy differences between ordered and disordered states are small and so the nature of the ground state is likely to be sensitive to small additional ordering forces. (*PA*, 1955, #9759)

175. CONSIDERATIONS ON DOUBLE EXCHANGE

Anderson, P. W. and Hasegawa, H.
***The Physical Review*, v. 100, no. 2, pp. 675–681, October 15, 1955**

Zener has suggested a type of interaction between the spins of magnetic ions which he named "double exchange." This occurs indirectly by means of spin-coupling to mobile electrons which travel from one ion to the next. This interaction was calculated for a pair of ions with general spin S and with general transfer integral, b, and internal exchange integral J. One result is that while the states of large total spin have both the highest and lowest energies, their average energy is the same as for the states of low total spin. This should be applicable in the high-temperature expansion of the susceptibility, and if it is, indicates that the high-temperature Curie–Weiss constant θ should be zero, and $1/\chi$ vs. T a curved line. This is surprising in view of the fact that the manganites, in which double exchange has been presumed to be the interaction mechanism, obey a fairly good Curie–Weiss law. The results can be approximated rather well by a simple semiclassical model in which the spins of the ion cores are treated classically. This model is capable of rather easy extension to the problem of the whole crystal, but the resulting mathematical problem is not easily solved except in special circumstances, e.g., periodic disturbances (spin waves). (*PA*, 1956, #1355)

176. FERROMAGNETIC AND ANTIFERROMAGNETIC CURIE TEMPERATURES

Brown, H. A. and Luttinger, J. M.
***The Physical Review*, v. 100, no. 2, pp. 685–692, October 15, 1955**

The methods of calculating Curie temperatures used by Opechowski and Weiss are extended to higher spin values. Using the former, Curie temperatures are found for the face-centered, body-centered, and simple cubic and

the hexagonal and quadratic layer lattices for spin 1/2 to 3. Weiss' method is applied to body-centred and simple cubics for spin 1/2 to 2 and to the quadratic layer lattice for spin 1/2 to 1. Numerical results show good agreement between the two methods for three-dimensional ferromagnetic lattices. However, the Opechowski method fails to locate the antiferromagnetic transition and predicts a transition for the two-dimensional lattices while the Weiss method does not. A classical-spin approximation is investigated and is found to give Curie temperatures within a few per cent of the quantum-mechanical results for spin 1 or greater. (*PA*, 1956, #460)

177. RESULTS AND PROBLEMS OF THE QUANTITATIVE THEORY OF COERCIVITY

Brenner, R.

***Zeitschrift für angewandte Physik*, v. 7, no. 10, pp. 499–507, October 1955 (in German)**

A critical review of the Kersten and Néel treatments. (*PA*, 1956, #459)

178. THE SPIN-WAVE THEORY OF ANTIFERROMAGNETISM

Marshall, W.

***Proceedings of the Royal Society of London*, Series A, v. 232, pp. 69–77, October 11, 1955**

Various criticisms of the spin-wave theory of antiferromagnetism are discussed. In particular, it is pointed out that the use of the Holstein-Primakoff (1940) notation introduces into the formulae large contributions from fictitious states which have no physical existence. This is in contrast with the ferromagnetic problem where contributions from these fictitious states are negligible. Hence conclusions drawn from the spin-wave theory, particularly as to the conditions required for antiferromagnetism, are not to be relied upon. (*PA*, 1955, #9760)

179. MEASUREMENTS OF THE REVERSIBLE PERMEABILITY AND THEIR THEORETICAL INTERPRETATION

Wilde, H.

***Zeitschrift für angewandte Physik*, vol. 7, no. 11, pp. 509–513, 1955 (in German)**

Discusses the field dependence of μ_r of a material for which the magnetization process is a movement of 180-deg domain walls. The largest contribution to μ_r is made by those boundaries which are about to perform Barkhausen jumps. By calculating these contributions and also those from boundaries which have just completed a jump, and averaging over all boundaries by a simple statistical method, $\mu_r - H$ curves are obtained which are in good agreement with the observed curves for a ferrite material. (*PA*, 1956, #1392)

180. ELECTRICAL ANALOG OF THE EDDY-CURRENT-LIMITED DOMAIN-BOUNDARY MOTION IN FERROMAGNETICS

Brouwer, G.

***Journal of Applied Physics*, v. 26, no. 11, pp. 1297–1302, November, 1955**

The observed losses in a ferromagnetic core are always greater than those calculated on the basis of a homogeneous permeability. In a magnetization process by domain-boundary displacements the permeability is certainly not homogeneous, but attains extreme values in the domain walls. As a result of this concentration of the changes in magnetic flux the dispersion curves of the initial permeability as a function of frequency show a shift of the dispersion region towards lower frequencies with increasing domain size. This is the well-known eddy-current anomaly encountered in laminated cores. An electric-circuit model was utilized to determine the eddy-current distribution and domain-boundary motion in a number of idealized cases. (*PA*, 1956, #1371)

181. THE ORIGIN OF FERROMAGNETISM OF THE TRANSITION METALS

Friedel, J.

***Journal de physique et le Radium*, v. 16, no. 11, pp. 829–838, November 1955 (in French)**

Ferromagnetism is interpreted on the basis of the band picture, the bandwidth being small and the exchange interaction intra-atomic. The absence of ferromagnetism in Pd and Pt is interpreted as arising from strong spin–orbit coupling. The Curie points of alloys are also discussed. (*PA*, 1956, #1352)

182. NOTE ON THE SPIN WAVE THEORY OF ANTIFERROMAGNETISM

Kanamori, J. and Yosida, K.
***Progress of Theoretical Physics*, Kyoto, v. 14, no. 5, pp. 423–433, November 1955**

Spins in an antiferromagnet subjected to an external field perpendicular to the preferred axis of antiferromagnetic magnetization are not exactly aligned parallel and antiparallel to this axis. It is shown that a better approximation to the spin wave theory can be worked out, if one takes the equilibrium directions of the spins as the axes of quantization. One obtains field-dependent resonance frequency of a microwave, which the usual spin wave theory fails to give, and also a higher approximation to the perpendicular susceptibility. The value of the latter in the limit of vanishing field strength agrees with that obtained by Kubo. (*PA*, 1956, #6769)

183. THE SPONTANEOUS HALL EFFECT IN FERROMAGNETICS. I.

Smit, J.
***Physica*, v. 21,, no. 11, pp. 877–887, November 1955**

Apart from the normal Hall voltage a magnetized ferromagnetic material usually shows a relatively large extra voltage in the same direction, which can be found by linear extrapolation to $B = 0$. It is shown that this spontaneous Hall effect cannot exist in a perfectly periodic lattice. Measurements at different temperatures suggest that the effect is closely related with the electrical resistivity ρ of the material. Existing theories on the origin of the effect are shown to be invalid, and it is shown that the explanation has to be based on the anisotropic scattering, caused by spin-orbit interaction, of the conducting electrons against the imperfections of the lattice. (*PA*, 1956, #3008)

184. THE SOLUTIONS OF THE FERRIMAGNETIC RESONANCE EQUATIONS

Dreyfus, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 19, pp. 1270–1272, November 7, 1955 (in French)**

The four solutions of the resonance equation previously derived are considered in more detail, and it is shown that there are in general two resonance peaks, one of which is of very low intensity and not usually observable. (*PA*, 1956, #1351)

185. INFLUENCE OF CRYSTALLINE ELECTRIC FIELDS ON ANTIFERROMAGNETIC TRANSITIONS

Roberts, L. D., Murray, R. B., and Dabbs, J. W. T.
***The Physical Review*, v. 100, no. 4, pp. 1100–1103, November 15, 1955**

The Van Vleck two-sublattice treatment of antiferromagnetism predicts theoretically an equality between the transition temperature T_c and the Weiss constant Δ, a prediction which is not usually borne out by experiment. In this paper, through the use of the effective spin Hamiltonian, the treatment of Van Vleck is extended to include a crystalline electric field term. It is shown that Δ and T_c depend on this in an important way, especially at low temperatures, and it is further shown that this term may contribute to the observed inequality of Δ and T_c. (*PA*, 1956, #1353)

186. ON THE HIGH-TEMPERATURE SUSCEPTIBILITY FOR THE HEISENBERG MODEL OF A FERROMAGNET

Rushbrooke, G. S. and Wood, P. J.
***Proceedings of the Physical Society*, London, Section A, v. 68, Part 12, pp. 1161–1169, December 1955**

Deals with the high-temperature expansions, in powers of T^{-1}, of the susceptibility, χ, and the inverse susceptibility, χ^{-1}, for the Heisenberg model of a ferromagnet. Expressions valid for any lattice, are given for the coefficients in these expansions, up to and including the coefficient of T^{-5}. The results are discussed numerically, for particular lattices, in their bearing on the Curie temperature. (*PA*, 1956, #2224)

187. ON THE INFLUENCE OF DISLOCATIONS ON THE COERCIVE FORCE OF FERROMAGNETICS

Vicena, F.
***Czechoslovak Journal of Physics*, v. 5, no. 4, pp. 480–501, December 1955 (in Russian with English summary)**

In two previous papers the dependence of coercive force for two types of internal stress distribution was investigated. In the present paper a study is made of the influence of elastic fields around dislocations on the motion of Bloch walls and thus on the coercive force. The results of the paper may be summed up as follows: (1) It is shown that dislocations represent an imperfection of the crystal which influences the displacement of Bloch walls between regions of spontaneous magnetization in a ferromagnetic. The contribution of the dislocations to the coercive force compared to other factors (e.g. inclusions) may be so great that it cannot be overlooked. (2) From the results of the considerations on the contribution of dislocations in unworked and strongly worked materials to the coercive force, it can be inferred that the existing phenomenological stress theory of coercive force can be replaced by a dislocation theory of the coercive force. (3) It was shown that the coercive force also depends on the parameters of the mosaic structure. The contribution of this factor to the coercive force, as determined in this paper, is uncertain due to the as yet insufficient knowledge on the mosaic structure of ferromagnetics. (4) It was possible, with very good order-of-magnitude agreement, to explain the influence of plastic deformations on the coercive force on the basis of dislocations. (*PA*, 1956, #7511)

188. SOME PROPERTIES OF FERRITES IN CONNECTION WITH THEIR CHEMISTRY

Gorter, E. W.

***Proceedings of the Institute of Radio Engineers*, v. 43, no. 12, pp. 1945–1973, December 1955**

After an elementary introduction, it is shown how the molecular-field hypothesis can account for the magnetic properties of ferromagnetics and antiferromagnetics, and for the noncompensated antiferromagnetics, with which latter materials the paper is concerned. A brief description of the spinel lattice is given, and an account of the crystal chemistry of the spinels which is necessary to understand the experimental saturation magnetizations which are discussed. A short survey of methods of preparation is given. The second part discusses the anisotropies, and some of the magnetization processes which influence permeability, and the factors which influence high-frequency permeability and losses. Among these are the ferromagnetic resonance phenomenon and the dimensional resonance and relaxation phenomena. In this part the way in which these factors are influenced by chemical composition and preparation technique is indicated. Finally, a short history of the development of the ferrites is given. (63 Refs.) (*PA*, 1956, #3005)

189. THE BARKHAUSEN EFFECT

Tebble, R. S.

***Proceedings of the Physical Society*, London, Section B, v. 68, Part 12, pp. 1017–1032, December 1955**

A critical examination is made of the elementary processes which are usually considered as responsible for the discontinuous and irreversible domain boundary movements associated with the Barkhausen effect. The domain structure of an iron-like crystal is considered and it is shown that, of the processes investigated, the only mechanism which will produce discontinuities of the observed order of magnitude and which will result in a hysteresis curve of the usual type, is one in which the movement of a limited section of a 180 deg domain boundary is delayed by a non-magnetic inclusion whose cross-sectional dimensions are of the same order as the boundary thickness and lie within the range 1 to 2×10^{-5} cm. Inclusions below a critical size (about 10^{-5} cm) will be associated only with reversible effects; the energy associated with larger inclusions (greater than 10^{-4} cm) will be reduced by the presence of subsidiary domain structures and the associated discontinuous boundary movements will be negligibly small. An explanation of the general form of the experimental results is given and it is suggested that any reduction in the hysteresis loss in ferromagnetic materials can be best brought about by the selective reduction of the number of inclusions whose size is within the critical range. (*PA*, 1956, #2250)

190. TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY IN CUBIC CRYSTALS

Keffer, F.

***The Physical Review*, v. 100, no. 6, pp. 1692–1698, December 1955**

Two theories of the temperature dependence of ferromagnetic anisotropy in cubic crystals, the nearest-neighbour quadrupole-quadrupole coupling theory of Van Vleck, and the more recent classical theory of Zener, seem to be contradictory. It is shown that these theories

are, respectively, high- and low-temperature approximations to the same physical picture: namely, an anisotropy which decreases with rising temperature due to statistical fluctuations from alignment of anisotropically-coupled neighbour spins. Zener's low-temperature approximation shows that the anisotropy decreases as the tenth power of the magnetization, Van Vleck's high-temperature approximation yields a lower power law. It is argued that most of the anisotropy has vanished before sufficiently high temperatures are reached for Van Vleck's approximation to be appropriate. Van Vleck's nearest-neighbour dipole-dipole coupling theory, which has no classical analogue and cannot be compared with Zener's theory, is discussed from a spin-wave picture. (*PA*, 1956, #2225)

191. INSTABILITY IN THE MOTION OF FERROMAGNETS AT HIGH MICROWAVE POWER LEVELS
Anderson, P. W. and Suhl, H.
***The Physical Review*, v. 100, no. 6, pp. 1788–1789, December 15, 1955**

Gives an explanation of the ferromagnetic resonance line broadening observed by Bloembergen at power levels low compared with those thought necessary for saturation. The spin precession is shown to become unstable due to the nonlinear effect of the demagnetizing field when the radiofrequency field is sufficiently strong. (*PA*, 1956, #2226)

192. THE STATISTICS OF FERROMAGNETIC ELEMENTARY PROCESSES AND THEIR INFLUENCE ON BARKHAUSEN NOISE
Bittel, H.
***Forschungsberichte des Wirtschafts—und Verkehrsministeriums Nordrhein-Westfalen*, no. 251, 42 pp., 1956 (in German)**

An elementary account of noise and stochastic processes as applied to Barkhausen reversals. The mean square noise voltage is calculated and shown to be proportional to the "Barkhausen volume." Experimental results on cylindrical Fe–Ni specimens show that the noise depends on the specimen shape. The statistical correlation of two reversals is investigated. The minimum and maximum times between the reversals are calculated and shown to depend, inter alia, on the demagnetizing factor. The frequency spectrum is also considered, and the correlation found to have a marked effect. (*PA*, 1957, #8021)

193. BEITRAGE ZUR THEORIE DES FERROMAGNETISMUS UND DER MAGNETISIERUNGSKURVE
Bader, F., et al.
"Reine und Angewandte Metallkunde," Vol. 14 Springer-Verlag, Berlin, 1956

Contributions to theory of ferromagnetism by six specialists include such topics as relation between ferromagnetic saturation point and crystal structure of transition metals, temperature dependence of magnetic values, inherent stresses, h-f permeability, and other problems connected with magnetization curve. (*EI*, 1956)

194. STATISTICS OF THE THREE-DIMENSIONAL FERROMAGNET. IV. THE FACE CENTERED AND BODY CENTERED CUBIC LATTICES
Dempsey, E. and ter Haar, D.
***Physica*, v. 22, no. 1, pp. 1–13, January 1956**

Kramers' variational method is used to derive the partition functions per spin for the cubic ferromagnetic structures. These partition functions are compared with the partition functions derived by the approximate methods of Bethe, Kirkwood and Zernike. The case of the two dimensional square ferromagnet with both nearest and next nearest neighbour interactions is also briefly discussed. (*PA*, 1956, #2994)

195. THE GROUND STATE OF ANTIFERROMAGNETICS AS OBTAINED BY THE METHOD OF ELEMENTARY EXCITATIONS
Tyablikov, S. V. and Amatuni, A. Ts.
***Doklady Akademii Nauk*, SSSR, v. 108, no. 1, pp. 69–72, 1956 (in Russian)**

It is assumed that antiferromagnetic lattices consist of layers; magnetic moments of the ions in a layer are supposed to be parallel to each other and antiparallel to the moments in adjacent layers. The energy is obtained as a function of the external field strength and the electronic spin operators, exchange integrals playing the part of parameters. The minimum of energy is derived and interpreted as the energy of the ground state. In this deduction the spin operators are, by the way of a method of approximation, replaced by classical variables. The resulting magnetization curve is compared with experimental data for single crystals of the chloride of monovalent copper. (*PA*, 1956, #7512)

196. APPLICATION OF NEUTRON DIFFRACTION TO THE STUDY OF ANTIFERROMAGNETISM
Johannin-Gilles, A.
***Journal de physique et le Radium*, v. 17, no. 1, pp. 72–76, January 1956 (in French)**

Outlines the theory of antiferromagnetism, according to which the occurrence of the phenomenon arises from the presence of neighbouring parallel and anti-parallel magnetic spins, and describes how neutron diffraction may be applied to a study of antiferromagnetic problems, the magnetic scattering of neutrons (which arises from the interaction of the neutron and atomic magnetic moments) depending on the direction of the atomic spin. Examples are given of the application of neutron diffraction to MnO, FeO and similar compounds, Fe_2O_3, MnF_2 and similar compounds, and to the transition metals. A bibliography of 35 papers is given. (*PA*, 1956, #3815)

197. APPLICATION OF THE BETHE-WEISS METHOD TO FERRIMAGNETISM
Smart, J. S.
***The Physical Review*, v. 101, no. 2, pp 585–591, January 15, 1956**

The Bethe–Weiss theory of ferromagnetism is extended and applied to systems containing two nonequivalent sets of sites, designated by A and B, for the magnetic atoms. Each B atom has n_a nearest A neighbours and each A atom has n_b nearest B neighbours. In the theoretical development, the following restrictions are imposed: the spin per atom is ½ and only nearest neighbour A–B interactions are considered ($\alpha = \beta = 0$, in Néel's notation). The A–B interaction J may be either positive or negative, however, so that the sublattice magnetizations below the Curie temperature may be either parallel or antiparallel, respectively. Expressions are derived for the Curie temperature and for the susceptibility above the Curie temperature. If the two sublattices are made equivalent, results for positive J reduce to Weiss, equations for the ferromagnetic case and results for negative J reduce to Li's equations for the antiferromagnetic case. A table of values of the ratio $kT_c/|J|$ as computed by the Néel, Ising–Bethe and Bethe–Weiss theories is given for various values of n_a and n_b. For a given magnitude of J, the Bethe–Weiss Curie temperature for negative J is always greater than that for positive J. An empirical formula which approximates the Bethe–Weiss criterion for the existence of a ferrimagnetic transition is $n_a n_b > 5(n_a + n_b)/2$. The Néel and Bethe–Weiss susceptibilities are calculated and compared for a ferrimagnet with $n_a = 4$, $n_b = 8$. The two general expressions for the susceptibility are found to agree quantitatively at extremely high temperatures. It is shown that for a ferrimagnet with J less than 0 the sublattice magnetizations in an external field become antiparellel not at the Curie temperature but considerably above. (*PA*, 1956, #2995)

198. POSSIBLE SOURCE OF LINE WIDTH IN FERROMAGNETIC RESONANCE
Clogston, A. M., Suhl, H., Walker, L. R., and Anderson, P. W.
***The Physical Review*, v. 101, no. 2, pp. 903–905, January 15, 1956**

Discusses the effect of sample finiteness and lattice imperfections on spin-wave dispersion and, hence, line width. (*PA*, 1956, #2996)

199. FERRIMAGNETIC RESONANCE AND SOME RELATED EFFECTS
Wangsness, R. K.
***American Journal of Physics*, v. 24, no. 2, pp. 60–66, February 1956**

The semiclassical resonance theory for a system of coupled magnetic sublattices is briefly reviewed and some similarities and differences of ferromagnetic and ferrimagnetic resonance considered. The use of the effective gyromagnetic ratio simplifies the interpretation of many experimental results for g-values. The qualitative application of this concept to some related phenomena shows that they can have features characteristic of the ferrimagnetic case. (*PA*, 1956, #1365)

200. CONDITION FOR RESONANCE IN A NEARLY COMPENSATED FERRIMAGNETIC
Niessen, K. F.
***Philips Research Reports*, v. 11, no. 1, pp. 57–65, February 1956**

The resonance condition is derived for a ferrimagnetic with two sublattices with different total moments, different anisotropy constants and different gyromagnetic

ratios. These three differences are supposed to be relatively small and their influence on the resonance frequency is to be found from the resonance equation. It may be used for an antiferromagnetic in whose sublattices a relatively small number of magnetic ions has been substituted by non-magnetic ones. (*PA*, 1957,#1447)

201. FERROMAGNETISM IN RELATION TO ENGINEERING MAGNETIC MATERIALS

Brailsford, F.

***Proceedings of the Institution of Electrical Engineers*, Paper No. 1947, v. 103A, pp. 39–51, February 1956**

After a brief introductory account of the earlier development of the subject of ferromagnetism a review is given of theoretical and experimental work mainly within the past ten years. This includes an account of ferromagnetic domains and of the small-particle theory of high coercivity. A description of the ferrites and of ferrimagnetism is given, and this is followed by a discussion of recent observations and ideas on the magnetic phenomena occurring at frequencies up into the microwave region. (*PA*, 1956, #3011)

202. SHORT MODERN REVIEW OF FUNDAMENTAL ELECTROMAGNETIC THEORY

Hammond, P.

***Proceedings of the Institution of Electrical Engineers*, v. 103, Part A, no. 7, p. 38, February 1956**

Discussion of paper indexed in Engineering Index, p. 618, 1954, from Part 1 (General) July 1954; author's reply. (*EI*, 1956)

203. SUBSIDIARY ABSORPTION PEAKS IN FERROMAGNETIC RESONANCE AT HIGH SIGNAL LEVELS

Suhl, H.

***The Physical Review*, v. 101, no. 4, pp. 1437–1438, February 15, 1956**

Gives an interpretation of the finding of Bloembergen and others that at high power levels there is an additional absorption peak at a d.c. field considerably below that required for resonance. The effect is attributed to an instability of spin precession similar in some respects to that discussed in *PA*, 1956, #2226. (*PA*, 1956, #3817)

204. FERROMAGNETIC RELAXATION AND GYROMAGNETIC ANOMALIES IN METALS

Kittel, C. and Mitchell, A. H.

***The Physical Review*, v. 101, no. 5, pp. 1611–1612, March 1, 1956**

It is suggested that the $3d$ ion cores and $4s$ electrons in ferromagnetic metals interact. This effect is shown to lead to an additional internal field H_i acting on the magnetization due to the $3d$ electrons and proportional to the $3d$–$4s$ interaction energy A and the magnetization of the $4s$ electrons M_s. With H_i about 300 oersted, the frequency dependence of the g factor can be understood and the formula $g - 2 = 2 - g'$ is more nearly obeyed. The relaxation time for ferromagnetic resonance is also calculated and is in agreement with observation. The value of A is only about 1% of the free atom value, due to screening by the $3d$ electrons, and the value of M_s is only about one gauss so that the s electron magnetization is itself negligibly small. (*PA*, 1956, #5206)

205. METHOD OF CALCULATING OF STATISTICAL SUMS FOR [THE EXCHANGE PROBLEM IN] FERROMAGNETICS TAKING INTO ACCOUNT THE RESTRICTIONS OF SPIN WAVE OCCUPATION NUMBERS

Tolmachev, V. V. and Tyablikov, S. V.

***Doklady Akademii Nauk*, SSSR, v. 108, no. 6, pp. 1029–1031, 1956 (in Russian)**

The Bloch spin wave treatment of the ferromagnetic exchange problem neglects a summation over nearest-neighbour pairs of atoms; this is justified only at low temperatures where ferromagnetic ordering occurs. The authors present a method of (formally) carrying out the required summation and show that their result reduces to that of Bloch in the low temperature limit. (*PA*, 1956, #8860)

206. TRANSITIONS AND PHASE DIAGRAMS IN AN ORTHORHOMBIC ANTIFERROMAGNETIC CRYSTAL

Gorter, C. J. and van Peski-Tinbergen, T.

***Physica*, v. 22, no. 4, pp. 273–287, April 1956**

Néel's molecular field model is applied to an orthorhombic antiferromagnetic crystal and its magnetic and thermal behaviour is analysed. Special attention is given to the case where the external field is applied in the direction preferred for antiferromagnetic alignment. The

transitions between the different antiferromagnetic states are considered as well as those to the paramagnetic state. (*PA*, 1956, #5209)

207. ON HIGH TEMPERATURE EXPANSIONS IN THE HEISENBERG THEORY OF FERROMAGNETISM

Domb, C. and Sykes, M. F.
***Proceedings of the Physical Society*, London, Section, B, v. 69, Part 4, p. 486, April 1956**

Describes a method of calculation of the high-temperature susceptibility in series form, in which averages of the permutation operators rather than of spin operators are computed, and obtains the final results more simply than heretofore. An additional expansion coefficient, a_6 is calculated for a number of lattices. (*PA*, 1956, #6768)

208. A NOTE ON L. VALENTA'S PAPER: THE SPONTANEOUS MAGNETIZATION OF A LINEAR MODEL OF A FERROMAGNETIC TOROID IN A MAGNETIC FIELD

Hrivnak, L.
***Czechoslovak Journal of Physics*, v. 6, no. 2, pp. 195–196, April 1956**

The use of a different approximation leads to an expression for the saturation magnetization which gives the expected value. (*PA*, 1957, #541)

209. ON THE DEFINITION AND DETERMINATION OF THE COERCIVE FORCE OF PERMANENT MAGNETS TAKING INTO ACCOUNT IRREVERSIBLE AFTER-EFFECT PHENOMENA

Kussman, A. and Yamada, O.
***Archiv für Electrotechnik*, Berlin, v. 42, no. 4, pp. 237–244, 1956 (in German)**

It is shown, experimentally and theoretically, that because of the existence of irreversible (Jordan) after-effect the measured coercive force of ferromagnetic materials is not a constant but depends upon the duration of the applied field. The variations may amount to several percent, vary logarithmically with time, and are independent of the demagnetization factor. Attention is drawn to the need to take this effect into account in defining coercive force, and in the measurement of B–H relations. (*PA*, 1956, #7534)

210. CONSTANT COUPLING APPROXIMATION FOR HEISENBERG FERROMAGNETISM

Kasteleign, P. W. and van Kranendouk, J.
***Physica*, v. 22, no. 4, pp. 317–337, April 1956**

A general expression is derived for the partition function of a Heisenberg ferromagnetic spin system with isotropic coupling between nearest neighbouring spins, in terms of a pair density matrix of a pair of nearest neighbouring spins. With the help of this pair density matrix an effective Hamiltonian H_e for a pair of spins is introduced, and it is shown that H_e contains only an isotropic coupling term of the Heisenberg type, an anisotropic coupling term of the Ising type, and a term representing an effective field acting on the two spins of the pair. The familiar molecular field approximation is obtained by assuming that the two coupling terms in H_e are zero. By minimizing the free energy, it follows that the effective field occurring in H_e is then equal to the Weiss molecular field. A next approximation is obtained by assuming that the effective isotropic coupling in H_e is equal to the actual coupling between the spins, and that the effective anisotropic coupling is zero, which is shown to correspond to the limiting behaviour of H_e for high temperatures. This "constant coupling" approximation constitutes a straightforward generalization of the quasi-chemical method for an Ising spin system to the case of Heisenberg coupling. The thermodynamic properties of the spin system, and in particular the critical data, are calculated on the basis of this constant coupling approximation, and numerical results are given for lattices with coordination number 6, 8 and 12. The theory is compared to the cluster method of P. R. Weiss, and it is shown that in the present theory the difficulty of an anti-Curie point does not occur, so that the constant coupling approximation gives useful results at all temperatures. (*PA*, 1956, #5210)

211. THEORY OF FERRO-, PARA-, AND FERRIMAGNETISM

Akulov, N. S.
***Doklady Akademii Nauk*, SSSR, v. 108, no. 4, pp. 603–606, 1956 (in Russian)**

Theoretical paper. The author develops ideas of an earlier communication in which magnetic properties are related to the total numbers of electrons in the *s* and *d*

bands, and discusses Co–Ni, Ni–Cu, Fe–Ce alloys by way of illustration. (*PA*, 1957, #1436)

212. ON METASTABLE APPROXIMATIONS IN COOPERATIVE ASSEMBLIES

Domb, C. and Sykes, M. F.

***Proceedings of the Royal Society of London*, Series A, v. 235, pp. 247–259, April 24, 1956**

The exact solution of the three-dimensional Ising model of a ferromagnetic presents difficulties of a very fundamental nature. It therefore seems that the most reliable information on the behaviour of the model is provided by exact series expansions of the partition function at low and high temperatures. However, the usual low-temperature expansion fails to converge in the neighbourhood of the critical point. By rearranging the terms of the series on the basis of physical considerations, it is possible to obtain a systematic set of successive approximations, each approximation taking exact account of clusters of a given size or less (metastable approximations). By extrapolation accurate estimates can be derived of the Curie point and critical values of the energy and entropy. It is found that there is a marked difference in behaviour between two- and three-dimensional lattices, a far larger proportion of the entropy change taking place in the temperature region below the Curie point in the latter case. The corresponding specific heat curves are therefore much closer to those observed experimentally. Finally, a brief discussion is given of the dependence of the specific heat curve on lattice structure. (*PA*, 1956, #4487)

213. A FERROMAGNETIC SPHERE IN A STRONG MAGNETIC FIELD

Fradkin, B. M.

***Zhurnal Tekhnicheskoi Fiziki*, v. 26, no. 5, pp. 1048–1059, 1956 (in Russian)**

It is assumed that the hysteresis loop is, with a sufficient degree of accuracy, represented by a rectangular graph. The process of inverting the direction of the field is studied, in particular the propagation of a wave of demagnetization. The magnetic effect of eddy currents is taken into account. The mean magnetic moment of the sphere is obtained in terms of the external field strength and the magnetic properties of the material. (*PA*, 1957, #543)

214. CONSTANT COUPLING APPROXIMATION FOR ANTIFERROMAGNETISM

Kasteleijn, P. W. and van Kranendonk, J.

***Physica*, v. 22, no. 5, pp. 367–385, May 1956**

The method developed in *PA*, 1956, #5210 for the investigation of the statistical properties of a Heisenberg ferromagnetic spin system is extended to an antiferromagnetic spin system with a two-sublattice structure and an isotropic coupling between nearest neighbouring spins. Both the case of a parallel and that of a perpendicular external field are discussed. The partition function of the spin system is expressed in terms of the effective Hamiltonian H_e of a pair of nearest neighbouring spins. In the parallel case, H_e contains in addition to the isotropic and anisotropic coupling terms and the effective field term occurring also in the ferromagnetic case, a term representing a staggered effective field which has the same magnitude but opposite direction for the two spins of the spin pair. In the perpendicular case two additional anisotropic coupling terms appear, so that H_e contains six terms in this case. By introducing specific assumptions about the values of the coupling parameters occurring in H_e, the molecular field and the constant coupling approximation are obtained. The thermodynamic properties of the spin system, and in particular the critical data, are calculated on the basis of the constant coupling approximation, and numerical results are given for the simple cubic and body-centred cubic lattice. In contradistinction to the ferromagnetic case the constant coupling approximation for an antiferromagnetic spin system leads to the appearance of an anti-Curie point, so that in this case the constant coupling approximation is reliable only above and in the immediate vicinity of the Curie point. (*PA*, 1956, #6000)

215. CONSTANT COUPLING APPROXIMATION FOR ISING SPIN SYSTEMS

Kasteleijn, P. W.

***Physica*, v. 22, no. 5, pp. 387–396, May 1956**

The constant coupling approximation for ferro- and antiferromagnetic spin systems with isotropic nearest neighbour interaction is applied to spin systems with Ising coupling. The partition function of the spin system is expressed in terms of the effective Hamiltonian H_e of a pair of neighbouring spins. In the ferromagnetic case, H_e contains only an effective Ising coupling term and an

effective field term. In the antiferromagnetic case, H_e contains in addition a staggered effective field term. The constant coupling approximation which is obtained by assuming that the effective Ising coupling is constant is shown to be equivalent to the familiar quasi-chemical approximation. For an antiferromagnetic spin system with an external field of arbitrary magnitude in the preferred direction this approximation is worked out in detail. Both for the paramagnetic and for the antiferromagnetic phase the thermodynamic quantities of the system are obtained from a basic equation that is analogous to the Bethe–Peierls equation for the ferromagnetic case. The critical data are evaluated, and an explicit formula is derived for the critical curve in the B vs. T plane. (*PA*, 1956, #6001)

216. THE REPRESENTATION OF MAGNETIZATION CURVES BY SIMPLE ALGEBRAIC OR TRANSCENDENTAL FUNCTIONS

Fischer, J. and Moser, H.

***Archiv für Elektrotechnik*, Berlin, v. 42, no. 5, pp. 286–299, 1956 (in German)**

Discusses the problems involved in the use of simple functions to represent magnetization curves and gives examples of their application. Criteria for testing the goodness of fit are developed and then examples of suitable functions to represent the initial region of the curve, the approach to saturation, or the whole curve are given. A table of 15 simple functions is given. (*PA*, 1956, #7535)

217. SEMICLASSICAL MODEL OF SPIN WAVES IN A FERRIMAGNETIC MEDIUM

Cofta, H.

***Acta Physica Polonica*, v. 15, no. 5, pp. 311–319, 1956 (in German)**

The dispersion relation $\omega(k) \sim k^2$ is derived for ferrimagnetic and antiferrimagnetic media. (*PA*, 1957, #7205)

218. METHOD OF DETERMINING MAGNETIC PERMEABILITIES OF A SUBSTANCE IN THE REGION OF FERROMAGNETIC RESONANCE

Philshchikov, A. I.

***Vestnik Moskovskogo Universiteta*, no. 5, pp. 49–54, 1956 (in Russian)**

Relationships are worked out which enable the magnetic susceptibility of a substance to be determined from experimental data in the region of ferromagnetic resonance. From these relations may also be determined the attenuation of a hollow resonator on account of losses in the ferromagnetic walls. A theoretical paper. (*PA*, 1957, #6330)

219. ON EVEN EFFECTS IN SINGLE CRYSTALS

Dyakov, G. P.

***Vestnik Moskovskogo Universiteta*, no. 5, pp. 43–48, 1956 (in Russian)**

The Akulov law concerning the magnetostriction of a single crystal magnetized to saturation agrees well with the experiments of Honda and his collaborators. For the (111) plane divergence arises between theory and experiment due to the field there being insufficient for saturation. The present paper, which is entirely theoretical, sets out to compute the magnetostriction for the (111) plane in the region of approach to saturation. (*PA*, 1957, #6885)

220. APPLICATION OF VARIATIONAL PRINCIPLE TO ISING MODEL OF FERROMAGNETIC

Kvasnikov, I. A.

***Doklady Akademii Nauk*, SSSR, v. 110, no. 5, pp. 755–757, 1956 (in Russian)**

The properties of a ferromagnetic are obtained by a variational principle applied to the statistical sum over N near-neighbour interactions, subject to N fixed conditions imposed by the lattice for this model. (*PA*, 1957, #4524)

221. THEORY OF SPONTANEOUS MAGNETIZATION OF FERROMAGNETIC SEMICONDUCTORS IN THE LOW TEMPERATURE REGION

Kondorskii, E. I., Pakhomov, A. S. and Shiklosh, T.

***Doklady Akademii Nauk*, SSSR, v. 109, no. 5, pp. 931–934, 1956 (in Russian)**

A number of workers have studied the spontaneous magnetization of ferrites following the basic idea of sublattices due to Néel. At low temperatures these workers give formulae which differ among themselves. The present paper follows the method of secondary quantization in the form developed by Bogolyubov and Tyablikov and a formula for the spontaneous magnetization of ferrites

is derived consisting of three terms. One term of the expression is numerical, whilst the other two tend to zero at absolute zero, one much more rapidly than the other. The net result at low temperatures is to give a "three-halves" law. (*PA*, 1957, #3455)

222. ORDERING AND ANTIFERROMAGNETISM IN FERRITES

Anderson, P. W.

***The Physical Review*, v. 102, no. 4, pp. 1008–1013, May 15, 1956**

The octahedral sites in the spinel structure form one of the anomalous lattices in which it is possible to achieve essentially perfect short-range order while maintaining a finite entropy. In such a lattice nearest-neighbour forces alone can never lead to long-range order, while calculations indicate that even the long-range Coulomb forces are only 5% effective in creating long-range order. This is shown to have many possible consequences both for antiferromagnetism in "normal" ferrites and for ordering in "inverse" ferrites. (*PA*, 1956, #5207)

223. THERMODYNAMIC BEHAVIOR OF AN IDEAL FERROMAGNET

Dyson, F. J.

***The Physical Review*, v. 102, no. 5, pp. 1230–1244, June 1, 1956**

The free energy of an ideal Heisenberg-model ferromagnet is calculated as a power series in the temperature T, using the mathematical machinery developed in an earlier paper. The spontaneous magnetization in zero external field is given by $[M(T)/M(0)] = S - a_0\theta^{3/2} - a_1\theta^{5/2} - a_2\theta^{7/2} - a_3S^{-1}\theta^4 + O(\theta^{9/2})$. Here θ is the temperature in dimensionless units, and a_0, a_1, a_2, a_3 are positive numerical coefficients which are computed for the three types of cubic crystal lattice. The first two terms are the result of the simple Bloch theory in which spin waves are treated as noninteracting Bose particles with constant effective mass. The a_1 and a_2 corrections come from the variation of effective mass with velocity. The a_3 term is the lowest-order correction arising from interaction between spin waves. This result is in violent contradiction to earlier published calculations which gave interaction effects proportional to $T^{7/4}$ and T^2. The smallness of the thermodynamic effects of spin-wave interaction is discussed in physical terms, and partially explained, in the introduction of this paper. A general proof is given that the thermodynamic effects of the "exclusion principle," which forbids more than (2S) spin deviations to occupy the same atom, are of order $\exp(-a\theta^{-1})$ and give zero contribution to any finite power of θ. The residual dynamical interaction between 2 spin waves gives rise to a second virial coefficient b_2' which is calculated and shown to be of order $T^{5/2}$. The a_3 term in the magnetization is proportional to b_2'. Effects of interaction of 3 or more spin-waves are estimated and found to be of order θ^5 or higher. (*PA*, 1956, #5999)

224. NEW MAGNETIC ANISOTROPY

Meiklejohn, W. H. and Bean, C. P.

***The Physical Review*, v. 102, no. 5, pp. 1413–1414, June 1, 1956**

The new anisotropy is described as being the result of an interaction between the spins of an antiferromagnetic material and a ferromagnetic material, and has been observed in fine particles of cobalt with a cobaltous oxide shell. This material, when cooled through the Néel temperature in a saturating magnetic field, possesses only one easy direction of magnetization. The coercive force and the remanent induction become asymmetrical along the axis of magnetization, and the material exhibits a rotational hysteresis that is independent of the field at high fields. An anisotropy constant of 5×10^6 ergs/cm^3 has been calculated from the torque curve. (*PA*, 1956, #7513)

225. GENERAL THEORY OF SPIN-WAVE INTERACTIONS

Dyson, F. J.

***The Physical Review*, v. 102, no. 5, pp. 1217–1230, June 1, 1956**

An ideal model of a ferromagnet is studied, consisting of a lattice of identical spins with cubic symmetry and with isotropic exchange coupling between nearest neighbours. The aim is to obtain a complete description of the thermodynamic properties of the system at low temperatures, far below the Curie point. In this temperature region the natural description of the states of the system is in terms of Bloch spin waves. The nonorthogonality of spin-wave states raises basic difficulties which are examined and overcome. The following new results are obtained: a practical method for calculating thermodynamic quantities in terms of a nonorthogonal set of basic

states; a proof that in 3 dimensions there do not exist states (shown by Bethe to exist in a one-dimensional chain of spins) in which two spins are bound together into a stable complex and travel together through the lattice; a calculation of the scattering cross-section of two spin waves, giving a mean free path for spin–spin collisions proportional to $T^{-7/2}$ at low temperatures; and an exact formula for the free energy of the system, showing explicitly the effects of spin-wave interactions. Quantitative results based on this theory are published in a second paper. (*PA*, 1956, #5998)

226. RELATIONS BETWEEN THE STRUCTURE OF FERRITES AND THE CONDITIONS OF THEIR RESONANCE IN WAVEGUIDES. UNIDIRECTIONAL GUIDES

Suchet, J.

***Onde électrique*, v. 36, pp. 508–519, June 1956 (in French)**

An account of the atomic and molecular structure of ferrites with particular relation to the factors determining the conditions for magnetic resonance. The effects of shape and of density are considered. The application of these data to the construction of a unidirectional waveguide are considered also and details of the performance of such a waveguide are given. (*PA*, 1957, #1471)

227. THE INFLUENCE OF TENSION ON THE STRUCTURE OF BITTER—AKULOV PATTERNS

Suda, P.

***Czechoslovak Journal of Physics*, v. 6, no. 3, pp. 300–302, June 1956**

If electrolytic polishing of a mechanically polished ferromagnetic material is of short duration, so that the deformed surface layers are not completely removed, colloidal magnetic particles on the surface form labyrinths the shape and size of which depend on the crystallographic orientation of the surfaces and the mechanical condition of the material. Such patterns have been studied on a sample of transformer sheet (4% silicon) under tension. As the tension increased the labyrinth pattern gave way to a dagger-like pattern which could be identified as domain structure. On removing the tension a pattern similar to the original is restored in spite of a 1% length increase. The observed phenomena can be explained by assuming the internal stresses are compensated by the applied tension thus eliminating their influence on the magnetic structure. (*PA*, 1957, #542)

228. EFFECT OF INHOMOGENEOUS DEMAGNETIZING FIELDS ON FERROMAGNETIC RESONANCE

Philshchikov, A. I.

***Izvestiya Akademii Nauk*, SSSR, *Seriya Fizicheskaya*, v. 20, no. 11, pp. 1284–1296, 1956 (in Russian)**

Inhomogeneous demagnetizing fields cause considerable distortions of the curves of resonance absorption and dispersion, particularly a marked expansion of the curves on the side of strong fields. With increasing demagnetizing fields the range of variation of permeability is considerably restricted and the relaxation frequency rises. The separation factor g is practically independent of the demagnetizing factor of the specimen. (*PA*, 1957, #4535)

229. SPONTANEOUS MAGNETIZATION AND MAGNETIC SUSCEPTIBILITIES OF AN ANTIFERROMAGNETIC WITH FOREIGN IONS IN ONLY ONE SUBLATTICE

Niessen, K. F.

***Philips Research Reports*, v. 11, no. 3, pp. 172–182, June 1956**

A study is made of an antiferromagnetic in one of whose sublattices a relatively small number of original A-ions is supposed to be replaced by ions of another metal B, the moment m of B being different from the moment m of A. The magnetization is then no longer zero. Its dependence on the temperature is investigated and also the change in the parallel and perpendicular susceptibilities due to the above replacement. (*PA*, 1956, #8283)

230. A THEORY OF METALLIC FERRO- AND ANTIFERRO-MAGNETISM ON ZENER'S MODEL

***Progress of Theoretical Physics*, v. 16, no. 1, pp. 45–57, July 1956**

The importance to the mechanism of ferromagnetism of exchange interaction between conduction electrons and unfilled inner shell electrons (called s–d interaction) has been pointed out by Zener. Especially for rare-earth

metals, this interaction seems to be the only mechanism which can cause ferro- and antiferro-magnetism. However, Zener's model is unsatisfactory because it is phenomenological and moreover does not involve antiferromagnetism and spin-wave mode. The present paper considers this s–d interaction on a more rigorous basis. By a certain approximation, there appear long-range exchange-type interactions between d-electron spins and in certain conditions both ferro- and antiferro-magnetism appear. The excitations of spin-wave modes are the same as those in the ordinary modes of the short range exchange force, viz, the energy of the spin-wave excitations proportional to q^2 for ferromagnetism and q for antiferromagnetism in the region of small wave vector q. The $T^{3/2}$ law for the temperature dependence of the magnetization of ferromagnetism is applicable up to very high temperatures, and this result is in good agreement with the results of experiments on metallic ferromagnetism. (*PA*, 1957, #7209)

231. ELECTRICAL RESISTANCE OF FERROMAGNETIC METALS

Kasuya, T.

***Progress of Theoretical Physics*, v. 16, no. 1, pp. 58–63, July 1956**

In ferromagnetic metals an anomalous electrical resistance is observed which is characteristic of the magnetization and is additive to the ordinary electrical resistance. The origin of this anomalous electrical resistance has been discussed by several authors, but all such attempts do not seem to have satisfactorily explained this phenomenon either quantitatively or qualitatively. In this paper the anomalous electrical resistance is calculated from the standpoint of s–d interaction as developed by the author. The anomalous electrical resistance occurs because the exchange energy between the conduction and the unfilled inner shell electrons depends on the relative direction of the spins of the electrons, and this interaction is not periodic in finite temperatures. In numerical values as well as in the temperature dependence, the results are in good agreement with experimental results. (*PA*, 1957, #6158)

232. MAGNETIC AFTER-EFFECT PHENOMENA

Holzmüller, W.

***Nachrichtentechnik*, v. 6, no. 7, pp. 306–312, July 1956 (in German)**

An account of resonance and relaxation effects, and of after-effect phenomena in magnetic materials. The temperature dependence of the various types of after-effect are described and the physical mechanisms responsible for these are described. Mechanical resonances of inclusions and holes, excited by the movement of domain walls, are investigated, and the damping of these oscillations by the emission of heat waves is calculated. It is also shown that although rotational processes are responsible for most of the changes of magnetization in ferrites, domain wall displacements can contribute to the hysteresis loss. (*PA*, 1957, #535)

233. THE DE HAAS–VAN ALPHEN EFFECT IN ALLOYS

Heine, V.

***Proceedings of the Physical Society*, London, Section A, v. 69, pt. 7, pp. 505–512, July 1956**

The theory of primary solid solutions is applied to the de Haas–van Alphen effect in dilute alloys. The experimental results are largely in agreement with the theory, except where there is the possibility of the existence of a bound state round the solute atoms. The de Haas-van Alphen effect appears to be well suited for studying this phenomenon as well as the effect of solutes from different rows of the periodic table. (*PA*, 1956, #8284)

234. THE OPTICS OF MAGNETIC CRYSTALS. I. EQUATION OF NORMALS

Fedorov, F. I.

***Spektroskopiya*, v. 1, no. 7, pp. 926–936, 1956 (in Russian)**

Theoretical paper. Deals with optical properties of homogeneous media possessing arbitrary electric and magnetic isotropies. Expressions are derived for the vectors of a plane wave field and the conditions for binormals. (*PA*, 1957, #9122)

235. SPIN EXCHANGE EFFECTS IN FERROMAGNETIC RESONANCE

Macdonald, J. R.

***The Physical Review*, v. 103, no. 2, pp. 280–286, July 15, 1956**

A discussion of theoretical and experimental work concerned with spin exchange effects in ferromagnetic reso-

nance is given. Qualitative and quantitative results of the author's exchange theory are summarized together with work of Ament and Rado in the same field. An approximate solution of the exchange problem due to the latter authors is used to analyze the recent ferromagnetic resonance results of Hoskins and Wiener on permalloys. Such analysis indicates that some of the observed effects may have arisen from exchange but that it cannot explain the observed experimental g shifts from the free-spin value. (*PA*, 1956, #6781)

236. SOME PROPERTIES OF THE COERCIVE FORCE IN SOFT MAGNETIC MATERIALS

Rodbell, D. S. and Bean, C. P.

***The Physical Review*, v. 103, no. pp. 886–895, August 15, 1956**

The coercive force is the value of the magnetic field amplitude when the net magnetization in the direction of the field is zero and has a zero time rate of change. An equivalent definition of the coercive force is contained in the expression for the average instantaneous domain wall velocity, $v = k(H - H_c)$ in which k depends upon motional energy losses and H is the applied magnetic field and H_c is the coercive force. This latter definition was used to measure the coercive force in specimens of magnetically annealed 65 permalloy (65% Ni–Fe) tapes and a 3.25% SiFe picture frame single crystal for both low- and high-field domain configurations. The coercive force measured in this way for low applied fields is the same as that determined by other techniques. For the high-field determination, with domain walls unattached to the specimen surfaces, the coercive force is, for these samples, less than half the low-field coercive force. The authors call the value determined at high fields the "internal coercive force" and believe this value to be characteristic of the bulk material. The low-field coercive force includes both the "internal coercive force" and a component due to preferential "pinning" of domain walls at the specimen surfaces. The experimentally observed dependence of the coercive force upon specimen thickness may be explained using surface pinning of domain walls. This explanation was previously postulated by Kijkstra. The difference in coercive force between surface free and surface pinned domain walls may be used to make a lower limit estimate of the domain wall energy density. The results are in order of magnitude agreement with the values expected from theory. Considerations of the experimentally determined expression for domain wall velocity given above show that the positional free-energy variations which determine the coercive force cannot be described by conservative periodic functions. (*PA*, 1956, #8277)

237. STATISTICAL CHARACTER OF THE REVERSAL OF MAGNETIZATION OF FERROMAGNETICS

Bunkin, F. V.

***Zhurnal Tekhnicheskoi Fiziki*, v. 26, no. 8, pp. 1782–1789, 1956 (in Russian)**

An examination is made of the basic assumptions made concerning the behaviour of a ferromagnetic domain. The paper then goes on to derive a mathematical description, using Markov chains, of domain behaviour under cyclic reversal of magnetization. Also discussed are the dependence of the possibility of transition of a domain upon the macroscopic state, and the statistical scatter of transition moments. (*PA*, 1957, #1455)

238. THE SPIN WAVE THEORY OF FERROMAGNETISM

Frank, D. and Meyer, K.

***Naturwissenschaften*, v. 43, no. 16, pp. 371, 372, 1956 (in German)**

Indications are given that spin waves obey Fermi–Direc statistics and the consequences of this idea are developed; a number of difficulties of earlier treatments are removed. (*PA*, 1957, #3429)

239. MATRIX THEORY OF SKIN EFFECT IN LAMINATIONS

Pipes, L. A.

***Journal of the Franklin Institute*, v. 262, no. 2, pp. 127–138, August 1956**

Technique for determining magnetic and electric field intensities and current density in plane conducting metal plates of constant permeability produced by external impressed alternating magnetic field; fundamental Maxwell field equations are used as basis of analysis and expressions for amplitudes of fields and currents are written in matrix form; methods described simplify calculations involving skin effect and magnetic shielding. (*EI*, 1956)

240. A NOTE ON THE GROUND STATE OF ANTIFERROMAGNETISM

Taketa, H. and Nakamura, T.

***Journal of the Physical Society of Japan*, v. 11, no. 9, pp. 919–923, September 1956**

Kasteleijn's method of obtaining the ground state of antiferromagnetism is generalized to the cases of two- and three-dimensional lattices. According to the generalization, the ground state of the three-dimensional antiferromagnetic Heisenberg model with the spin quantum number equal to one half is paramagnetic in the absence of anisotropy energy. The magnetization of sublattices is calculated as a function of the degree of anisotropy. With increasing coordination numbers the anistropy energy necessary for establishing the antiferromagnetic state decreases rapidly. (*PA*, 1957, #1437)

241. TEMPERATURE DEPENDENCE OF ANISOTROPY ENERGY OF FERROMAGNETICS

Kasuya, T.

***Journal of the Physical Society of Japan*, v. 11, no. 9, pp. 944–947, September 1956**

The temperature dependence of anisotropy energy of ferromagnetics was calculated by the spin-wave method which assumes the existence of only pseudodipole interaction in which some restricted long-range forces are included. The temperature dependence obtained is $(M/M_0)^{16}$, a result which is in fairly satisfactory agreement with the experimental $(M/M_0)^{20}$ law, and is an improvement on Van Vleck's result $(M/M_0)^3$. This small discrepancy is discussed from the standpoint of *s–d* interaction. (*PA*, 1957, #527)

242. MAGNETIZING AND DEMAGNETIZING PERMANENT MAGNETS

Parker, R. J.

***Electrical Manufacturing*, v. 58, no. 3, pp. 116–123, September 1956**

For many applications magnet can be magnetized only after it has been assembled in magnetic circuit of end product; fundamentals of magnetization reviewed to show how to determine amount of magnetizing (or demagnetizing) flux required; types of equipment and techniques. (*EI*, 1956)

243. MAGNETIC SPECTRA

Birks, J. B.

***Proceedings of the Institution of Electric Engineers*, Paper 2217R, published October 1956 (To be republished in v. 104B, 1957)**

The various types of magnetic spectra are reviewed. In ferromagnetic metals, relaxations of various time-constants occur. Above 200 Mc/s the magnetic dispersion is attributable to incomplete penetration of surface domains, due to skin effect, and internal phenomena are not observed. In low conductivity paramagnetic materials, three types of relaxation have been found, namely spin-lattice, spin-spin, and a third yet to be identified. The application of a static magnetic field normal to the h.f. field causes electron-spin resonance absorption at the Larmor precession frequency. This induced resonance, which has been observed in paramagnetic materials, in ferromagnetic metals and in ferrites, is broadened by relaxation effects. Similar induced nuclear magnetic resonance is found at lower frequencies. The magnetic spectra of the ferrites exhibit similar natural resonances in the absence of an applied static field. These resonances, which occur in both the microwave and r.f. regions, are due to domain spin rotations in the internal anistropy field, and to domain wall displacements, and their identity is discussed. Magnetic dispersion due to relaxation of translational and other magnetization processes occurs at r.f. and lower frequencies. The relaxation of irreversible magnetization processes also occurs in the l.f. region. (*PA*, 1956, #8861)

244. A SURVEY OF THE THEORY AND APPLICATIONS OF FERRITES AT MICROWAVE FREQUENCIES

Clarricoats, P. J. B., Hayes, A. G., and Harvey, A. F.

***Proceedings of the Institution of Electrical Engineers*, Paper 2229R, published October 1956 (To be republished in v. 104B, 1957)**

A brief review of gyromagnetic media in general is followed by a more detailed description of the microwave behaviour of a ferromagnetic medium, of which ferrites form a suitable class of material. The general physical properties of ferrites are outlined briefly, together with a description of several of the mechanisms to account for the dispersion which occurs in their r.f. permeability. The propagation of an electromagnetic wave

through an infinite ferrite medium is considered. The properties of different guided systems containing ferrites are then studied. The behavious of various ferrite waveguide structures is described and their applications are suggested. Most of the data quoted are from published papers, but in a few instances some unpublished work of the authors has been included for completeness. An extensive bibliography completes the survey. (*PA*, 1957, #562)

245. ON THE SPIN-WAVE THEORY OF FERROMAGNETISM

Meyer, K.

***Zeitschrift für Naturforschung*, v. 11a, no. 10, pp. 865–873, 1956 (in German)**

It is shown that the excited states of a ferromagnetic crystal with only one valence electron per atom can be described in terms of a system of spin-waves obeying Fermi-Dirac statistics. A procedure for calculating the states taking into account interactions between nearest neighbours is described, and is applied to the determination of the ground state of systems with a negative exchange integral. (*PA*, 1959, #1377)

246. FERROMAGNETIC RESONANCE IN INHOMOGENEOUS CONDITIONS

Pilshchikov, A. I., Trishina, Z. D., and Zvereva, T. A.

***Isvestiya Akademii Nauk*, SSSR, *Seriya Fizicheskaya*, v. 20, no. 11, pp. 1299–1309, 1956 (in Russian)**

The inhomogeneous conditions of ferromagnetic resonance in polycrystalline specimens of ferromagnetic alloys are due to the differences in the orientation of the crystallagraphic axes of the crystallites with respect to external field, to internal demagnetizing fields and to inhomogeneous internal residual stresses. An experimental investigation of the ferromagnetic resonance effects in various types of permalloy specimens is presented and discussed on the basis of the theoretical considerations in a previous paper. (*PA*, 1957, #4536)

247. ANALYSIS OF FERROMAGNETIC AND ANTIFERROMAGNETIC SECOND-ORDER TRANSITIONS

Hofmann, J. A., Paskin, A., et al.

***Physics and Chemistry of Solids*, v. 1, no. 2, pp. 45–50, September–October 1956**

Procedures for separating magnetic contribution to specific heats of ferro- and antiferromagnetic materials; in analyzing latter, it is found that specific heats of binary salts can be fitted by combinations of two Debye functions; in both materials, total energy of ordering W is determined; ratio W/NkT_C is found to compare favorably with calculations by others. 25 references. (*EI*, 1957).

248. THE ANISOTROPY CORRECTION IN FERROMAGNETIC RESONANCE

Standley, K. J., and Stevens, K. W. H.

***Proceedings of the Physical Society*, London, Section B, v. 69, pt. 10, pp. 993–996, October 1956**

A method is described for finding the net absorption, at a given magnetic field, resulting from the superposition of absorption lines from the randomly distributed crystallites of a polycrystalline material. It is then shown that, due to magnetocrystalline anisotropy the maximum in a ferromagnetic resonance curve does not coincide with the centre of gravity of the absorption line. This is important because the usual resonance equation $h\nu = g\beta H$ implies the use of the centre of gravity field, so that to obtain the true g a correction must be made to the field for maximum absorption. The magnitude of the correction depends on K_1/M and is estimated numerically. (*PA*, 1957, #1438)

249. ON THE IMPORTANCE OF THE DENSITY OF DISLOCATIONS FOR THE THEORY OF THE COERCIVE FORCE OF RECRYSTALLIZED MATERIALS

Kersten, M.

***Zeitschrift für angewandte Physik*, v. 8, no. 10, pp. 496–502, October 1956 (in German)**

A theory of coercive force is developed in which it is supposed that the boundary walls between domains are fixed at dislocations and, in between the dislocations, distort into cylindrical form under the influence of an applied magnetic field. An expression for the coercive force is obtained which gives values of the correct order and which gives a relation between the coercive force and the temperature, for iron, which is in excellent agreement with the observed results. Using the expression for the coercive force and the known values for different materials, the surface density of dislocations in the materials can be calculated. The values obtained are of the

order of 10^6 cm^{-2} which is in good agreement with values obtained in other ways. The theory is also applied to the relation between coercive force and initial permeability, and to the volumes of material involved in Barkhausen discontinuities. (*PA*, 1957, #2402).

250. MAGNETIC RESONANCE IN FERRITES

Bloembergen, N.

***Proceedings of the Institution of Radio Engineers*, v. 44, no. 10, pp. 1259–1269, October 1956**

Ferromagnetic resonance in ferrites is reviewed. The concept of tensor permeability, the influence of magnetic anisotropy, demagnetizing fields, and damping mechanisms are discussed. Special consideration is given to coupled magnetic systems and the behaviour in ferrites with compensation points. The general theoretical results are compared with a few illustrative examples. The behaviour in polycrystalline material, g-value, line width, and anisotropy as a function of temperature and external magnetic field are outlined. (*PA*, 1957, #3444)

251. FUNDAMENTAL THEORY OF FERRO- AND FERRIMAGNETISM

Van Vleck, J. H.

***Proceedings of the Institution of Radio Engineers*, v. 44, no. 10, pp. 1248–1258, October 1956**

The presentation is centered around the four important forms of magnetic energy in ferromagnetic media: (I) the Zeeman energy of the elementary magnets in the applied magnetic field, (II) the classical electromagnetic interaction between dipoles, (III) the Heisenberg exchange energy, and (IV) the energy of anisotropy which is pseudodipolar of pseudoquadrupolar in structure but is attributable ultimately to rather recondite quantum-mechanical spin–orbit interaction. The primary cause of ferromagnetism is (III), and anisotropy arises from (IV). Domain structure and the concomitant hysteresis phenomena owe their existence to (II). The magnetic theory of the ferrites is in many ways simpler and less ambiguous than that for conducting ferromagnetic media, as there are no complications due to electron migrations. Néel's theory of ferrimagnetism explains the saturation magnetization and other properties of the ferrites. (*PA*, 1957, #3432)

252. FERROMAGNETIC CURIE TEMPERATURES BY THE KRAMERS—OPECHOWSKI METHOD

Brown, H. A.

***The Physical Review*, v. 104, no. 3, pp. 624–625, November 1, 1956**

The method of Kramers and Opechowski for obtaining the particular function of a magnetic lattice with nearest neighbour interaction as a power series in inverse temperature is extended to the fifth degree for the body-centered and simple cubic and the quadratic layer lattices. Curie temperatures inferred from the behaviour of the susceptibility demonstrate the internal consistency of the approach and show satisfactory agreement with the results of the Bethe–Peierls–Weiss method. (*PA*, 1957, #2398)

253. A RELATION BETWEEN HYSTERESIS CONSTANT AND COERCIVE FORCE.

Kornetzki, M.

***Zeitschrift für angewandte Physik*, v. 8, no. 11, pp. 536–538, November 1956 (in German)**

Although the permeability of many magnetic materials at low field strengths increases linearly with the field strength (Rayleigh law), in many other cases the permeability appears to increase linearly with the induction giving a hyperbolic magnetization curve in this region. If the asymptote of this curve is taken as to the coercive force a relation can be found between the Jordan hysteresis constant h and the coercive force such that $hH_c = 4$. This is in good agreement with the observed mean value of this product. The theoretical interpretation of this result is discussed. (*PA*, 1958, #657)

254. FERROMAGNETIC RESONANCE LINE WIDTH IN INSULATING MATERIALS

Clogston, A. M., Suhl, H., Walker, L. R., and Anderson, P. W.

***Physics and Chemistry of Solids*, v. 1, no. 3, pp. 129–136, November 1956**

Energy spectrum of spin waves in ferromagnetic body of finite size is very different from spectrum in infinitely extended body; in finite sample degeneracy exists be-

tween spin wave of wave vector and manifold of short wavelength spin waves; in presence of lattice irregularities degeneracy leads to resonance line width comparable to those experimentally observed; factors upon which line width depends. (*EI*, 1957)

255. SPATIAL CORRELATIONS IN A FERROMAGNETIC NEAR THE CURIE POINT
de Gennes, P. G., and Herpin, A.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 21, pp. 1611–1613, November 19, 1956 (in French)**

The mean value of the product $\delta S_0\, \delta S_R$, where δS_R is the fluctuation of the spin at R, is calculated on the basis of molecular field theory and found to be proportional to $\exp(-k, R)/Rr_1^2$, where $r_1 = 1.17$. A for iron and k_1^2 is proportional to $|1 - T/\theta|$ near the Curie point θ. (*PA*, 1957, #2397)

256. THE CALCULATION OF PRIMARY EXCITATIONS IN MAGNETIC SUBSTANCES
de Gennes, P. G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 22, pp. 1730–1732, November 1956 (in French)**

A general discussion of the spin-wave treatment and its application to neutron diffraction and the Bloch wall. (*PA*, 1957, #5447)

257. ON SOME ELECTRICAL AND MAGNETIC PROPERTIES OF METALLIC SOLID SOLUTIONS
Friedel, J.
***Canadian Journal of Physics*, v. 34, no. 12A, pp. 1190–1211, December 1956**

"Electron transport" conference paper. The resistivity, thermoelectric power, and magnetic susceptibility of metallic solid solutions at room temperature are reviewed, and their relation with the electronic structure emphasized. The special properties of transitional impurities are related to the emptying of their *d* shells. (*PA*, 1957, #9162)

258. FERROMAGNETIC RESONANCE IN METAL SINGLE CRYSTALS
Artman, J. O.
***The Physical Review*, v. 105, no. 1, pp. 74–84, January 1, 1957**

Microwave susceptibility expressions for ferromagnetic resonance have been derived for metal single crystals possessing crystalline anisotropy. Crystals of uniaxial and cubic magnetic symmetry are considered. When the magnetization $\boldsymbol{M}$ is aligned with the applied field $\boldsymbol{H}$, the results are equivalent to those of Kittel. When a simple multidomain structure occurs on a crystal face, two resonances are found for a given $\boldsymbol{H}$. These correspond to microwave excitation being perpendicular or parallel to $\boldsymbol{H}$. These multidomain resonances are related to $\boldsymbol{H}$, saturation magnetization $\boldsymbol{M}$, anisotropy parameter $\boldsymbol{K/M}$, and the ratio of skin-depth to domain width. Thus domain spacings can be inferred from microwave measurements. In particular, predictions of the theory are compared with the microwave measurements of Kip and Arnold and magnetic domain pattern observations in the literature. Secondary resonances are found in Ni by Reich can also be attributed to a multidomain structure. (*PA*, 1957, #2400)

259. ELECTROMAGNETIC PROPAGATION EFFECTS IN FERROMAGNETIC RESONANCE
Seavey, M. H. and Tannenwald, P. E.
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
AF19(122)-458, TR-143, January 16, 1957

It has been shown that an examination of electromagnetic wave propagation is necessary in the interpretation of ferromagnetic resonance experiments under almost all circumstances of conductivity, geometry and frequency. The electromagnetic effects observed under resonance conditions are examined in detail for insulators, moderate conductors and metals. Modifications of the "u" resonance line which occur when the sample size is of the same magnitude as the skin depth and/or wavelength are derived. Criteria for observing body resonances are given. Detailed calculations and figures are presented which give the power absorbed in semi-infinite and finite thickness slabs of various conductivities.

260. AN ELECTRICAL ANALOGUE OF MAGNETIC DOMAINS
Davis, P. F.
Reports of the British Electrical and Allied Industries Research Association, Leatherhead, Surrey, England, Report N/T78, 1957

An analogue for elucidating the domain structure in a picture frame specimen of a single crystal of iron is described. It may be used for finding either the magnetic energy or the field associated with a domain structure. Two forms of the analogue are described. One consists of a square mesh network of resistance wires composed of different gauges of wire running in different directions, the wires having the highest resistance per unit length run in the direction analogous to the direction of magnetization of the domain. The other form consists of parallel plates of resistive material immersed in an electrolytic tank. (*PA*, 1959, #3647)

261. TEMPERATURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF THE ELECTRONS IN A METAL
Zilberman, G. E. and Itskovich, F. I.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 1, pp. 158–160, 1957 (in Russian)**

Theoretical paper. Considers what happens in very weak magnetic fields where χ is practically independent of H. The contributions due, respectively, to small electron groups, a large electron group, a group of holes are worked out. It is pointed out how these contributions, with appropriate coefficients, when added can account for experimentally observed facts including even the curve with several maxima found by Verkin and Mikhailov for Zn. (*PA*, 1957, #6333)

262. ON THE PERIOD OF OUT-OF-STEP OF ORDERED ALLOYS WITH ANTI-PHASE DOMAIN STRUCTURE
Fujiwara, K.
***Journal of the Physical Society of Japan*, v. 12, no. 1, pp. 7–13, January 1957**

The period of out-of-step of ordered alloys with anti-phase domain structure, measured in atomic distance, is generally not an integer, in spite of sharp splittings of superlattice reflections. This fractional property of the period has been examined theoretically. The general treatment of this problem has shown that a regular and uniform arrangement of the different periods of anti-phase domains can explain the fractional value of the period. The results of numerical calculations for some models suggest, however, that complete regularity in arrangement is not always necessary but only uniformity is essential for the interpretation of the diffraction patterns. (*PA*, 1957, #5499)

263. AN ELECTRICAL ANALOGUE OF MAGNETIC DOMAINS
Davis, P. F.
***British Journal of Applied Physics*, v. 8, no. 1, pp. 19, 20, January 1957**

An electrical analogue which may be used for finding either the magnetic energy or the field associated with a domain structure consists of a square mesh network of resistance wires composed of different gauges of wire running in different directions; the wires having the highest resistance per unit length run in the direction analogous to the direction of magnetization of the domain (a three-dimensional form might consist of parallel plates of resistive material immersed in an electrolytic tank). (*PA*, 1957, #7206)

264. MAGNETOSTATIC MODES IN FERROMAGNETIC RESONANCE
Walker, L. R.
***The Physical Review*, v. 105, no. 2, pp. 390–399, January 15, 1957**

It has been found recently that in ferromagnetic resonance experiments performed in inhomogeneous r.f. exciting fields at a fixed frequency, absorption of power takes place at a number of distinct magnetic fields. This is ascribed to the existence of long wavelength modes of oscillation of the ferromagnetic sample. The mode spectrum of spheroids is examined for the case, which may often hold in practice, where exchange and electromagnetic propagation can be ignored simultaneously. (*PA*, 1957, #3431)

265. EINFUHRUNG IN DIE PHYSIK DER MAGNETISCHEN WERKSTOFFE
Koch, K. M., Jellinghaus, W.
F. Deuticke, Vienna, 1957

266. ELECTRICITY AND MAGNETISM
Bleaney, B. I. and Bleaney, B.
Clarendon Press, Oxford, 1957

267. ON THE THEORY OF ANTIFERROMAGNETISM. II.
Amatuni, A. T.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 17–27, 1957 (in Russian)**

The methods of Part I are used to derive formulae for the magnetization and magnetic susceptibility of an anisotropic antiferromagnetic at temperatures less than the Néel temperature. Good agreement with the experimental results of van den Handel, et al., on single crystals of $CuCl_2$ $2H_2O$ was obtained. (*PA*, 1958 #4120)

268. ELECTROMAGNETIC PROPAGATION EFFECTS IN FERROMAGNETIC RESONANCE
Seavey, M. H., Jr. and Tannenwald, P. E.
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
Technical Report 143, January 1957

269. LINEAR TRANSITIONAL PROCESSES TAKING PLACE IN FERROMAGNETIC BODY INFLUENCED BY ACTION ON IT OF APERIODIC PULSE AND PERIODIC MAGNETIC FIELDS
Zatsepin, N. N.
***Physics of Metals and Metallography* (Translation of *Fizika Metallov i Metallovedenie*), v. 48, no. 1, pp. 30–34, 1957**

Transitional electromagnetic processes calculated in parallel slab of infinite length and width of material with constant permeability and specific electrical conductivity. (*EI*, 1957)

270. ON THE THEORY OF THE g-FACTOR IN FERROMAGNETIC METALS
Turov, E. A.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 183–184, 1957 (in Russian)**

A formula for the internal field (H_i) is calculated on the basis of the *s–d* exchange model of a terromagnetic due to Vonsovskii and Turov. Comparison with the formula for H_i obtained by Kittel and Mitchell shows fundamental disagreement, the reason for which is not yet clear. (*PA*, 1958, #4117)

271. CALCULATION FROM MAGNETOSTRICTION DATA OF THE MAGNITUDE OF CHANGE OF THE CURIE TEMPERATURE WITH PRESSURE
Belov, K. P., and Panina, I. K.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 185–186, 1957 (in Russian)**

A formula is derived relating the change of the Curie temperature with pressure ($\Delta\theta/\Delta p$) to the magnetostriction constant and thermodynamic coefficients. Agreement with published experimental values of $\Delta\theta/\Delta p$ is good for Ni–Fe–Co alloys, but poor for a Ni–Cu alloy. (*PA*, 1958, #4124)

272. ON LINEAR TRANSITION PROCESSES TAKING PLACE IN A FERROMAGNETIC UNDER THE INFLUENCE OF APERIODIC, PULSED AND PERIODIC MAGNETIC FIELDS
Zatsepin, N. N.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 41–47, 1957 (in Russian)**

Formulae are derived for the magnetic field resulting from non-stationary processes in ferromagnetic plates placed in magnetic fields varying with time in the following ways: exponentially increasing, sawtoothed, square wave and sine wave. (*PA*, 1958, #4149)

273. THE *S–D* EXCHANGE IN FERROMAGNETIC METALS
Galperin, F. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 2, pp. 381–382, 1957 (in Russian)**

The theory of the *s–d* exchange has been developed in detail by Vonsovskiĭ. In the present state of the theory it is not possible to evaluate exchange integrals between *s*- and *d*- electrons of the same atom and for neighbouring atoms, or the *s*- electron transfer integral. Up to now therefore it has been possible to demonstrate only qualitative agreement between theory and experiment. The present paper aims to show that the repeated integrals can be found by empirical methods and that when substituted in the Vonsovskiĭ relation for pure ferromagnetic metals the results give satisfactory agreement with experiments as shown in a table of data for Gd, Ni, Co and Fe. (*PA*, 1957, #8023)

274. CONTRIBUTION TO THE THEORY OF FERROMAGNETISM OF METALS AND ALLOYS AT LOW TEMPERAURES

Kondorskii, E. I. and Pakhomov, A. S.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 2, pp. 381–382, 1957 (in Russian)**

Formulae for the temperature dependence of spontaneous magnetization near absolute zero have been obtained for a ferromagnetic lattice consisting of one kind of atoms in the case when the number of electrons with uncompensated spins is larger than the number of atoms and for lattices of binary ordered alloys of various structure. The method of approximate secondary quantization was used in the calculations. It is shown that in all of the considered cases the theory leads to a temperature dependence of spontaneous magnetization which can be expressed by a "$T^{3/2}$ law." (*PA*, 1957, #6335)

275. DEPENDENCE OF FERROMAGNETIC RESONANCE LINE WIDTH ON SHAPE OF SPECIMEN

Berk, A. D.
***Journal of Applied Physics*, v. 28, no. 2, pp. 190–192, February 1957**

Dependence examined on phenomenological grounds; if damping terms of Bloch–Bloembergen type are assumed in equation of motion of magnetization, line width for ellipsoidal sample is given by expression in terms of magnetization, demagnetizing factors, gyromagnetic ratio and other factors. (*EI*, 1957)

276. SPONTANEOUS MAGNETIZATION AND MAGNETIC SUSCEPTIBILITIES OF AN ANTIFERROMAGNETIC WITH FOREIGN IONS IN BOTH SUBLATTICES

Niessen, K. F.
***Philips Research Reports*, v. 12, no. 1, pp. 69–81, February 1957**

The spontaneous magnetization is calculated at a function of the temperature for an antiferromagnetic, in the two sublattices of which a different but relatively small number of original ions are assumed to be replaced by ions of another metal, carrying another magnetic moment. For a real calculation the Néel temperature of the material must be measured and also the Néel temperature of the original antiferromagnetic (in which the above replacement has not yet taken place). From the ingredients used for the preparation of the material the sum of the foreign ions in the two sublattices will be known, but not their ratio. This ratio, however, can be derived as a function of the temperature from the spontaneous magnetization. The change in the parallel and perpendicular susceptibilities, due to the above replacement of original by foreign ions is also determined. (*PA*, 1958, #6351)

277. FLUX REVERSAL IN SOFT FERROMAGNETICS

Humphrey, F. B. and Gyorgy, E. M.
***Journal of Applied Physics*, v. 30, no. 6, June 1959**

To describe the flux reversal process in soft ferromagnetics, at least three mechanisms are required. A domain wall motion process is satisfactory only when the drive field is slightly larger than the coercive force. In the intermediate drive region, a nonuniform rotation model is necessary to be consistent with the experimental observations. In particular such a model predicts the observed linear relationship between drive and the inverse of the reversal time, the observed shape of the flux reversal transient and the observed value of the switching coefficient. In the high drive region with a transverse field applied, a coherent rotation model provides the best explanation of the experimental observations. The three regions can be demonstrated with a single sample in the case of the thin film.

278. DEPENDENCE OF THE FERROMAGNETIC RESONANCE LINE WIDTH ON THE SHAPE OF THE SPECIMEN

Berk, A. D.
***Journal of Applied Physics*, v. 28, no. 2, pp. 190–192, February 1957**

The dependence of line width of the ferromagnetic resonance on the shape of the sample is examined on phenomenological grounds. If a damping term of the Bloch–Bloembergen type is assumed in the equation of motion of the magnetization, the line width for an ellipsoidal sam-

ple is given by $\Delta H = [1 + M_s^2\gamma^2 (N_x - N_y)^2/4\omega^2]^{-\frac{1}{2}} 2/\gamma T_2$. The Landau–Lifshitz form of damping leads to a line width which is independent of the shape of the specimen. (*PA*, 1957, #5448)

279. CONCERNING THE MAGNETIZATION OF BODIES IN THE PRESENCE OF MAGNETIC VISCOSITY

Rozovskii, M. I.

***Zhurnal Technicheskoi i Fiziki*, v. 27, no. 2, pp. 355–359, 1957 (in Russian)**

Theoretical paper, using ideas and differential equation due to Arkadev. The author puts forward a method of solving the problem of the magnetization of bodies, in particular of a cylinder, suitable for any shape of experimental curve of viscous magnetization. (*PA*, 1958, #9273)

280. FERROMAGNETIC RELAXATION BY THE EXCHANGE INTERACTION BETWEEN FERROMAGNETIC ELECTRONS AND CONDUCTION ELECTRONS

Mitchell, A. H.

***The Physical Review*, v. 105, no. 5, pp. 1439–1444, March 1, 1957**

The Hamiltonian for the exchange interaction between the ferromagnetic *d*-electrons and the conduction *s* electrons is derived. The ferromagnetic relaxation time caused by the *s–d* exchange interaction is calculated in a spin-wave approximation. When one uses a screened value of the exchange integral ($J_{atomic}/30$), the calculated relaxation time for nickel at room temperature is 5×10^{-8} sec as compared to the time 2.5×10^{-10} sec needed to account for the experimental line width. The exchange relaxation may be dominant in materials such as alloys which have narrower lines than nickel. (*PA*, 1957, #4527)

281. THE OPTICS OF MAGNETIC CRYSTALS. II. BINORMALS AND BIRADIALS. OPTICAL SURFACES

Fedorov, F. I.

***Optika i Spektroskopiya*, v. 2, no. 3, pp. 361–370, 1957 (in Russian)**

Confirmation of previous work. The directions of the binormals of a general magnetic crystal are determined and limits found between which values of the refractive index may lie. The cases of the bipolar normal optical surfaces and their cross-sections are considered for rhombic, monoclinic and triclinic magnetic crystals. Entirely theoretical. (*PA*, 1957, #9123)

282. THE ENERGY OF MAGNETIZATION

Vautier, R.

***Journal des recherches du centre national de la recherche scientifique, Laboratoires de Bellevue*, no. 38, pp. 23–29, March 1957 (in French)**

The energy of magnetization is analyzed with particular reference to a permanent magnet circuit with an air-gap. The relations between the total energy of magnetization and the energy of the demagnetizing field, and the area under different portions of the *B–H* loop, are considered. (*PA*, 1959, #4790)

283. THEORY OF BLOCH WALL BENDING WITH STRAY FIELD EFFECT

Dietze, H. D.

***Zeitschrift für Physik*, v. 149, no. 3, pp. 276–298, 1957 (in German)**

The theory of Kersten is extended by taking account of the effect on the initial permeability of stray fields produced during Bloch wall distortion. The temperature variation of the permeability is affected by these fields; application is made to iron. (*PA*, 1958, #5108)

284. FRACTION OF TOTAL ENERGY AND ENTROPY OF MAGNETIC ORDER ATTAINED AT CURIE TEMPERATURE BY ANTIFERROMAGNETIC SALTS

Paskin, A.

***Physics and Chemistry of Solids*, v. 2, no. 3, pp. 232–236, 1957**

Recent magnetic calculations based on Bethe-Peierls-Weiss method of computing magnetic order in ferro- and antiferromagnetic spin configurations are extended to obtain fraction of total energy of magnetic order and fraction of total entropy of magnetic order realized at Curie temperature: calculations are carried out both quantum mechanically and classically. (*EI*, 1957)

285. AN INVESTIGATION OF ELECTRON PARAMAGNETIC RESONANCE FOR VARIOUS MAGNETIC FIELD ORIENTATIONS. MICROWAVE MAGNETO-OPTIC EFFECTS
Hedwig, P.
Experimentelle Technik der Physik, v. 5, no. 3, pp. 132–143, 1957 (in German)

The paper gives calculations of the microwave absorption, Faraday effect and Cotton–Mouton effect for all possible orientations of the r.f. and d.c. fields on the basis of the Bloch equations and these are claimed to be more exact than those of earlier authors. Apparatus is described for the measurement of these three parameters at 3.365 cm by well known methods although some subtleties in the interpretation are noted. High homogeneity of the microwave field is achieved by working the resonator close to cut-off. Detailed results are given for $MnSO_4$ which agree with the theory. The Cotton–Mouton effect is also demonstrated for DPPH. (*PA*, 1959, #4816)

286. FERROMAGNETISM
Kittel, C.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 896–922, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #405)

287. ANTIFERROMAGNETISM
Gorter, C. J.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 923–941, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #406)

288. METAMAGNETICS OR SUBSTANCES ANTIFERROMAGNETIC AT THRESHOLD FIELD
Néel, L.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 942–960, 1957 (in French)

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #407)

289. LINE-BREADTHS AND THE THEORY OF MAGNETISM
Van Vleck, J. H.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 993–1014, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #396)

290. STOCHASTIC THEORY OF MAGNETIC RESONANCE
Kubo, R.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 1063–1080, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #397)

291. THE CONCEPT OF TEMPERATURE IN MAGNETISM
Van Vleck, J. H.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 1081–1100, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #1575)

292. MAGNETISM AT VERY LOW TEMPERATURES AND NUCLEAR ORIENTATION
Kurti, N.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 1101–1139, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #391)

293. THE VAN VLECK MODEL OF FERROMAGNETISM
Marshall, W.
Il Nuovo Cimento, Supplement, v. 6, no. 3, pp. 1186–1187, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #409)

294. STATISTICAL THEORY OF FERRO- AND ANTIFERROMAGNETISM
Van Kranendonk, J.
***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 1190–1191, 1957**

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #410)

295. EXCHANGE AND SUPEREXCHANGE COUPLING BETWEEN CONDUCTION ELECTRONS AND D ELECTRONS IN MAGNETIC MATERIALS
Pratt, Jr., G. W.
***The Physical Review*, v. 106, no. 1, pp. 53–66, April 1, 1957**

An analysis is made of the magnetization of the conduction electrons in a ferromagnetic material induced by their exchange interaction with the *d*-electrons. The problem is set up by using the density matrix some special properties of which are proved in the appendix. When this formalism is used, the exchange interaction between a conduction electron and the inner as well as the *d*-electrons associated with a given atom are found as a function of the relative spin orientation of the atom and the conduction electron. The problem is treated for $T \ll T_c$ and for $T \sim T_c$. Results for Fe have been calculated by using the nearly free electron method and the cellular methods. The effect of correlation is taken into account by the Bohm and Pines technique. A magnetization of about 0.20 μ_0 per atom is found. An antiferromagnetic coupling is found to be possible between magnetic ions in dilute alloys such as has been found experimentally in Cu—Mn. The mechanism is a superexchange coupling of the magnetic ions through the conduction electrons. A moleular field theory has been worked out for this case on the basis of an antiferromagnetic coupling between the magnetic ions and a ferromagnetic coupling between these ions and the conduction electrons. This theory is found to admit the possibility of an antiferromagnetic–ferromagnetic transition. Application of this theory to the Cu—Mn alloys shows that it is unnecessary to assume that the *s–d* exchange interaction is as weak as previously believed. It is, furthermore, suggested that the combination of direct and superexchange interactions between the 4f and conduction electrons in the rare earths is responsible for their magnetic properties and in particular is the source of the observed antiferromagnetic–ferromagnetic transitions in erbium and dysprosium. (*PA*, 1957, #5450)

296. PLASTIC DEFORMATION AND MAGNETOSTRICTION
Rieder, G.
***Zeitschrift für angewandte Physik*, v. 9, no. 4, pp. 187–202, April 1957 (in German)**

Previous theories of internal strains as a result of plastic deformation are brought together in a single theory, which considers also the mechanical effects of crystal energy. This theory also takes into account plastic and quasi-plastic distortions. Classical elastic theory is extended by the introduction of antisymmetrical stress tensors. The application of this theory to problems of magnetization is considered, in particular, the effect of dislocations in impeding movement of domain walls and the relations between distractions and coercive force. (*PA*, 1958, #7565)

297. THE THEORY OF ELECTRON EMISSION FROM FERROMAGNETICS UNDER THE INFLUENCE OF AN ELECTROSTATIC FIELD
Veksler, A. Z.
***Fizika Metallov i Metallovedenie*, v. 4, no. 2, pp. 222–227, 1957 (in Russian)**

On the basis of the *s–d* exchange model of a ferromagnetic it is shown that the electron emission produced by an applied electrostatic field depends on the square of the spontaneous magnetization. The theory agrees with experimental results from various sources. (*PA*, 1958, #4064)

298. ELECTRON EMISSION THEORY IN FERROMAGNETIC MATERIALS UNDER ACTION OF ELECTROSTATIC FIELD
Veksler, A. Z.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*) v. 4, no. 2, pp. 23–27, 1957**

Calculation, on basis of *s–d* exchange model: it is shown that current varies quadratically with spontaneous magnetization. (*EI*, 1957)

299. CHARACTERISTIC FEATURES OF THE NEEL THEORY OF THE MAGNETIC AFTER-EFFECTS OF FOREIGN ATOMS
Schreiber, F.
Zeitschrift für angewandte Physik, v. 9, no. 4, pp. 203–212, April 1957 (in German)

A simplified exposition of Néel's theory of magnetic viscosity due to diffusion of interstitial foreign atoms is given for the restricted case of a single time constant (single Bloch wall). Electric circuit analogues are set up to illustrate the Richter magnetic after-effect and the dependence of the initial permeability on frequency. (*PA*, 1958, #7190)

300. THE OPTICS OF MAGNETIC CRYSTALS. III. UNIAXIAL AND SINGLY-REFRACTING MAGNETIC CRYSTALS
Fedorov, F. I.
Optika i Spektroskopiya, v. 2, no. 4, pp. 514–523, 1957 (in Russian)

The propagation of a plane-polarized light wave in a singly refracting magnetic crystal is discussed. It is shown that the crystal's transparency must have directional properties related to its magnetic field. (*PA*, 1957, #9124)

301. APPLICATION OF VARIATIONAL PRINCIPLE IN PROBLEMS OF A BINARY ALLOY AND ISING SYSTEM
Kvasnikov, I. A.
Doklady Akademii Nauk, SSSR, v. 113, no. 4, pp. 777–779, 1957 (in Russian)

The method of previous papers is extended in a binary alloy Ising system. (*PA*, 1957, #9256)

302. CALCULATION OF THE MAGNETIZATION OF A UNIAXIAL FERRITE AT LOW TEMPERATURES
Yakovlev, E. N.
Doklady Akademii Nauk, SSSR, v. 115, no. 4, pp. 699–701, 1957 (in Russian)

The magnetization is calculated using an approximate method of boson second quantization. The resulting formulae, showing the decrease of magnetization with temperature for weak fields and the opposite for strong fields, are discussed physically. (*PA*, 1958, #3257)

303. CRITICAL SIZE AND NUCLEATION FIELD OF IDEAL FERROMAGNETIC PARTICLES
Frei, E. H., Shtrikman, S. and Treves, D.
The Physical Review, v. 106, no. 3, pp. 446–455, May 1, 1957

The field at which the spins of a previously saturated ideal ferromagnetic particle cease to be aligned is defined as the nucleation field. This field is calculated, using calculus of variation, for an infinite cylinder and a sphere, assuming three mechanisms of magnetization reversal: spin rotation in unison, magnetization curling, and magnetization buckling. Theoretical treatment shows that, in fact, only curling and rotation in unison need be considered. The critical size for single-domain behaviour, defined as the largest size at which magnetization reversal proceeds by rotation in unison, is calculated for the prolate ellipsoid and is found to be practically independent of magnetocrystalline anisotropy and elongation and approximately equal to $A^{1/2}/I_s$. Here A is the exchange constant and I_s is the saturation magnetization. For cylinders larger than the critical size, the coercive force, for a field applied in the direction of the long axis, is found to be equal to the nucleation field, when magnetocrystalline anisotropy is neglected. The coercive force thus calculated decreases with the radius of the cylinder, R, according to $H_c = 6.78A/I_sR^2$. Available experimental data are discussed and are generally found to be in a better agreement with this than with previous theory. (*PA*, 1957, #6352)

304. INFLUENCE OF SUCCESSIVE MAGNETIC FIELDS WITH RANDOM AMPLITUDE ON THE MAGNETIZATION OF FERROMAGNETIC SUBSTANCES
Néel, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 244, no. 20, pp. 2441–2446, May 13, 1957 (in French)

The change of magnetization is calculated by assuming a Gaussian distribution, and application is made to the theory of magnetic viscosity where the random fields are the equivalent fluctuation fields. (*PA*, 1957, #9271)

305. GENERALIZATION OF THE SPIN-WAVE MODEL TO THE CASE OF SEVERAL ELECTRONS SURROUNDING EACH [LATTICE] SITE

Izyumov, Yu.A.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 5, pp. 1058–1064, 1957 (in Russian)**

The energy of a weakly excited state of ferromagnetic or antiferromagnetic crystals in which each site is surrounded by several electrons is calculated by the method of approximate secondary quantization applied to a system consisting of two types of interacting Fermi particles. It is found that besides the usual excitations of the ferro-antiferromagnon type some additional excitations appear in these systems which weakly depend on the quasi-momentum. A physical interpretation of the elementary excitations thus found is put forward. (*PA*, 1958, #1769)

306. THE ISING MODEL AND FERRIMAGNETISM

Stevens, K. W. H.

***Proceedings of the Physical Society*, London, Section B, v. 70, pt. 5, pp. 537–539, May 1957**

An expression is found for the susceptibility of a body-centred cubic structure with ions of different g-values at the centre and corners of the unit cell, and with nearest-neighbour spins coupled by an Ising type interaction. It is shown that the susceptibility can be expressed as the sum of the susceptibilities of an antiferromagnetic and a ferromagnetic with different g-values. At high temperatures the susceptibility is similar to that of an antiferromagnetic but as the temperature is lowered the susceptibility becomes progressively more dependent on the ferromagnetic contribution. (*PA*, 1957, #6334)

307. ON THE SUSCEPTIBILITY OF A FERROMAGNETIC ABOVE THE CURIE POINT

Domb, C. and Sykes, M. F.

***Proceedings of the Royal Society of London*, Series A, v. 240, pp. 214–228, May 21, 1957**

Series expansions for the susceptibility of a ferromagnetic at high temperatures are examined in detail to estimate the curvature of the reciprocal of the susceptibility immediately above the Curie point. For an Ising model with spin 1/2 a substantial number of terms of the series are available, and the series is well behaved (i.e. the coefficients vary smoothly). The asymptotic behaviour of the coefficients can be conjectured with fair confidence, and a closed formula can be derived based on this conjecture. For an Ising model with spin greater than 1/2 fewer terms of the series are available, but the series is still well behaved, and an extrapolation can again be undertaken fairly confidently. For the Heisenberg model with spin 1/2 the behaviour of the coefficients is considerably more erratic and the predictions are more tentative. It is concluded generally that the curvature of the reciprocal susceptibility depends primarily on the lattice structure and little on the type of interaction; that there is little variation between the different types of two-dimensional, and different types of three-dimensional lattice, although there is a marked difference between two- and three-dimensional lattices. The experimental curve of Weiss and Forrer for nickel is examined, and it is found that the data can be fitted quite well by the extrapolation formula for a three-dimensional lattice. It is thus possible to account for the experimental results assuming only short-range interatomic forces. (*PA*, 1957, #8713)

308. INTERPRETATION OF THE CREEPING [REPTATION] OF HYSTERESIS CYCLES

Néel, L.

***Compte rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 22, pp. 2668–2674, May 27, 1957 (in French)**

The effect is the continuous displacement of the hysteresis cycle of a specimen to which magnetic fields of different amplitudes H_A and H_B are successively applied. It is described by considering the action of a small field of spatially random amplitude additional to the applied fields, this field having its origin in the fluctuating interaction between the elementary domains of the specimen under the action of the successively applied fields. (*PA*, 1957, #9757)

309. CORRECTION FOR THE FINITE MAGNETIC MODULATION AMPLITUDE IN PARAMAGNETIC AND NUCLEAR MAGNETIC RESONANCE LINES

Spry, W. J.

***Journal of Applied Physics*, v. 28, no. 6, pp. 660–662, June 1957**

A general method of correcting for the finite magnetic modulation amplitude in line shape analyses of paramag-

netic or nuclear magnetic resonance lines is described. The method consists of determining the proper "folding" function for the detection system. Once this has been determined, the numerical "unfolding" procedure of A. R. Stokes can be used to compute the true line shape from the observed shape of an arbitrary experimental line. (*PA*, 1958, #1781)

310. A THERMODYNAMICAL THEORY OF "WEAK" FERROMAGNETISM IN ANTI-FERROMAGNETICS

Dzyaloshinskii, I. E.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 6, pp. 1547–1562, 1957 (in Russian)**

A thermodynamical theory of "weak" ferromagnetism of Fe_2O_3 and $MnCO_3$ and $CoCO_3$ is developed on the basis of Landau's theory of phase transitions of the second kind. It is shown that "weak" ferromagnetism is due to relativistic spin–lattice and magnetic dipole interactions. A strong dependence of the properties of such "weak" ferromagnetic substances on the magnetic symmetry of the crystal is noted. Their behaviour in an external magnetic field is studied. (*PA*, 1958, #3224)

311. ON THE MAGNETIC PROPERTIES OF SUPERCONDUCTORS OF THE SECOND TYPE

Abrikosov, A. A.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 6, pp. 1442–1452, 1957 (in Russian)**

A study is made of the magnetic properties of the second type (massive) superconductors for which the parameter κ of the Ginsburg–Landau theory is greater than $1/\sqrt{2}$. The results explain some of the experimental data on the behaviour of superconducting alloys in a magnetic field. (*PA*, 1958, #2337)

312. THERMODYNAMICS OF IRREVERSIBLE PROCESSES IN A [MAGNETICALLY] POLARIZED MAGNETOELASTIC MEDIUM. I.

Vlasov, K. B.

***Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 542–544, 1957 (in Russian)**

313. ON THE THEORY OF ANTIFERRO-MAGNETISM

Tsukernik, V. M.

***Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 566, 567, 1957 (in Russian)**

In a ferromagnetic, equilibrium is achieved by interaction of spin waves with each other. In an antiferromagnetic, on the other hand, the basic process is shown to be the interaction of spin waves and lattice waves. (*PA*, 1958, #4121)

314. THE REVERSIBLE SUSCEPTIBILITY TENSOR OF THE STONER-WOHLFARTH MODEL

Aharoni, A., Frei, E. H., Shtrikman, S. and Treves, D.

***Bulletin of the Research Council of Israel*, v. 6A, no. 3–4, pp. 215–238, April–July, 1957**

The reversible susceptibilities as a function of applied field are calculated both for the direction of the field and for a direction perpendicular to the field. The theory is based on the model used by Stoner and Wohlfarth to calculate the magnetication curve. This assumes an assembly of particles, each of which has an uni-axial anisotropy energy. The case of the positive anisotropy coefficient is discussed in detail, and theoretical results for single particles and for the assembly are given. The irreversible parallel susceptibility is calculated for the same model. The case of negative anisotropy coefficient is briefly discussed. Certain features that are common also to cubic anisotropy are considered. The available experimental data are considered, and preliminary results of experiments given. (*PA*, 1958, #8107)

315. ON THE THEORY OF THE TRANSVERSE PHOTOMAGNETIC EFFECT

Moizhes, B.Ya. and Obraztsov, Yu.N.

***Zhurnal Tekhnicheskoi Fiziki*, v. 27, no. 7, pp. 1446–1453, 1957 (in Russian)**

The theory of the transverse photomagnetic effect in semiconductors discovered by Kikoin and Bykovskii is considered; the effect is at right angles to the usual photomagnetic effect, and is present when the magnetic field has a component normal to the illuminated surface of the semiconductor. The behaviour of *p*-type Ge, where the voltage changes sign on increasing the magnetic field, can be explained if ~1.5% of the holes have a mobility ~10

times the average hole mobility. The behaviour of the short-circuited transverse photomagnetic current is a more sensitive indication of the presence of such "light" holes. (*PA*, 1958, #7929)

316. FREQUENCY SPECTRUM OF THE BARKHAUSEN NOISE

Biorci, G. and Pescetti, D.

***Journal of Applied Physics*, v. 28, no. 7, pp. 777–780, July 1957**

The spectral density of the Barkhausen noise was measured and a theoretical interpretation of the results is given. It is assumed that the single pulse is exponential with a time constant of the order of 10^{-4} sec. Then the computed spectral density is constant up to 1 kc/s, and then decreases exponentially. This behaviour is only slightly dependent on the shape of the pulse. The theoretical conclusions are in good agreement with experimental data taken on iron, nickel, and ferroxcube specimens. The usual model introduced to explain the mechanism giving rise to the noise leads to the conclusion that the intensity of the spectrum is proportional to the frequency of the magnetizing current. This conclusion is not experimentally verified because of the extreme simplifications involved in the model itself. (*PA*, 1958, #234)

317. NOTES ON THE GROUND STATE OF ANTIFERROMAGNETISM

Nagai, O.

***Journal of the Physical Society of Japan*, v. 12, no. 8, p. 978, August 1957**

Extends previous work studying the onset of antiferromagnetism, predicted by the anisotropic exchange Hamiltonian by including in part the effects of correlation among neighboring spins in the manner used by Marshall. As in the initial work, it is found that the number of antiparallel pairs of spins decreases with increasing coordination number, in contradiction to the results of spin wave theory. It is concluded that the introduction of correlation in the present manner does not necessarily lead to a better approximation. (*PA*, 1958, #3223)

318. THEORY OF THE WIEDEMANN EFFECT

Yamamoto, M.

***Journal of the Physical Society of Japan*, v. 12, no. 8, pp. 981–982, August 1957**

Under the combined action of a circular and longitudinal magnetic field, a ferromagnetic experiences a twist. A theory of the effect applicable to cylindrical rod specimens is given. (*PA*, 1958, #3258)

319. ON A NONLINEAR THEORY OF TRANSITION PROCESSES IN A FERROMAGNETIC PLATE, MAGNETIZED BY A LONGITUDINAL ALTERNATING FIELD

Zatsepin, N. N.

***Fizika Metallov i Metallovedenie*, v. 5, no. 1, pp. 30–36, 1957 (in Russian)**

A series expansion is made for the field $H(z,t)$ at times and positions z inside a one-dimensional ferromagnetic. Expressions are derived for the first (linear) and second (non-linear) terms of the series when the applied field has the form of a square wave. (*PA*, 1958, #4143)

320. CONTRIBUTION TO NON-LINEAR THEORY OF TRANSITIONAL PROCESSES IN FERROMAGNETIC PLATE MAGNETIZED WITH LONGITUDINAL VARIABLE FIELD

Zatsepin, N. N.

***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*) v. 5, no. 1, pp. 23–29, 1957**

Solution given to problem of transitional processes in plate magnetized with longitudinal, variable field; nonlinearity of plate material magnetization curve is calculated by small parameter method. (*EI*, 1957)

321. ON THE ADDITION OF A SECOND ANISOTROPY CONSTANT IN THE THEORY OF EVEN [CHETNII] EFFECTS

Dyakov, G. P.

***Fizika Metallov i Metallovedenie*, v. 5, no. 1, pp. 161–162, 1957 (in Russian)**

The author's theory of magnetostriction is modified by the addition of a further term to the series for crystalline anisotropy. This adds further (sometimes large) terms to the expression for the magnetostriction. (*PA*, 1958, #4145)

322. APPLICATION OF VARIATIONAL PRINCIPLE TO ISING MODEL OF ANTIFERROMAGNETICS

Kvasnikov, I. A.
Doklady Akademii Nauk, SSSR, v. 113, no. 3, pp. 544–547, 1957 (in Russian)

Follows the method of a previous paper on ferromagnetics, the N conditions on the statistical sum over neighbours now being modified to apply to antiferromagnetics. (*PA*, 1957, #9255)

323. INFLUENCE OF FOREIGN IONS ON THE CRITICAL FIELD STRENGTH OF AN ANTIFERROMAGNETIC

Niessen, K. F.
Philips Research Reports, v. 12, no. 4, pp. 355–363, August 1957

The critical field strength is calculated for an antiferromagnetic material in each of whose sublattices a number of original magnetic ions has been replaced by foreign magnetic ions with different magnetic moments, or simply by non-magnetic ions. The change in the critical field strength can be given by a simple formula. (*PA*, 1959, #441)

324. "SATELLITE-ELECTRON" THEORY OF FERROMAGNETISM, ANTIFERROMAGNETISM AND RELATED PHENOMENA

Singh, L.
Naturwissenschaften, v. 44, no. 15, pp. 417–418, 1957

An account of a speculative theory of ferromagnetism based on satellite orbits of the unpaired $3d$-electrons. Magnetic properties of transition-metal oxides are discussed in the light of the concept of these satellite orbits. (*PA*, 1958, #225)

325. MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS WITH AN IMPURITY BAND IN A STRONG MAGNETIC FIELD

Klinger, M. I.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 33, no. 2(8) pp. 379–386, 1957 (in Russian)

Magnetic susceptibility of semiconductors with impurity bands in strong magnetic fields is considered. It is established that for a certain dispersion law the susceptibility rapidly oscillates with increase of the field strength. Since these oscillations substantially depend on the model accepted for the semiconductor with impurity bands their experimental observation may be considered as partial confirmation of the correctness of the proposed model. (*PA*, 1958, #1683)

326. CONTRIBUTION TO THE THEORETICAL STUDY OF MOLECULAR MAGNETIC SUSCEPTIBILITIES

Tillieu, J.
Annales de physique, Paris, Series 13, v. 2, no. 7–8, pp. 471–497, July–August 1957 (in French)

A variational method is developed to determine the components of the magnetic susceptibility tensor under the postulates that the permanent magnetic moment is zero and the system is describable by a real wave-function. It has the advantage that only the wave-function of the state studied need be known. Expanding the perturbed state ψ as $\psi = \psi_0 [1 + g\mathcal{H}]$, where ψ_0 is the unperturbed state and $\mathcal{H}$ the field (assumed uniform and constant) expressions for the energy and the magnetic susceptibility tensor $\chi_{\mu\nu}$ are given in terms of the components of g which are determined to make $\chi_{\mu\nu}$ a maximum. The resulting formulae are shown to be gauge invariant thus allowing any convenient choice of origin to be made which would simplify calculations. The disadvantages of the Van Vleck formulation and the poor approximations used in previous calculations are mentioned. (*PA*, 1958, #5100)

327. THE DE HAAS–VAN ALPHEN EFFECT IN A VARYING MAGNETIC FIELD

Kosevich, A. M.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 33, no. 3(9), pp. 735–745, 1957 (in Russian)

A theoretical study is made of the characteristic features of the oscillations of the magnetic moment of a metallic sample at low temperatures in a pulsed magnetic field. (*PA*, 1958, #1783)

328. ON THE QUESTION OF PIEZOMAGNETISM

Dzyaloshinskii, I. E.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 33, no. 3(9), pp. 807–808, 1957 (in Russian)

The assertion that piezomagnetic substances are forbidden by invariance arguments is shown to be incorrect by a discussion of the symmetry properties of antiferromagnetics. (*PA*, 1958, #2408)

329. ROTATIONAL MODEL OF FLUX REVERSAL IN SQUARE LOOP FERRITES

Gyorgy, E. M.

***Journal of Applied Physics*, v. 28, no. 9, pp. 1011–1015, September 1957**

A brief review of the experimentally established details of the flux reversal process in square loop ferrites is given. The discrepancies between the experimental results and the predictions of the domain wall motion theory are discussed. The switching coefficient S_w is examined in detail. The rotational model is based on the solution of the modified Landau and Lifshitz equation and predicts the shape of the output voltage pulse, the relationship between the flux reversal time and the applied field, and the minimum switching coefficient that can be obtained for a given ferrite. The switching coefficients determined experimentally are within a factor of three of the minimum value of S_w predicted by this model. (*PA*, 1958, #8128)

330. ON THE THEORY OF FERROMAGNETISM. I. THE COLLECTIVE ELECTRON MODEL

Meyer, K.

***Zeitschrift für Naturforschung*, v. 12a, no. 10, pp. 786–797, 1957 (in German)**

The statistical thermodynamics of the collective electron model is worked out in detail and Stoner's procedure justified. (*PA*, 1959, #4775)

331. ON THE THEORY OF FERROMAGNETISM. II. THE HEISENBERG MODEL

Meyer, K.

***Zeitschrift für Naturforschung*, v. 12a, no. 10, pp. 797–804, 1957 (in German)**

A statistical calculation is based on an approximation to the energy levels of the Heisenberg model, the energy depending only on the spin component S^2 of the system (Energieschwerpunktmethode). The results obtained are those of the Weiss theory. (*PA*, 1959, #4776)

332. CONTRIBUTION TO THE THEORETICAL STUDY OF MOLECULAR MAGNETIC SUSCEPTIBILITIES

Tillieu, J.

***Annales de physique*, Paris, Series 13, v. 2, no. 9–10, pp. 631–675, September–October 1957 (in French)**

The general formulae derived in an earlier paper are simplified for the cases of simple product wave-functions and Heitler–London bond orbitals and used to calculate the magnetic susceptibilities of σ–bonds; particular applications being to the hydrogen molecule, C–H bonds and σ C–C bonds in various states of hybridization. General formulae for the susceptibilities of π–electron systems are applied to the double bond C = C and triple bond C ≡ C systems, employing different types of wave-functions (used by Slater, Heitler–London, Craig, Coulson). Tables giving the calculated susceptibilities for the hydrogen molecule and a large number of saturated and unsaturated aliphatic hydrocarbons show good agreement (all within 5%) with experimental data. (*PA*, 1958, #5101)

333. ON THE NON-LINEAR SURFACE EFFECT IN A FERROMAGNETIC CYLINDER MAGNETIZED CIRCULARLY

Zatsepin, N. N.

***Fizika Metallov i Metallovedenie*, v. 5, no. 2, pp. 230–233, 1957 (in Russian)**

The same methods as in an earlier paper are used to calculate the magnetic field in a cylinder magnetized by a continuously varying circular field. Account is taken of the cyclic variation of the magnetic susceptibility. (*PA*, 1958, #4144)

334. MAGNETIC MATERIALS WITH THE PERMINVAR EFFECT. I. CONTRIBUTION TO THE UNDERSTANDING OF THE PERMINVAR EFFECT AND ITS TEMPERATURE DEPENDENCE

von Kienlin, A.

***Zeitschrift für angewandte Physik*, v. 9, no. 10, pp. 520–526, October 1957 (in German)**

The Perminvar effect is described and its connection with the uniaxial anisotropy observed by Kaya in a permalloy crystal is discussed. Existing theories of the effect based on a degree of uniaxial anisotropy are reviewed and a qualitative explanation of the temperature dependence of the anisotropy for these theories is suggested. (*PA*, 1958, #8124)

335. MODELLVORSTELLUNGEN ZU DEN ERSCHEINUNGEN DER FERROMAGNETISCHEN HYSTERESE

Wilde, H.
Nachrichtentechnische Zeitschrift, v. 10, no. 10, pp. 497–502, October 1957

Models for demonstrating effects of ferromagnetic hysteresis; inadequacy of Preisach-type model for demonstrating all hysteresis effects; broadened concept of effects includes response of reversible permeability as function of pre-magnetization; discussion of physical shape of improved model. (*EI*, 1957)

336. ON THE HIGH TEMPERATURE SUSCEPTIBILITY FOR THE HEISENBERG MODEL OF A FERROMAGNETIC

Wood, P. J. and Rushbrooke, G. S.
Proceedings of the Physical Society, London, Section A, v. 70, Part 10, pp. 765–768, October 1957

Series expansions for the susceptibility previously obtained for spin $1/2h$ are extended to the case of arbitrary spin. Results are given as far as θ^{-6}, where θ = reduced temperature, and these are consistent with previous work. A brief discussion is given of some calculations of Curie temperatures. (*PA*, 1958, #1768)

337. EFFECTIVE MAGNETIC ANISOTROPY AND MAGNETOSTRICTION OF MONOCRYSTALS

Baltzer, P. K.
The Physical Review, v. 108, no. 3, pp. 580–587, November 1, 1957

The effective magnetic anisotropy energies associated with the domain theory are derived to second order for cubic crystals. These effective anisotropy energies are expressed in terms of the intrinsic anisotropy for an undeformed crystal, the magnetostriction, and the elastic moduli. Also, in the process of deriving the effective anisotropy energies to second order, the expression for the magnetostriction of a cubic crystal is expanded to sixth order in the direction cosines for the magnetization. The interrelation between the effective anisotropy in domains and domain walls is studied and its influence upon the domain configuration suggested. (*PA*, 1958, #7161)

338. EFFECT OF DEFECTS OF SPIN INTERACTIONS IN A SIMPLE CUBIC LATTICE

Isihara, A.
The Physical Review, v. 108, no. 3, pp. 619–629, November 1, 1957

Effects of lattice defects such as foreign atoms or holes on spin–spin interactions in a simple cubic lattice are calculated by using the so-called spherical model developed by Montroll, Berlin and Kac, and others. In the case when the concentration of defects is low and the distance between any pair of defects is large, the exact positions of the defects are not important and the excess free energy and other thermodynamical functions are determined by the concentration and the nature of defects. The Langevin–Curie law of magnetic susceptibility is modified by the presence of defects. (*PA*, 1958, #806)

339. REPRESENTATION OF EFFECTS OF THE OVERHAUSER TYPE

Manley, J. H.
American Journal of Physics, v. 25, no. 8, pp. 539–542, November 1957

A discussion of observations in magnetic resonance experiments and their relations to the processes involved entails consideration of the populations of magnetic states. By adding a population coordinate to an energy diagram a representation is obtained by which the time change-of-state population can be illustrated. This is applied to effects of the Overhauser type in solids, especially in semiconductors. (*PA*, 1958, #4139)

340. EFFECT OF CRYSTALLINE ELECTRIC FIELDS ON FERROMAGNETIC ANISOTROPY

Wolf, W. P.
The Physical Review, v. 108, no. 5, pp. 1152–1157, December 1, 1957

The effect of the electrostatic crystalline field is considered for a magnetic crystal in which the ions are strongly coupled by ferromagnetic exchange. On the basis of the one-ion approximation that the exchange can be represented by a Weiss molecular field, it is possible to derive expressions for the anisotropy constants, $K_i(T)$, in terms of the parameters occurring in the spin Hamiltonian of the isolated ions, and the magnetization of the lattice at the temperature T. The treatment assumes that the magnetic electrons can be considered as localized on the individual ions, and thus applies primarily to nonmetallic substances such as ferrites. The presence of more than one aligned sublattice is easily taken into account if the magnetization of each sublattice can be calculated from the Néel equations. (*PA*, 1958, #1764)

341. THEORY OF FERROMAGNETIC ANISOTROPY

Carr, W. J., Jr.

The Physical Review, v. 108, no. 5, pp. 1158–1163, December 1, 1957

By means of a virial theorem and perturbation theory, the anisotropy energy of a ferromagnetic crystal is expressed in terms of the Coulomb energy alone. This latter energy is approximated by a multipole expansion and the anisotropy constants are given in terms of electric multipole moments and crystalline-potential constants. The multipole moments, which arise from the orbital angular momentum induced by spin-orbit coupling, have been estimated from the known values of angular momentum. The method avoids explicitly carrying out high order perturbations, and furnishes a physical interpretation of the anisotropy mechanism without the use of phenomenological couplings. In most cases, the principal mechanism leading to anisotropy is found to be different from those considered by Van Vleck. (*PA*, 1958, #1765)

342. THEORY OF ANTIFERROMAGNETIC–FERROMAGNETIC TRANSITIONS IN DILUTE MAGNETIC ALLOYS AND IN THE RARE EARTHS

Pratt, G. W. Jr.

The Physical Review, v. 108, no. 5, pp. 1233–1242, December 1, 1957

In a previous paper a theory of direct exchange and superexchange coupling between d or f electrons and conduction electrons was given. This led to the possibility of an antiferromagnetic–ferromagnetic transition. The present paper is devoted to a more complete treatment of this magnetic transition by examining a particular case. Both the molecular-field theory and a cluster theory due to Oguchi are applied. Each leads to a magnetic transition and both predict that for all such transitions the ferromagnetic state must have a lower free energy at 0°K than the antiferromagnetic state. The transition is found to be of second order. Expressions are given for the parallel and perpendicular susceptibility in the neighborhood of the Néel point. A discussion is given showing how the direct exchange interaction with the conduction electrons makes a magnetic transition possible. A comparison is made between the theory given here and recent experimental results in Cu–Mn alloys. (*PA*, 1958, #8875)

343. CRITERION FOR FERROMAGNETISM FROM OBSERVATIONS OF MAGNETIC ISOTHERMS

Arrott, A.

The Physical Review, v. 108, no. 6, pp. 1394–1396, December 15, 1957

A criterion is proposed for determining the onset of ferromagnetism in a material as its temperature is lowered from a region in which the linearity of its magnetic moment vs. field isotherm gives an indication of paramagnetism. Within the limits of validity of a molecular field treatment, the Curie temperature is shown to be in general indicated by the third power of the magnetization being proportional to the internal magnetic field. The method was employed to redetermine the Curie point of nickel from the data of Weiss and Forrer, of Fe_3O_4 from the data of Smith and of some alloys from the data of Kaufmann and his collaborators and the author. (*PA*, 1958, #8114)

344. SOME MAGNETOTHERMAL RELATIONS FOR FERROMAGNETICS

Teale, R. W. and Rowlands, G.

Proceedings of the Physical Society, London, Section B, v. 70, Part 2, pp. 1123–1134, December 1957

An expression is derived which relates associated magnetic and thermal changes for reversible rotation of the intrinsic magnetization or reversible domain wall motion. A coefficient in the expression depends upon the type of internal magnetic energy change which accompanies these processes, and hence experiments are proposed to differentiate between the various possible energy changes. An effect arising from the second term in the magnetocrystalline energy expression is predicted. (*PA*, 1958, #1135)

345. ON THE *S–D* EXCHANGE MODELS OF TRANSITION METALS

Berdyshev, A. A. and Izyumov, Yu.A.

Fizika Metallov i Metallovedenie, v. 5, no. 3, pp. 552–553, 1957 (in Russian)

The addition of weak $s - d$ exchange to the homopolar model of a transition metal with an arbitrary number of d-electrons per atom, leads to the appearance of terms in T (temperature), $T^{1/2}$ and $T^{-1/2}$ in the formula for spontaneous magnetization. The term in T is the largest and gives $\sim$ 10% departure from the usual $T^{3/2}$ law. This is in better agreement with experiment. (*PA*, 1958, #331)

346. ON A DEFINITION OF THE PONDEROMOTIVE INTERACTION FORCE BETWEEN A MAGNET AND A FERROMAGNETIC MATERIAL
Shmarts, V. L.
Fizika Metallov i Metallovedenie, v. 5, no. 3, pp. 556–568, 1957 (in Russian)

A mathematical formulation of the field inside a ferromagnetic medium placed in the field of a magnet, leading to a calculation of the force on the ferromagnetic. It is shown that the behaviour of permanent magnet materials is different from that of electromagnet materials. (*PA*, 1958, #7197)

347. ON THE THERMODYNAMICS OF THE FERROMAGNETIC STATE AT LOW TEMPERATURES
Kaganov, M. I. and Tsukernik, V. M.
Fizika Metallov i Metallovedenie, v. 5, no. 3, pp. 561–563, 1957 (in Russian)

At low temperatures the specific heat of a metal is given by $C = \alpha T^3 + \beta T + C_s$ where C_s is the spin heat capacity. With large applied fields, $C_s \sim \exp(-\mu H/kT)$; with small H, $C_s \sim T^{3/2}$. Search of the literature leaves it uncertain whether C_s has been observed in either of these cases. (*PA*, 1958, #8108)

348. ON THERMODYNAMIC IRREVERSIBLE PROCESSES OF POLARIZED MAGNETOELASTIC MEDIA. II.
Vlasov, K. B.
Fizika Metallov i Metallovedenie, v. 5, no. 3, pp. 385–389, 1957 (in Russian)

Relations between the kinetic coefficients are derived for the case of an isotropic magnetoelastic medium polarized in the initial state by a magnetic field. Symmetry considerations divide the coefficients into even and odd functions of the magnetic field strengths. Equations are obtained for all the coefficients required to specify the symmetric and antisymmetric parts of the stress tensor, and their properties are studied in detail. (*PA*, 1959, #4779)

349. MAGNETIC PROPERTIES AND THE STRUCTURE OF METALS
Sucksmith, W.
British Journal of Applied Physics, Supplement No. 6 (Physics of non-destructive testing), S24–S27, 1957

There are many physical properties which are important both from the theoretical and experimental points of view in the study of ferromagnetic metals and their alloys. Some of these are of a more fundamental nature and are related to field-independent characteristics such as saturation intensity and Curie point. They may also affect the behaviour of ferromagnetic materials in low fields. Others which are concerned primarily with such low field properties as permeability, magnetostriction, and domain structure are dealt with. These relationships are examined in order to appreciate the extent to which magnetic properties can be used as a means of detecting variations in the structure and properties of magnetic materials. The report concludes with a consideration of newer developments in magnetism which may have application in future. (*PA*, 1958, #3227)

350. ON THE STATICS AND DYNAMICS OF MAGNETIC DOMAIN BOUNDARIES
Harrington, J. V.
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
TR-166, January 13, 1958
(ASTIA AD-110, 028)

A semiclassical analysis of the spin orientation in 180 and 90 deg domain walls is presented, taking into account both the rotational or latitude angle θ and the precessional or longitude angle ϕ of the macroscopic magnetization vector in ferromagnetic single crystals. Euler equations for the crystal are derived, solutions obtained for 180 and 360 deg walls, and indicated results verified by experiment. The Euler equations for wall motion are also derived and a solution obtained.

351. CONTRIBUTION TO THE THEORY OF ANTIFERROMAGNETISM AT LOW TEMPERATURES
Kaganov, M. I. and Tsukernik, V. M.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 34, no. 1, pp. 106–109, 1958 (in Russian)

The energy spectrum of a uniaxial antiferromagnetic substance was obtained without invoking nominal magnetization of the spin sublattices in the ground state. (*PA*, 1958, #7163)

352. THEORY OF DE HAAS–VAN ALPHEN EFFECT FOR OPEN ISOENERGY SURFACES
Zilberman, G. E.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 34, no. 1, pp. 243–245, 1958 (in Russian)

The de Haas–van Alphen effect concerns the correlation of the collective magnetic susceptibility of an electron assembly with variations in the applied magnetic field. In any such assembly surfaces of constant electronic energy can be defined; when these isoenergy surfaces are plane the situation is analogous to that dealt with in the dispersion theory of crystals and the results of this theory can be applied to the de Haas–van Alphen effect. (*PA*, 1958, #8144)

353. ON THE THEORY OF MAGNETIC SUSCEPTIBILITY OF METALS
Bonch-Bruevich, V. L. and Gertsenshtein, M. E.
Zhurnal Eksperimentalnoi i Teoreticheski Fiziki, v. 34, no. 1, p. 261, 1958 (in Russian)

354. THE SPONTANEOUS HALL EFFECT IN FERROMAGNETICS. II.
Smit, J.
Physica, v. 24, no. 1, p. 39–51, January 1958

It is shown that the spontaneous part of the Hall effect arising from the spontaneous magnetization is caused by skew scattering of the magnetized conduction electrons (in this case the 3*d*-electrons) due to their transverse polarization induced by spin-orbit interaction, which acts as an impact parameter in the collision process. The problem could be approximately solved for scattering on an impurity atom by converting it into that of the scattering on a vortex-like perturbing centre. The order of magnitude of the calculated Hall angle agrees with the experimental one ($\sim 10^{-2}$). It is shown quite generally that for lattice vibration scattering the Hall effect should be proportional to the square of the resistivity, as has been found experimentally for pure iron and nickel. (*PA*, 1958, #3233)

355. SPIN WAVES
Van Kranendonk, J. and Van Vleck, J. H.
Reviews of Modern Physics, v. 30, no. 1, pp. 1–23, January 1958

A review discussing spin deviations, the harmonic oscillator approximation for ferromagnetism, results for magnetization and specific heat, the effect of dipolar coupling, ferromagnetic resonance, antiferromagnetism and ferrimagnetism, spin relaxation processes, and the validity of the model. (*PA*, 1958, #4119)

356. CRITICAL MAGNETIC SCATTERING OF NEUTRONS BY IRON
Lowde, R. D.
Reviews of Modern Physics, v. 30, no. 1, pp. 69–74, January 1958

In the vicinity of a phase transformation an effect occurs in the magnetic scattering of neutrons (critical scattering) which results in the production of additional background. Theory and experiment are compared over a region at and near the 110 reflection in the Laue neutron diffraction pattern of an iron crystal, the "critical" part of the observed background being separated from normal background and from phonon scattering and its space and temperature dependence studied. Predictions from the Heisenberg theory of ferromagnetism are found to be verified near the Laue position but not elsewhere (possibly due to the breakdown of the quasielastic approximation used in the calculations). It is concluded that the localized-electron type of theory accounts for the observed phenomena within the limitations of the available scattering formulae. (*PA*, 1958, #6028)

357. ON THE PROBLEM OF NON-HOMOGENEITY OR DEMAGNETIZING FIELDS IN FERROMAGNETIC RESONANCE
Frait, Z.
Czechoslovak Journal of Physics, v. 8, no. 1, pp. 113–118, 1958 (in Russian)

Proposes a method for quantitatively calculating the influence of the inhomogeneity of demagnetizing fields on the shape of resonance curves. General expressions are given for the components of the mean complex permeability. The components of the mean effective permeability are calculated and plotted for a special case (thin band of ferromagnetic metal pressed to a rectangular opening of the resonance cavity of mode $H_{0_{Ln}}$). It is shown that not only broadening of the resonance curve occurs as a result of the inhomogeneities, but that the magnitude of the *g*-factor, determined from the maximum μ_R, differs from the correct value. Attention is drawn to the role played by this phenomenon in ferromagnetic resonance of polycrystalline ferrites. (*PA*, 1959, #4807)

358. PARALLEL SUSCEPTIBILITY OF AN ANTIFERROMAGNETIC CRYSTAL WITH TWO MAGNETIC SUB-LATTICES AT LOW TEMPERATURES

Korchovei, A.

***Revue de Physique*, Bucharest, v. 3, no. 1, pp. 57–70, 1958, *Studii si Cercčetari Fizika*, v. 8, p. 399, 1957 (in Russian)**

Using the method of spin waves, the author calculates low-temperature susceptibility of an antiferromagnetic for the case when the external magnetic field is parallel to the axis of spontaneous antiferromagnetism (the parallel susceptibility χ_{11}). The result obtained is identical with that reported by Kubo. (*PA*, 1959, #7175)

359. ON THE GROUND STATE OF ANTIFERROMAGNETISM

Nagai, O.

***Memoirs of the Faculty of Science, Kyusyu University*, Series B, v. 2, no. 4, pp. 129–135, January 1958**

The ground state of antiferromagnetism is investigated by Marshall's method. The magnetization of sublattice as a function of a (an anisotropic parameter), and especially the critical value of a at which the antiferromagnetic ordering disappears, are computed. The number of antiparallel pairs is also calculated. Various treatments, including Marshall's method, are examined. The approximate method of Slater is extended to two and three-dimensional lattices. (*PA*, 1959, #1580)

360. ON STATICS AND DYNAMICS OF MAGNETIC DOMAIN BOUNDARIES

Harrington, J. V.

Massachusetts Institute of Technology, Research Laboratory of Electronics, Cambridge

TR166, January 13, 1958

Semiclassical analysis of variation of spin orientation in 180- and 90-deg domain walls is presented which takes into account both rotational or latitude angle and precessional or longitude angle of macroscopic magnetization vector in ferromagnetic single crystals; considerations of magnetic system: statics and dynamics of Bloch walls: ferromagnetic resonance relationships; domain pattern observations. (*EI*, 1958)

361. EFFECTIVE NUCLEAR SPIN INTERACTIONS IN FERROMAGNETICS

Suhl, H.

***The Physical Review*, v. 109, no. 2, p. 606, January 15, 1958**

Describes a new type of indirect nuclear spin–spin interaction which takes place through the hyperfine coupling of the nucleus to the electron spins of the same ion and the exchange interaction between electron spins on different ions. A formula is derived for the second moment and in the case of Mn^{++} gives a value for the line width of 0.14 Mc. It is considered that the difficulty of observing nuclear resonance in ferromagnetics may arise from this cause. (*PA*, 1958 #2392)

362. THE INTERPRETATION OF TEMPERATURE-INDEPENDENT PARAMAGNETISM

Guy, J., Tillieu, J. and Baudet, J.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 4, pp. 574–576, January 27, 1958 (in French)**

It is shown by a variational method that the modulus of the Langevin diamagnetic susceptibility of molecules is greater than or equal to the Van Vleck paramagnetism, in disagreement with some experimental results. (*PA*, 1958, #4116)

363. APPROXIMATE THEORY OF FERRIMAGNETIC SPIN WAVES

Kaplan, T. A.

***The Physical Review*, v. 109, no. 3, pp. 782–787, February 1, 1958**

The wave-functions and the energy spectrum of the spin-wave problem in a normal spinel are found by means of a straightforward extension of Anderson's approach to antiferromagnetism. Only $A - B$ exchange is assumed to exist, and the calculation is carried to second order in the magnitude of the propagation vector $\boldsymbol{k}$. Five distinct energy surfaces (E vs. $\boldsymbol{k}$) are found, two of which are identical, in the classical limit, to the ones previously reported by H. Kaplan. Although the energy surfaces are all spherically symmetric, the wave-functions depend in general on the direction of $\boldsymbol{k}$. The error in a calculation by Vonsovski and Seidov, which led to a linear energy vs. $\boldsymbol{k}$ relation for the lowest branch (as opposed to the quadratic relation found by H. Kaplan) is pointed out. (*PA*, 1958, #1767)

364. REMARKS ON THE VOLUME MAGNETOSTRICTION AND THE ANISOTROPIC FORCED MAGNETOSTRICTION

Sato, H.

The Physical Review, v. 109, no. 3, pp. 802–807, February 1, 1958

The manner in which the anisotropic forced magnetostriction contributes to the magnetostriction of ferromagnetic substances at high magnetic fields is discussed theoretically. In the past, the isotropic forced volume magnetostriction has been considered to be the only cause of the forced magnetostriction. This is probably one reason for the discrepancies between the experimental value of the volume magnetostriction and the theoretical value expected from the pressure dependence of the Curie point, etc. In addition to this, the limitations of the present theory concerning the relation between the isotropic volume magnetostriction and the related properties mentioned above are briefly examined in connection with the discrepancies between experiment and theory. (*PA*, 1958, #1782)

365. A NEW METHOD OF INTERPRETING THE MAGNETIC SUSCEPTIBILITIES OF DIAMAGNETIC ORGANIC COMPOUNDS

Dorfman, Ya.G.

Doklady Akademii Nauk, SSSR, v. 119, no. 2, pp. 305–306, 1958 (in Russian)

The susceptibility is usually considered as a sum of classical diamagnetism and Van Vleck paramagnetism. This is refined by allowing for intermolecular paramagnetism and the diamagnetism of individual atoms. The resulting four-term formula compares favourably with experiment and the empirical formula of Pascal. (*PA*, 1958, #6054)

366. COMPARISON OF THE LAWS OF APPROACH TO SATURATION DEDUCED FROM MAGNETIZATION AND DIFFERENTIAL SUSCEPTIBILITY MEASUREMENTS

Dana, H.

Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 246, no. 8, pp. 1182–1185, February 24, 1958

Shows that Polley's results may be represented by $\chi H^3 = AI_0 + BH^{5/2}$, in agreement with an expression for the law of approach not containing an H^{-1} term. (*PA*, 1958, #4147)

367. NEW PHYSICAL CONSTANTS FROM DIMENSIONAL ANALYSIS

Gresky, A. T.

Journal of the Franklin Institute, v. 265, no. 2, pp. 85–95, February 1958

Use of specific form of dimensional analysis to interpretation of certain controversial subjects, such as equations and units of measurement in electricity and magnetism. P. M. S. Blackett's hypothesis regarding magnetic field of massive rotating bodies, and interrelationships among physical constants, laws, and hypotheses. (*EI*, 1958)

368. THE ELECTRONIC STRUCTURE OF THE METALS OF THE FIRST TRANSITION PERIOD

Lomer, W. M. and Marshall, W.

Philosophical Magazine and Journal of Science, Eighth Series, v. 3, pp. 185–203, February 1958

Three distinct lines of experimental work now point towards a new conception of the electronic structure of the transition metals. Recent X-ray work has shown that in Fe and Cr the valence electrons are not as well localized near the atoms as had been supposed, while in Co, Ni and Cu the compact 3*d*-shell is nearly complete. Saturation magnetic moments of Ni-rich alloys show that Ti and V act as though they had respectively four and five electrons to contribute to the conduction band of Ni. Neutron diffraction evidence shows that pure Ti and V have no magnetic moments, ordered or disordered, and that in Ni–Cr alloys the Cr atom carries a moment not much different from Ni, though each added atom removes nearly 5 μ_B from the saturation moment. It is therefore suggested that elements of atomic number less than Fe have few 3*d*-electrons and many conduction electrons, while for those above iron this is reversed. It appears as though this conclusion can be maintained almost independently of crystal structure or composition of alloy. On this basis the variation of saturation magnetic moment of all the binary ferromagnetic alloys can be explained. (*PA*, 1958, #1281)

369. MAGNETIZATION REVERSAL BY ROTATION

Gillette, P. R. and Oshima, K.

Journal of Applied Physics, v. 29, no. 3, pp. 529–531, March 1958

General differential equations are derived, usable for

any body for which demagnetization and anisotropy factors can be written. These equations are applied to a sphere, a cylinder and a thin sheet.

370. MAGNETIZATION CURVE OF THE INFINITE CYLINDER

Aharoni, A. and Shtrikman, S.
***The Physical Review*, v. 109, no. 5, pp. 1522–1528, March 1, 1958**

The nucleation field for an infinite circular ferromagnetic cylinder, with the field applied along its axis, is rigorously calculated by exploring the whole eigenvalue spectrum of Brown's equations. The nucleation fields for cylinders with "large" radii are found to be those of the magnetization curling. For "small" radii the nucleation field is found to be somewhat smaller than that for the magnetization buckling. However, the difference is only about 1 percent, and the exact mode of reversal is very close to the buckling. The transition from exact buckling to curling is abrupt. These two modes are shown to be the only modes for nucleation for any radius, the other modes giving higher nucleation fields. It is shown that the magnetization reversal occurs in one jump, which means that the magnetization curve for the cylinder is a rectangular loop. (*PA*, 1958, #2413)

371. ANALYTICAL THEORY OF THE BEHAVIOUR OF FERROMAGNETIC MATERIALS

Biorci, G. and Pescetti, D.
***Il Nuovo Cimento*, v. 7, no. 6, pp. 829–842, March 16, 1958**

It is shown that every transformation in the J–H plane of a ferromagnetic specimen can be computed from the magnetization curve and saturation loop of the material. This is based on the assumption that each volume element is characterized by a rectangular loop of sides a and b (Preisach model). Also, it must be assumed that a distribution function $\phi(a,b)$, related to the probability density of finding a loop with given (a,b), exists and is unique. Then, given an arbitrary path of H, $\phi(a,b)$ permits the computation of the corresponding path of J. The function $\phi(a,b)$ can be computed numerically by manipulation of the magnetization curve and saturation loop. Experiments have been carried out on two materials, magnetically quite different. The theoretical curves fit the experimental data quite well. (*PA*, 1958, #2391)

372. THE APPROACH OF POLYCRYSTALLINE FERROMAGNETICS TO SATURATION AS H^{-2}

Danan, H.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 12, pp. 1822–1844, March 24, 1958 (in French)**

The effect of the K_2 term in the magnetocrystalline energy on the magnitude of the H^{-2} term in the law of approach has been investigated, and application is made to cobalt and iron. (*PA*, 1958, #4148)

373. THE INTERACTION ENERGY OF PARALLEL BLOCH WALLS

Kaczér, J.
***Czechoslovak Journal of Physics*, v. 8, no. 3, pp. 278–284, 1958**

The paper gives an exact calculation of the interaction energy of parallel 180 deg Bloch walls of an unbounded uniaxial ferromagnetic as a function of their distance and of the external field. The general relation, valid for a periodic domain structure, is applied to the special case of two Bloch walls. (*PA*, 1959, #4794)

374. INSTABILITY OF BLOCH'S WALLS DUE TO INTERSTITIAL ATOMS IN A BODY-CENTERED FERROMAGNETIC MATERIAL

Biorci, G., Ferro, A., and Montalenti, G.
***Atti dell' Accademia Nazionale dei Lincei, Rendiconti, Classe di Scienze Fisiche, Mathematiche e Naturali*, v. 24, no. 5, pp. 542–547, March, 1958 (in Italian)**

Néel has given a theory of the time variation of the the permeability after demagnetization, based on a gradual rearrangement of the interstitial atoms. He also suggested a simple equation holding when H is a step function. It is shown here that this simple equation cannot account for the macroscopic behaviour of the material. The experimental facts may be explained by assuming that there exists for every 180-deg wall a position of instability due to the foreign atoms. (*PA*, 1959, #2485)

375. CALCULATION OF THE INDUCED MAGNETIC MOMENT OF AN OBLATE FERROMAGNETIC ELLIPSOID OF REVOLUTION IN AN ALTERNATING MAGNETIC FIELD

Gelbukh, L. A.

Zhurnal Tekhnecheskoi Fiziki, v. 28, no. 3, pp. 592–598, 1958 (in Russian)

An approximate method is described. The formulae derived determine in magnitude and phase the longitudinal and transverse components of the magnetic moment of the spheroid. (*PA*, 1959, #416)

376. ON THE THERMODYNAMICAL THEORY OF RESONANCE AND RELAXATION PHENOMENA IN FERROMAGNETICS
Skrotskii, G. V., and Shmatov, V. T.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 34, no. 3, pp. 740–745, 1958 (in Russian)

The methods of thermodynamics of irreversible processes are applied to derive the variation of magnetization of ferromagnetics with time. The role of spin–lattice relaxation in ferromagnetic resonance is discussed. The equations obtained are compared with the Landau–Lifshitz and Bloch equations. (*PA*, 1958, #8111)

377. EFFECT OF ELECTRONIC MEAN FREE PATH ON SPIN-WAVE RESONANCE IN FERROMAGNETIC METALS
Rado, G. T.
Journal of Applied Physics, v. 29, no. 3, pp. 330–332 March 1958

It is suggested that under certain conditions the interpretation of ferromagnetic resonance phenomena in metals should not make use of Ohm's law because the electronic mean free path may not be negligible in comparison to an appropriately defined effective skin depth. Such conditions can exist even at moderately low temperatures provided the equivalent permeability is sufficiently large. The anomalous effects due to the mean free path are shown to be particularly important in spin-wave resonance, i.e., in a modified ferromagnetic resonance which is appreciably influenced by the exchange interactions existing in the skin depth. A suitable perturbation method is developed for calculating these anomalous effects on the basis of Maxwell's equations and the spin-wave equation. Using a relation proposed by Reuter and Sondheimer, a simple first-order result is then obtained for the surface impedance and for the equivalent permeability derived therefrom. The limitations of the underlying physical model are pointed out, and the applicability of the theory to existing experimental results is briefly discussed. (*PA*, 1958, #8864)

378. FERROMAGNETIC DYNAMICAL RESPONSE
Callen, H. B.
Journal of Applied Physics, v. 29, no. 3, pp. 333–334, March 1958

A dynamical equation, describing the response of the magnetization to an applied field, is proposed. The analysis is based on a spin-wave picture. The dynamical equation contains three parameters, defined in terms of particular magnon–magnon and magnon–phonon transition probabilities. A more detailed theory for one of these parameters is developed. The resultant size and shape dependence of the magnetic loss is suggestive of experimental observations. (*PA*, 1958, #8862)

379. FERROMAGNETIC RESONANCE IN UNIAXIAL POLYCRYSTALLINE MATERIALS
Morrison, C. A. and Karayianis, N.
Journal of Applied Physics, v. 29, no. 3, pp. 339–340, March 1958

A theoretical determination is made of the resonance curve of a nonconducting polycrystalline ferromagnetic material with uniaxial crystalline anisotropy. A finite intrinsic line width is assumed for the single crystal, and effects of grain boundaries, impurities, inhomogeneities and volume and surface divergence of the magnetization are ignored. The results are compared qualitatively with experiment. (*PA*, 1958, #8867)

380. DAMPING AND THE DISPERSION RELATIONS IN ANTIFERROMAGNETIC RESONANCE
Dayhoff, E. S.
Journal of Applied Physics, v. 29, no. 3, pp. 344–345, March 1958

The tensor susceptibility of an antiferromagnetic with uniaxial anisotropy is calculated using several modifications of the Bloch damping term. The axial component of the susceptibility is particularly simple and is readily tested by the Kronig–Kramers dispersion relations as modified by Gourary. It is found that, of the damping terms considered, only one which includes relaxation to the instantaneous equilibrium magnetizations will pass this test. (*PA*, 1958, #8872)

381. THEORY OF MAGNETOSTRICTION AND *g* FACTOR IN FERRITES

Tsuya, N.
Journal of Applied Physics, v. 29, no. 3, pp. 449–451, March 1958

A quantum mechanical theory based upon the Heitler–London approximation is developed to explain the spatial variation of magnetostriction and g factor in ferrites. As a first step, the electronic wave-functions of cations of transition elements in the crystal field were found, taking into account the crystal structure of ferrites. The g factors of various cations in ferrites were determined by a method similar to that of Abragam and Pryce, and g factors thus found were related to those of ferrimagnetic resonance absorption by the use of the theory of Wangsness and the author. The magnetostriction was obtained by the perturbation method and it was concluded that there are four mechanisms predominant among those giving rise to magnetostriction. They are (1) the interplay of spin–orbit interaction with the strain potential, (2) classical dipolar interaction, (3) the interplay of anisotropic exchange interaction with the strain potential, and (4) the interplay of the potential with the intra-spin–spin interaction. Other mechanisms were estimated to be ineffective. The predominant mechanisms in Ni ferrite are (1) and (2); in Co ferrite, (1); in magnetite, (1), (2), and (4). In annealed Mn ferrite and Cu ferrite, the mechanism (2) is most effective. In quenched Cu ferrite, both mechanisms (2) and (3) are the most important. (*PA*, 1959, #401)

382. MAGNETOSTRICTION AND ELASTIC PROPERTIES OF FERROMAGNETIC SUBSTANCES AT HIGH MAGNETIC FIELDS

Sato, H.
Journal of Applied Physics, v. 29, no. 3, pp. 456–458, March 1958

The manner in which the anisotropic forced magnetostriction contributes to the magnetostriction of ferromagnetic substances at high magnetic fields is discussed from a localized model of ferromagnetism. With this assumption, the free energy of a ferromagnetic substance can be conveniently divided into several terms and it can be concluded quite naturally that a free-energy term corresponding to that of ferromagnetic anisotropy gives rise to an anisotropic forced magnetostriction. In the past, the isotropic forced volume magnetostriction has been considered to be the only cause of the forced magnetostriction. This is probably one reason for the discrepancies between the experimental value of the volume magnetostriction and the theoretical value expected from the pressure dependence of the Curie point, etc. From a similar point of view, anomalous behaviour of elastic properties of a ferromagnetic substance, such as the change of the temperature coefficient of the elastic constants at the Curie point, the dependence of the elastic constants upon the direction of the magnetic field, etc., are explained as an intrinsic change in the elastic constants with spontaneous magnetization. In the past, these effects have been explained only as a result of the deformation of the crystal lattice due to the spontaneous magnetostriction (volume effect, morphic effect). (*PA*, 1958, #8932)

383. DOMAIN WALL MOTION IN METALS

DeBlois, R. W.
Journal of Applied Physics, v. 29, no. 3, pp. 459–467, March 1958

A brief review on the ferromagnetic domain wall is presented, touching on its energy and thickness, its coercive force, and its motion in metal loops, tapes, and wires, as governed by eddy currents and by relaxation processes. The experimental results are presented of an extension of the Sixtus–Tonks experiment to axial domain wall velocities over 50 km/sec, made possible by use of nearly perfect iron whiskers. Plots of axial velocity vs. applied field are nonlinear and in some cases show velocity discontinuities at room temperature in the region 3 to 8.5 km/sec. At 77° K velocity discontinuities beginning at 2 km/sec are observed. Nucleating fields of over 250 are indicated. Data analysis yields a relaxation damping coefficient, $\beta_r \approx 10$ g/sec cm^2 for normal domain wall motion. (*PA*, 1959, #2488)

384. RIGOROUS APPROACH TO THE THEORY OF FERROMAGNETIC MICROSTRUCTURE

Brown, W. F., Jr.
Journal of Applied Physics, v. 29, no. 3, pp. 470, 471, March 1958

Current "domain" theory relies heavily on Bloch walls and the Landau–Lifshitz method of assembling them. A rigorous attack on the same problem leads to a nonlinear boundary-value problem; with electronic computers available, this problem is now less formidable than when it was first formulated and numerical calculations were carried out for an infinite cylinder that reverses its magnetization by "magnetization curling." The conditions

under which this process occurs can be determined by means of a linear theory, similar to the theory of elastic stability, developed independently by the author and by Frei, Shtrikman, and Treves. To follow the process beyond its initial stages, a nonlinear differential equation must be integrated by numerical methods. The calculations show that the only stable states are ones of uniform positive or negative longitudinal magnetization; the transition between them occurs in a single jump, and only during the jump is the magnetization nonuniform. Thus a particle with no stable states other than "single-domain" ones may be "multi-domain" during transitions. The results suggest that stable nonuniform states will be found in a finite body, and even in an infinite cylinder if imperfections are present. (*PA*, 1959, #403)

385. MODEL FOR NONLINEAR FLUX REVERSALS OF SQUARE-LOOP POLYCRYSTALLINE MAGNETIC CORES

Haynes, M. K.

***Journal of Applied Physics*, v. 29, no. 3, pp. 472–474, March 1958**

The theory of the reversal waveforms of polycrystalline magnetic cores proposed by Goodenough is based on the growth of ellipsoidal domains of reverse magnetization which originate from nucleating centres at grain boundaries. The present model extends this theory with the assumption that the nucleating centres are randomly distributed throughout the core volume. Radial field variations are neglected. The rate of change of reversed magnetization area of the irreversibly moving and colliding walls is calculated as a function of their position, starting from a Poisson distribution of nucleating centres, and then converted to a function of flux. The equation derived for rate of flux change is

$$\frac{dx}{dt} = \frac{4.82}{S_w}(H - H_0)(1 - x)\left(-\ln\frac{1-x}{2}\right)^{\frac{1}{2}}$$

where S_w is the switching coefficient, H_0 is the threshold field, H is the applied field, and x is the ratio of flux density to retentivity. This nonlinear differential equation is solved for the simple case of constant current drive. For more complicated circuit conditions, solutions of the core equations require numerical methods. Programs have been written for the IBM Type 704 DPM. to calculate the behaviour of circuits containing many such cores interacting and switching together. Results obtained check reasonably well with experimental evidence. (*PA*, 1959, #404)

386. CONSTRAINT PRINCIPLE IN FERROMAGNETIC DOMAIN THEORY

Gold, L.

***Journal of Applied Physics*, v. 29, no. 3, pp. 544–545, March 1958**

The need for a constraint principle is demonstrated by a more precise analysis of the classic Landau–Lifshitz (LL) domain configuration. A constraint minimization of the (LL) configuration leads to the requirement of increasing wall thickness in vanishingly small specimens. The Néel–Kaczer theory (NK), based on wall magnetostatic energy, also predicts variable wall thickness. But (NK) theory is formulated for (infinite) sheet thicknesses well above the thin film region and it requires a gradual fall-off of wall size as the sheet thickness diminishes. The constraint calculation is characterized by a precipitous wall increase as the single-domain realm is approached, a type of behaviour that may have been observed in thin film experiments. (*PA*, 1958, #8930)

387. MULTIPLICITIES OF THE UNIFORM PRECESSIONAL MODE IN FERRIMAGNETIC RESONANCE

Solt, I. H., Jr., White, R. L., and Mercereau, J. E.

***Journal of Applied Physics*, v. 29, no. 3, pp. 324–325, March 1958**

In order to interpret correctly the experimental results obtained from ferrimagnetic resonance experiments, it is necessary to understand completely the multiplicity of lines that can be observed. Most of these lines have been shown to be higher order precessional modes which are quite well understood. There still exists, however, some uncertainty connected with the uniform precessional mode. The uniform mode is of most importance since it is for this mode that values of line widths, g values, and anisotropy constants are usually quoted in the literature. It can be distinguished experimentally from the higher order modes since (a) its intensity of absorption is proportional to the uniform component of the r.f. magnetic field over the sample and (b) its intensity decreases much less rapidly with diminishing sphere size than for the higher order modes. We have observed, however, that there are several lines possessing these characteristics of the uniform mode. The relative intensities of these lines are strong functions of both temperature and frequency, they have different anisotropy constants, and their separation decreases with sphere radius. Data exhibiting these properties will be presented for experi-

ments on spherical single crystals of MnZn ferrites performed in the microwave frequency range of 8000-12,000 Mc. A discussion of several possible mechanisms that might give rise to this phenomenon will be given.

388. INHOMOGENEOUS BROADENING OF MAGNETIC RESONANCE LINES

Clogston, A. M.

***Journal of Applied Physics*, v. 29, no. 3, pp. 334–336, March 1958**

An inhomogeneously broadened magnetic resonance line is narrowed by dipole fields. The theory of this effect is developed in terms of the classical equations of motion of a magnetized medium by expanding the magnetization and fields into Fourier series. An expression is obtained for the imaginary parts of the susceptibility tensor. In the applicable range of the theory, the line width decreases inversely as the magnetization, and is strongly shape dependent.

389. RELATIONS BETWEEN DIFFERENT MODES OF ACQUISITION OF THE REMANENT MAGNETIZATION OF FERROMAGNETIC PARTICLES

Wohlfarth, E. P.

***Journal of Applied Physics*, v. 29, no. 3, pp. 595–596, March 1958**

The relations, valid under stated conditions, are between the remanence acquired in a given field and that acquired after dc or ac demagnetization in the same field. A relation for the "remanence coercivity" is also derived. (*PA*, 1958, #3222)

390. ROTATIONAL MODEL OF FLUX REVERSAL IN SQUARE LOOP SOFT FERROMAGNETS

Gyorgy, E. M.

***Journal of Applied Physics*, v. 29, no. 3, p. 283, March 1958**

A model based on the solution of the modified Landau and Lifshitz equation, but not assuming uniform magnetization rotation throughout the sample, is analyzed and applied to ferrites, permalloy tape and thin evaporated metal films.

391. SUR LA PERMITTIVITE ET LA PERMEABILITE MAGNETIQUE DES MELANGES

Quivy, D.

***Bulletin de la société francaise des électriciens*, v. 8, no. 88, pp. 214–222, April 1958**

On permittivity and magnetic permeability of mixtures; study of possibility of employing logarithmic law for calculation of disordered mixtures, taking as basis, prior calculations of mixtures of one form and one direction. (*EI*, 1958)

392. CONCERNING THE EFFECTS OF COUPLING BETWEEN FERROMAGNETIC PARTICLES EXHIBITING HYSTERESIS

Néel, L.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 16, pp. 2313–2319, April 21, 1958 (in French)**

Considers an assembly of ferromagnetic particles interacting in pairs. According to the nature of the hysteresis cycles described, the magnetization produced on applying a field H a second time is not in general equal to that produced the first time, as in the usual models. (*PA*, 1958, #7188)

393. "CREEPING" (REPTATION) OF ASYMMETRICAL HYSTERESIS LOOPS AS A FUNCTION OF THE NUMBER OF CYCLES DESCRIBED

Van Dang, N.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 16, pp. 2357–2359, April 21, 1958 (in French)**

If a ferromagnetic specimen is exposed repeatedly to a succession of fields H_A and H_B, the magnetizations produced after the nth cycle J_{An}, J_{Bn} vary with n. Experiments show that the creeping terms $J_{An} - J_{A1}$ are proportional to $(\log n)^{1/2}$ for $n > 20$ in agreement with the theory of Néel assuming a random internal field coupling the elementary domains. (*PA*, 1958, #6055)

394. A THERMODYNAMIC THEORY OF "WEAK" FERROMAGNETISM OF ANTIFERROMAGNETICS

Dzyaloshinsky, I.
***Journal of the Chemistry and Physics of Solids*, v. 4, no. 4, pp. 241–255, 1958**

A thermodynamic theory of "weak" ferromagnetism of $\alpha - Fe_2O_3$, $MnCO_3$ and $CoCO_3$ is developed on the basis of Landau's theory of phase transitions of the second kind. It is shown that the "weak" ferromagnetism is due to the relativistic spin-lattice and the magnetic dipole interactions. A strong dependence of the properties of "weak" ferromagnetics on the magnetic crystalline symmetry is noted and the behaviour of these ferromagnetics in a magnetic field is studied. (*PA*, 1958, #8286)

395. A FERROMAGNETIC DYNAMICAL EQUATION

Callen, H. B.
***Journal of the Chemistry and Physics of Solids*, v. 8, no. 4, pp. 256–270, 1958**

Based on general considerations concerning the dissipative mechanism, a ferromagnetic dynamical equation is proposed. This equation contains three parameters, which have definite quantum-mechanical significance. A simple theory for one such parameter is given, and an explicit rotational dynamic equation is obtained in the special case in which the $(k = 0) \rightarrow (k \neq 0)$ spin-wave transitions dominate the dissipative process. It is suggested that certain observed size and shape effects may be explained qualitatively on the basis of this equation. (*PA*, 1959, #8287)

396. HEISENBERG'S MODEL OF FERRO- AND ANTIFERROMAGNETISM

Kikuchi, R.
***Annals of Physics*, v. 4, no. 1, pp. 1–28, May 1958**

Heisenberg's model of ferromagnetism, which is better than the Ising model in taking account of the exchange coupling of electrons, is treated for various lattices, extending the author's treatment of the Ising model reported previously. The first approximation using a pair of orbitals as the fundamental cluster gives the same results as those obtained by Yvon, Nakamura, Kastelein and van Kranendonk based on different approaches. In the second approximations, ferromagnetic states appear only for the three-dimensional lattices. The anti-Curie point does not appear, but difficulties still remain for low temperatures. It is shown that the same technique can be applied to the case of spin one and also to antiferromagnetism. (*PA*, 1958, #5103)

397. THE HEISENBERG EXCHANGE OPERATOR FOR FERROMAGNETIC AND ANTIFERROMAGNETIC SYSTEMS

Nesbet, R. K.
***Annals of Physics*, v. 4, no. 1, pp. 87–103, May 1958**

The Heisenberg exchange operator has never been derived by methods which are applicable to the general case of arbitrary spin, although this operator has served as a starting postulate of theories of ferromagnetism and antiferromagnetism. A derivation of the Heisenberg operator, valid for the interaction of ions or atoms of arbitrary spin in a crystalline environment, is given which is intended to meet the principal theoretical objections to earlier derivations. The "exchange integral" is shown to be a linear combination of two types of terms, ordinarily of opposite sign, arising respectively from the ordinary exchange integrals in the Hartree–Fock approximation and from a superchange effect which occurs in the first order of configuration interaction corrections to the Hartree–Fock approximation. The Heisenberg exchange operator, according to the present derivation, can represent the interaction between ions or atoms in a crystal only when an unfilled shell of orthogonalized atomic orbitals remain uncombined with orbitals on other atoms in the single determinant approximation at the equilibrium internuclear distance. The formula obtained for the "exchange integral" is used to calculate the transition temperatures of the antiferromagnetic oxides MnO, FeO, NiO, and CoO. The ratios between these temperatures are shown to depend primarily on spectroscopic data for the ions, and are found to be in reasonable agreement with experimental values. (*PA*, 1958, #5104)

398. SPIN–ORBIT COUPLING AND THE EXTRAORDINARY HALL EFFECT

Strachan, C. and Murray, A. M.
***Nature*, v. 181, p. 126, May 3, 1958**

The outline of a quantum-mechanical treatment is given which shows that spin–orbit coupling can account for the fact that the Hall effect in ferromagnetics varies as the square of the resistivity and is temperature dependent. (*PA*, 1958, #4125)

399. INTERACTION OF SPIN WAVES AND ULTRASONIC WAVES IN FERROMAGNETIC CRYSTALS

Kittel, C.

The Physical Review, v. 110, no. 4, pp. 836–841, May 15, 1958

A field-theoretical treatment is given of the magnetoelastic coupling of magnons and phonons in a ferromagnetic crystal. The effects of the coupling are large when the wavelengths and frequencies of the two fields are equal. If the two transverse phonon states of a given wave vector are degenerate, then the rotatory dispersion of the phonons will be large. The possibility exists of creating nonreciprocal acoustic elements, such as acoustic gyrators. At simultaneous resonance the phonon attenuation is expected to be large. The possibility of magnetostrictive transducers at microwave frequencies is discussed. A calculation is given of the damping by eddy currents of spin waves in a metal. (*PA*, 1959, #411)

400. COUPLING BETWEEN ELEMENTARY FERROMAGNETIC DOMAINS: THE "SEESAW" EFFECT

Néel, L.

Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 246, no. 21, pp. 2963–2968, May 28, 1958 (in French)

Extends previous work. The initial hysteresis cycle for an assembly of interacting domains is not a closed curve. The gap is a rapidly decreasing function of the number of cycles of applied field. (*PA*, 1958, #7189)

401. "CREEPING" (REPTATION) OF ASYMMETRICAL HYSTERESIS LOOPS AS A FUNCTION OF THE ASYMMETRY AMPLITUDE

Van Dang, N.

Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 246, no. 21, pp. 3034–3037, May 28, 1958

A continuation of previous work. The effect is measured between zero field and a field h, and for a given order has a maximum when h is of the order of the coercive force. (*PA*, 1959, #6056)

402. STATISTICS OF THE ISING FERROMAGNET

Levitas, A. and Lax, M.

The Physical Review, v. 110, no. 5, pp. 1016–1027, June 1, 1958

The model of ferromagnetism proposed by Ising is treated by synthesizing a cluster treatment with the spherical model. The spherical model is used to determine approximately the molecular field acting on the cluster and the effective interactions between dipoles of the cluster. The method is applied to the square net and to the cubic lattice and the critical temperatures are obtained. The result for the square net is that $E/kT_c = 0.831$ and for the cubic lattice that $E/kT_c = 0.442$. In these results E is the energy required to change an adjacent pair of dipoles from parallel to antiparallel relative orientation. (*PA*, 1958, #5106)

403. ORIENTATION OF NUCLEI IN FERROMAGNETS

Marshall, W.

The Physical Review, v. 110, no. 6, pp. 1280–1285, June 15, 1958

A theoretical discussion is given of the various orientation effects acting on nuclei in ferromagnets, and the results are compared to experimental measurements on the specific heat and the anisotropy in the emission of γ-rays by radioactive Co^{60}. The orientation is due to an effective magnetic field which is, neglecting some small terms, the sum of one negative and four positive contributions, all of which are roughly comparable. The uncertainty in the total field predicted is considerable but nevertheless rough agreement is obtained with the few experimental results at present available. (*PA*, 1958, #5107)

404. EXCITATION OF SPIN WAVES IN A FERROMAGNET BY A UNIFORM R.F. FIELD

Kittel, C.

The Physical Review, v. 110, no. 6, pp. 1295–1297, June 15, 1958

It is possible to excite exchange and magnetostatic spin waves in a ferromagnet by a uniform r.f. field, provided that spins on the surface of the specimen experience anisotropy interactions different from those acting on

spins in the interior. For modes with an odd number of half,wavelengths should be excited in a flat plate. The definition of what is meant by a different anisotropy interaction is worked out and is a rather lenient condition. Experiments which would determine the exchange energy constant should be possible using sufficiently thin platelets of single crystals having parallel faces. The theory may account for the observation by Waring and Jarrett of a large number of resonance peaks in $NiMnO_3$. (*PA*, 1958, #8876)

405. **CONTRIBUTION TO THE PHENOMENOLOGICAL THEORY OF KINETIC PROCESSES IN FERROMAGNETIC DIELECTRICS. I. RELAXATION IN A GAS OF SPIN WAVES**
Kaganov, M. I. and Tsukernik, V. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 34, no. 6, pp. 1610–1618, 1958 (in Russian)**

The relaxation time in ferromagnetic dielectrics due to interaction between spin waves is computed. (*PA*, 1959, #1579)

406. **THEORY OF BLOCK ELECTRONS IN A MAGNETIC FIELD**
Kohn, W.
***Proceedings of the Physical Society*, London, v. 72, Part 6, pp. 1147–1150, 1958**

The energy levels corresponding to closed and open trajectories of a Bloch wave-packet are discussed, and improved expressions are given for the area enclosed by a closed trajectory. (*PA*, 1959, #3630)

407. **ON THE DEPENDENCE OF COERCIVE FORCE ON THE DENSITY OF DISLOCATIONS**
Malek, Z.
***Zeitschrift für angewandte Physik*, v. 9, no. 6, pp. 279–280, June 1958 (in German)**

The theoretical relations derived by Vicena and Kersten are compared with recent experimental results. The values calculated from Kersten's formula are two orders of magnitude too great, and Vicena's formula gives values slightly too small. (*PA*, 1958, #8112)

408. **ON THE GALVANOMAGNETIC, THERMOMAGNETIC, AND THERMOELECTRIC EFFECTS IN ISOTROPIC METALS AND SEMICONDUCTORS**
Moore, E. J.
***Australian Journal of Physics*, v. 11, no. 2, pp. 235–254, June 1958**

The calculation of the galvanomagnetic, thermomagnetic, and thermoelectric effects in those isotropic metals and semiconductors which can be represented by the two-band model is simplified and extended to cases not previously treated. General expressions are obtained for effects involving time-independent electric fields, magnetic fields, and thermal gradients. Analytic formulae are given for the isothermal galvanomagnetic effects when a h.f. electric field is applied together with a time-independent magnetic field. Throughout, emphasis is placed on coefficients which are experimentally or theoretically important. The parameters occurring in the two-band model of metals and semiconductors are estimated. (*PA*, 1959, #7897)

409. **COUPLED MAGNETOELASTIC WAVES IN FERROMAGNETICS AND FERROACOUSTIC RESONANCE**
Akhiezer, A. I., Baryakhtar, V. G. and Peletminskii, S. V.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 1(7), pp. 228–239, 1958 (in Russian)**

A phenomenological theory of coupled magnetoacoustic waves in ferromagnetics and ferrites is presented (the coupling between the elastic and magnetic waves being due to spontaneous magnetization). Sound velocities in the ferromagnetic which depend on the magnetization and strength of the applied magnetic field are determined. The absorption coefficient of sound due to electrical conductivity and relaxation of the magnetic moment is determined. A possibility of resonance excitation of magnetic waves with the aid of ultrasound is indicated. (*PA*, 1959, #2156)

410. **NEUTRON SCATTERING BY ANTIFERROMAGNETS ABOVE THE NEEL POINT**
De Gennes, P. G.
***Journal of the Chemistry and Physics of Solids*, v. 6, no. 1, pp. 43–45, July 1958**

The general features of scattering in the elastic approxi-

mation are displayed by using the concept of a wavelength-dependent susceptibility. "Critical" scattering occurs above the Néel point, in the directions which would correspond, below the Néel point, to superlattice lines. The shape of the diffuse spots is given in terms of the Néel and paramagnetic Curie temperatures, for various types of lattices. (*PA*, 1959, #8325)

411. THE EFFECT OF TEMPERATURE ON THE "CREEPING" [REPTATION] OF ASYMMETRICAL HYSTERESIS CYCLES

Van Dang, N.

***Comptes rendus hebdomadaires des séances de la académie des sciences, Paris*, v. 247, no. 1, pp. 56–59, July 7, 1958**

A continuation of previous work. Reports results of experiments between 20° K and room temperature, and finds that the temperature changes have no very marked effects on the phenomenon which, it is concluded, has origins different from those responsible for magnetic viscosity. (*PA*, 1958, #8135)

412. EFFECTIVE PARAMETERS IN FERRIMAGNETIC RESONANCE

Wangsness, R. K.

***The Physical Review*, v. 111, no. 3, pp. 813–816, August 1, 1958**

The steady state solution for the susceptibility tensor of a two-sublattice system has been found by using sublattice equations of motion which include complete Landau–Lifshitz relaxation terms with individual relaxation parameters and which describe relaxation toward the instantaneous total field acting on the sublattice. It is shown that one can define effective parameters describing the behaviour of the system as a whole which remain finite throughout the compensation region and, in particular, insure that the absorption coefficient will remain positive. It is also found that the effective gyromagnetic ratios characterizing the absorption and Faraday effect are different in principle, and a new term is found in the expression for the off-diagonal element which is a consequence both of the sublattice structure and total field relaxation. In the case of small damping, many of these distinctions disappear and some parameters reduce to those previously obtained. It is shown that the inclusion of total field relaxation is necessary to obtain results which are unambiguous and correct in principle; the magnetization line width product is also shown to be continuous, but vanishing at the compensation point for angular momentum. (*PA*, 1959, #3627)

413. EFFECT OF CRYSTAL FIELD AND SPIN–ORBIT COUPLING ON MAGNETIC SUSCEPTIBILITY OF SYSTEM WITH f^2 ELECTRON CONFIGURATION

Herzfeld, C. M. and Levine, D. B.

***Journal of Research of the National Bureau of Standards*, v. 61, no. 2, pp. 117–121, August 1958**

The effects of a crystal field of octahedral symmetry and of spin–orbit coupling on an ion with f^2 electron configuration are considered. Only fourth-degree terms in the crystal-field potential are taken into account. The eigenvalues and eigenvectors of the resulting 33×33 secular determinant are determined numerically for eight values of D/ζ, where D is a crystal-field parameter, and ζ the spin–orbit coupling constant of the ion. Perturbations by an external magnetic field are computed using second-order perturbation theory. All eigenvalues are tabulated for $D/\zeta = -10^{-4}, -2 \times 10^{-4}, -5 \times 10^{-4}, -10^{-3}, -2 \times 10^{-3}, -5 \times 10^{-3}, -10^{-2}, -10^{-1}$. They can be adapted directly to any finite nonzero positive value of ζ and, by interpolation, for values of D/ζ not tabulated. The magnetic susceptibility of a powder is calculated and displayed as a function of temperature and D/ζ, for $\zeta = \infty$, 10^3 cm^{-1}, and 5×10^2 cm^{-1}. The relation of the results of the calculations to measurements on compounds of U^{+4} is discussed. (*PA*, 1959, #5872)

414. OCTAHEDRAL COMPLEXES. I. MAGNETIC SUSCEPTIBILITIES IN THE FIRST TRANSITION SERIES

Griffith, J. S.

***Transactions of the Faraday Society*, v. 54, pt. 8, pp. 1109–1116, August 1958**

General formulae for matrix elements in octahedral complexes are given and applied to the calculation of spin–orbit coupling energies. A structural isomorphism is established between $(dt_{2g})^n$ and p^n configurations and used to give a short derivation of Kotani's formulae for susceptibilities of low-spin d^n complexes. The method is then extended to cover high-spin complexes and formulae are given for their susceptibilities. Agreement with experimental data is fairly good. (*PA*, 1959, #412)

415. MAGNETOSTRICTION CURVES OF POLYCRYSTALLINE FERROMAGNETICS

Lee, E. W.

***Proceedings of the Physical Society*, London, v. 72, Part 2, pp. 249–258, August 1958**

An approximate method is given for calculating the magnetostriction of a random polycrystal as a function of the magnetization in the range over which magnetization occurs by rotation of the domain magnetization vectors. Calculations valid for the cases of cubic and hexagonal symmetry (these only for the case in which the easy axis is the hexagonal axis) are given in parametric form. Using these calculations and earlier calculations of Brown for the range of magnetization where boundary displacements occur it is possible to calculate the magnetostriction as a function of magnetization over the entire range from zero to saturation. (*PA*, 1958, #8142)

416. AN (ELECTRIC-CIRCUIT) ANALOGUE OF THE SKIN EFFECT IN A FERROMAGNETIC METAL

Vitol, V. G. and Kirko, I. M.

***Zhurnal Eskperimentalnoi i Teoreticheskoi Fiziki*, v. 28, no. 9, pp. 2055–2061, 1958 (in Russian)**

An iterated network system (containing saturable core inductors and series and shunt resistors), to the end of which alternating voltages (50 c/s) could be applied, is proposed as a useful analogue for studying the penetration of alternating electromagnetic fields into ferromagnetics. (With permeability a nonlinear function of field the problem is mathematically intractable.) The shape of the permeability curve for the inductor cores and the resistance values required for the analogy to hold in a given case are derived. As examples of the method, the variation of permeability with depth and external field are obtained for two plates of a particular ferromagnetic–one thick and the other thin in comparison with the skin depth. (*PA*, 1959, #3637)

417. PROPAGATION OF A MAGNETIC FIELD INTO A SUPERCONDUCTOR

Keller, J. B.

***The Physical Review*, v. 111, no. 6, pp. 1497–1499, September 15, 1958**

The propagation of a magnetic field into a superconducting wire of circular cross section is analyzed theoretically. Upper and lower bounds are obtained on t_0, the time required for the field to reach the axis, and on $R(t)$, the inner radius of the normally conducting region. The lower bound is just the approximate result obtained by Sixtus and Tonks, Pippard and Lifshitz. It has been verified experimentally by Faber for applied fields less than 1.04 times the critical field. It is believed that for large applied fields the actual results should be closer to the upper bounds. (*PA*, 1959, #2483)

418. EXTINCTION EFFECTS IN NEUTRON SCATTERING FROM SINGLE MAGNETIC CRYSTALS

Hamilton, W. C.

***Acta Crystallographica*, v. 11, Part 9, pp. 585–594, September 1958**

Results arising from treatment of the magnetic scattering of neutrons, taking due account of the possibility of polarization of the neutron beam, indicate that the usual expressions for primary and secondary extinction must be modified in certain cases. Extinction, particularly primary extinction, will be generally more severe for reflections which have both nuclear and magnetic contributions than for either pure nuclear or pure magnetic reflections. Formulae and curves are presented for primary and secondary extinction corrections which are applicable to both magnetized and unmagnetized ferromagnetic or antiferromagnetic crystals. Some of the results obtained may be conveniently used to determine relative amounts of primary and secondary extinction, and consequently both mosaic block size and angular distribution. Many of the calculations are of interest in predicting the effects of extinction on experiments designed either to produce or use polarized neutron beams. The precession of the neutron polarization axis about the magnetic axis can affect the reflected intensity if extinction is severe. This effect is discussed briefly and is shown to be serious only for magnetized crystals. The paper also discusses the necessary changes in the scattering formulae if all the spins in the unit cell do not lie along a unique magnetic axis. (*PA*, 1959, #7163)

419. SPIN WAVES IN A FERROMAGNETIC METAL

Abrikosov, A. A. and Dzyaloshinskii, I. E.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 3(9), pp. 771–775, 1958 (in Russian)**

Spin waves in a ferromagnetic metal are examined on

the basis of Landau's theory of the Fermi fluid. (*PA*, 1959, #2486)

420. LINEAR ANTIFERROMAGNETIC CHAIN WITH ANISOTROPIC COUPLING

Orbach, R.

***The Physical Review*, v. 112, no. 2, pp. 309–316, October 15, 1958**

The exact solution is given for a linear chain of N atoms of spin ½ coupled together by the anisotropic Hamiltonian

$$h = 2J \sum_{i=1}^{N} [S_i^z S_{i+1}^z + (1 - \alpha)(S_i^x S_{i+1}^x + S_i^y S_{i+1}^y)]$$

The energy of the antiferromagnetic ground state is computed and comparison is made with a variational method. The parameter α is allowed to vary between 0 and 1, regulating the relative amount of Ising anisotropy. The short-range order $\Sigma_i S_i^z S_{i+1}^z$, is calculated exactly from the variation of the ground-state energy with α. It is shown that a kink in the short-range order curve calculated using the variational method is fictitious, and the associated discontinuity $\partial^2 D/\partial\alpha^2$ is nonexistent. A discussion is given of long-range order and criticisms are presented regarding the predictions of the variational method. (*PA*, 1959, #4777)

421. ANOMALOUS SKIN EFFECT IN FERROMAGNETICS

Gurevich, V. L.

***Zhurnal Tekhnecheskoi Fiziki*, v. 28, no. 10, pp. 2352–2354, 1958 (in Russian)**

The problem of anomalous skin effect under the conditions of ferromagnetic resonance is analyzed by solving a set of equations consisting of the system of Maxwell's equations, the kinetic equation for the conduction electrons, and the Landau–Lifshitz equation of motion for the vector of the intensity of magnetization. (*PA*, 1959, #8330)

422. THE INTERPRETATION OF MAGNETIC SUSCEPTIBILITY AND THE ΔE EFFECT IN TERMS OF DOMAIN PROCESSES

Lewis, B. and Street, R.

***Proceedings of the Physical Society*, London, v. 72, Part 4, pp. 604–617, October 1958**

General formulae applicable to any model or any domain process are derived for the magnetic susceptibility χ and the magnetically dependent part of Young's modulus ΔE. From these formulae expressions are obtained for χ and ΔE in the initial magnetization regions for domain assemblies where magnetization proceeds by (a) rotation of domain magnetization vectors against internal strain anisotropy, (b) rotation against magnetocrystalline anisotropy characterized by one, three, or four preferred axes and (c) simple movement of 90- and 180-deg boundary walls. It is then shown how the types and relative importance of the domain processes operative in the initial magnetization region may be determined from measurements of χ and ΔE. Examples of this procedure are given and include the case of annealed cobalt for which the ΔE effect is due entirely to rotations against uniaxial magnetocrystalline anisotropy energy, while the susceptibility arises mainly from 180-deg boundary wall movement. For annealed nickel, experimental values of ΔE and χ obtained by a number of workers vary widely and this is shown to be due to (1) differences in the relative proportions of 90- and 180-deg boundaries and (2) the influence of the annealing process on the ease of boundary wall movement. (*PA*, 1959, #1588)

423. SUSCEPTIBILITY OF THE ISING MODEL OF AN ANTIFERROMAGNET

Sykes, M. F. and Fisher, M. E.

***Physical Review Letters*, v. 1, no. 9, pp. 321–322, November 1, 1958**

A rearrangement of the series for the susceptibility χ in the case of spin ½ enables the authors to conclude that $d\chi/dT = +\infty$ at the critical temperature T_c where the specific heat anomaly occurs. (*PA*, 1959, #4778)

424. THEORY OF IMPURITY PARAMAGNETISM IN SEMICONDUCTORS AT LOW TEMPERATURES

Seiden, J.

***Comptes rendus hebdomadaires des séances de l'académie de sciences*, Paris, v. 247, no. 25, pp. 2313–2315, December 22, 1958 (in French)**

The paramagnetism due to electrons on un-ionized donors is discussed for concentrations which are sufficiently high so that the interactions among the impurities become important. A simple discussion in terms of the Ising model is given. (*PA*, 1959, #3625)

425. THERMAL ACTIVATION OF FERROMAGNETIC DOMAINS

Stacey, F. D.

***Proceedings of the Physical Society*, London, v. 73, Part 1, pp. 136–138, January 1959**

Derives an expression for the probability of a particular energy being available to overcome the potential barrier inhibiting the movement of a domain wall. (*PA*, 1959, #3648)

426. TEMPERATURE DEPENDENCE OF ANISOTROPY ENERGY IN ANTIFERROMAGNETS

Pincus, P.

***The Physical Review*, v. 113, no. 3, pp. 769–770, February 1, 1959**

The Akulov–Zener classical theory of the temperature dependence of ferromagnetic anisotropy energy is extended to the antiferromagnetic case. The result, for short-range interactions only, is that

$$K_n(T)/K_n(0) = [M(T)/M(0)]^{n(n+1)/2}$$

where $K_n(T)$ is the nth order anisotropy constant and $M(T)$ is the sublattice magnetization. Here, $K_n(0)$ and $M(0)$ refer to the corresponding quantities at absolute zero. The result is verified by a spin-wave calculation. (*PA*, 1959, #5900)

427. EFFECTIVE FERRIMAGNETIC RESONANCE PARAMETERS WITH GILBERT-TYPE RELAXATION TERMS

Wangsness, R. K.

***The Physical Review*, v. 113, no. 3, pp. 771–772, February 1, 1959**

Steady-state effective parameters of the susceptibility tensor were found for a two-sublattice system by using equations of motion with Gilbert-type relaxation terms. To the same order in the molecular field coefficient, these parameters differ from those previously found for Landau–Lifshitz type terms in that they have infinite discontinuities in the compensation region, there is no distinction between the effective gyromagnetic ratios characterizing the absorption of the Faraday effect, and there is no additional term appearing in the expression for the off-diagonal element. (*PA*, 1959, #5904)

428. TRANSFORMATIONS OF ISING MODELS

Fisher, M. E.

***The Physical Review*, v. 113, no. 4, pp. 969–981, February 15, 1959**

The "star-triangle" and "decoration" transformations are generalized so as to apply to arbitrary mechanical systems coupled to the spins of a standard Ising net. This leads to exact solutions for further plane Ising nets and also for lattices in which the spins on alternate sites have a magnitude greater than $S = \frac{1}{2}$. A general class of antiferromagnetic Ising models is constructed; exact closed expressions can be derived for all the thermodynamic magnetic properties of these models in an arbitrary magnetic field. The magnetizations and susceptibilities of Ising nets in which different spins have different magnetic moments are investigated and a valuable relation between the susceptibilities of the honeycomb and triangular lattices is derived. It is shown how correlation functions involving a given spin can be expressed in terms of correlations involving the nearest-neighbour spins instead. (*PA*, 1959, #5875)

429. EXCITATION OF SPIN WAVES IN AN ANTIFERROMAGNET BY A UNIFORM RF FIELD

Orbach, R. and Pincus, P.

***The Physical Review*, v. 113, no. 5, pp. 1213–1215, March 1, 1959**

It is possible to excite spin-waves in an antiferromagnet provided that spins on the surface of the specimen experience anisotropy interactions different from those acting on the spins in the interior. Modes with an odd number of half-wavelengths should be excited in a flat plate. The condition for different anisotropy interactions is worked out and proves to be a lenient condition. Experiments which would determine the exchange energy constant and the anistropy field should be possible using sufficiently thin platelets of single crystals having parallel faces. (*PA*, 1959, #5901)

430. ON EXPLANATIONS OF ELECTRIC AND MAGNETIC CONSTANTS AND UNITS

Gresky, A. T.

***Journal of the Franklin Institute*, v. 267, no. 3, pp. 201–210, March 1959**

Employing dimensional methods, it is suggested that "explanations" of the free-space dielectric constant ε and

the magnetic permeability constant μ may lie in their proposed relationships to four highly fundamental quantities; for example, $\varepsilon g = m_e^2(h\alpha_e c)^{-1}$ and $\mu g = h\alpha_e(m_e^2 c)^{-1}$. The latter is considered to reflect a specific intrinsic property of the electron, that is, a constancy in the ratio of its magnetic moment (Bohr magneton) to its spin ($h/2$). The former, equal to $1/\mu g c^2$, reflects an additional intrinsic relationship of the electron to light velocity, presumably a characteristic of its associated photons. Other constants and units are similarly analyzed to suggest possible methods for understanding the submicroscopic nature of electric and magnetic phenomena. (*PA*, 1959, #5341)

431. SPIN–ORBIT COUPLING AND THE EXTRAORDINARY HALL EFFECT

Strachan, C. and Murray, A. M.

***Proceedings of the Physical Society*, London, v. 73, Part 3, pp. 433–447, March 1959**

In general terms a qualitative account of the extraordinary Hall effect in ferromagnetic media may be based on spin–orbit coupling. The magnitude of the effect produced is, classically, very sensitive to the actual path of the electron, or, quantum-mechanically, to some of the detail of its wave-function. Here conventional quantum-mechanical transport theory is used in some quantitative detail to evaluate the actual magnitude of the extraordinary Hall coefficient R_s. The initial states of electrons after collisions with the lattice are assumed to be superposition of Bloch functions with random phases. Bloch functions for the *s*- and *d*-bands of nickel are chosen in sufficient detail to make possible a numerical calculation. It is found that R_s/ρ^2, where ρ is the resistivity, increases very slightly for the pure metal with increasing temperature. At 290°K, R_s is found to be slightly less than -2×10^{-12} ohm cm gauss^{-1}. (*PA*, 1959, #7155)

432. EXCLUDED-VOLUME PROBLEM AND THE ISING MODEL OF FERROMAGNETISM

Fisher, M. E. and Sykes, M. F.

***The Physical Review*, v. 114, no. 1, pp. 45–48, April 1, 1959**

The relationship between the excluded-volume problem for a discrete random walk on a lattice and the corresponding Ising model of ferromagnetism is investigated. Systematic methods are presented for the construction of rigorous lower bounds to the limit $\mu = \lim_{n\to\infty}(c_{n+1}/c_n)$, where c_n is the number of n-step self-avoiding walks on a given lattice. In this way Temperley's conjecture that $\mu = \coth(J/kT_c)$, where Tc is the Curie temperature of the corresponding Ising-model ferromagnet, is disproved. The series c_n for various two- and three-dimensional lattices are enumerated exactly for values of n from 10 to 20. Extrapolation of these series, by procedures known to be valid from exact Ising-model results, yields more accurate values of μ than Wall's statistical calculations and also shows that $c_n \sim n^\alpha \mu^n$ where $\alpha \cong \frac{1}{3}$ for plane lattices and $\alpha \cong \frac{1}{2}$ for three-dimensional lattices. This means that the entropy of the nth "link" of a polymer molecule in solution should vary as $\delta S_n = k \ln\mu + k\alpha/n$. The relevance of these results to the interpretation of the boundary tension of the Ising model, to the critical behaviour of gases, and to the mean square size of a polymer molecule is discussed briefly. (*PA*, 1959, #7154)

433. ANTIFERROMAGNETIC GROUND STATE

Fisher, J. C.

***Journal of the Physics and Chemistry of Solids*, v. 10, no. 1, pp. 44–46, April 1959**

The ground-state wave function for an antiferromagnetic spin array, corresponding to the Hamiltonian $H = J\text{E (neighbours) } S_i + S_j$, has been approximated by a simple linear combination of those basis vectors that can be derived from the idealized Néel ground state by transferring a few spin deviations between neighbouring spins. The resulting wave function is very nearly an eigenfunction of H, the corresponding energy is

$$\lambda_0 = -[1 + (2Zs - 1)^{-1}]\, JZNS^2/2$$

and the fractional spin alignment is

$$\theta = 1 - ZS/(2Zs - 1)^2$$

The energy is very close to that given by the spin-wave approximation, but the fractional spin alignment lies about halfway between the spin-wave value and unit. (*PA*, 1959, #7174)

434. REMARKS ON MAGNETICALLY DILUTE SYSTEMS

Sato, H., Arrott, A., and Kikuchi, R.

***Journal of the Physics and Chemistry of Solids*, v. 10, no. 1, pp. 19–34, April 1959**

Because of the inadequacies of previous treatments of the magnetic properties of magnetically dilute systems when used to interpret experimental results, a re-examination of the problem starting from a simple model is made. The treatments of the problem discussed here, using an Ising model, show that a Curie or a Néel temperature does not appear until a finite concentration of magnetic atoms is obtained if the atomic distribution is random. This concentration depends on the coordination number of the lattice and on the range of interaction, but not on the strength of the interaction. The results given here for nearest-neighbour interactions describe the general behaviour observed in magnetically dilute solutions. Such things as anomalously high values of "effective magnetic moments" per magnetic atom and its concentration-dependence, curvature in inverse susceptibility against temperature plots, and parasitic paramagnetism in the weakly ferromagnetic alloys, etc., are reasonably well explained. When the system has antiferromagnetic interactions, it is found that the inverse susceptibility shows a complicated temperature-dependence varying with concentration and that the existence of a maximum in the susceptibility does not necessarily mean the onset of antiferromagnetism. Special references are made to iron in gold and chromium and to manganese in copper. (*PA*, 1959, #7150)

435. FORM EFFECT IN LINEAR MAGNETOSTRICTION

Stauss, H. E.

***Journal of Applied Physics*, v. 30, no. 5, pp. 698–701, May 1959**

The influence of the shape of the specimen upon the measured value of magnetostriction is a matter of importance. The classical thermodynamical calculation of Becker applies to specimens in like magnetic fields and consequently compares bodies with unlike intensities of magnetization. In the present paper use is made of the principle of virtual work to make a calculation of the form effect as dependent upon the intensity of magnetization. The form effect for an ellipsoid in an extended uniform field is found to be a constrictive strain of the magnitude

$$\Delta A_{11} = \frac{-(1-2\mu)}{E}\frac{NI^2}{2}$$

where ΔA_{11} is the form effect in strain, μ is Poisson's ratio, E is Young's modulus, N is the coefficient of self-demagnetization, and I the intensity of magnetization. Above saturation the form effect is

$$\Delta A_{11} = -\frac{(1-2\mu)}{E}\frac{NI_s^2}{2}$$

where I_s is the saturation value of I. The meaning of the term form effect has been expanded to include not only the change in strain in the specimen resulting from the shape of the specimen itself, but also the change resulting from the position of the specimen relative to the magnetizing apparatus. A calculation of the form effect in this extended sense is made for two useful experimental arrangements; one where a specimen is sandwiched between two movable rods and the other where the specimen is situated in the fixed gap of a magnet. For the first case it is found that the form effect depends upon the self-demagnetization of the entire ferromagnetic arrangement and not of the specimen itself. In the second case, the form effect is dependent upon the ratio of gap energy to the volume of the ferromagnetic system and can be small, subject to the qualification that the form effect does not include the effects of any stresses that develop within the gap. (*PA*, 1959, #7166)

436. FERRIMAGNETIC RESONANCE MODES IN SPHERES

Fletcher, P. C. and Bell, R. O.

***Journal of Applied Physics*, v. 30, no. 5, pp. 687–698, May 1959**

The magnetostatic solutions of ferrimagnetic resonance in ferrite spheres are briefly derived. General and specific solutions are given for values of n up to five for the magnetostatic potentials, r.f. distributions of magnetization, and fields for resonance. Some experimental results are given and compared with the theory. (*PA*, 1959, #7178)

437. FLUX REVERSAL IN SOFT FERROMAGNETICS

Humphrey, F. B. and Gyorgy, E. M.

***Journal of Applied Physics*, v. 30, no. 6, pp. 935–939, June 1959**

To describe the flux reversal process in soft ferromagnetics, at least three mechanisms are required. A domain wall motion process is satisfactory only when the drive field is slightly larger than the coercive force. In the intermediate drive region, a nonuniform rotation model is necessary to be consistent with the experimental observations. In particular such a model predicts the observed

linear relationship between drive and the inverse of the reversal times, the observed shape of the flux reversal transient and the observed value of the switching coefficient. In the high drive region with a transverse field applied, a coherent rotation model provides the best explanation of the experimental observations. The three regions can be demonstrated with a single sample in the case of the thin film. (*PA*, 1959, #8308)

III. MAGNETIC PROPERTIES OF GENERAL MATERIALS AND METHODS OF STUDY

A. Films, Thin Layers, Particles, Whiskers and Wires

438. PROPRIETES D'UN FERROMAGNETIQUE CUBIQUE EN GRAINS FINS
Néel, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 224, pp. 1488–1490, 1947a

439. LE CHAMP COERCITIF D'UNE POUDRE FERROMAGNETIQUE CUBIQUE A GRAINS ANISOTROPES
Néel, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 225, pp. 109–111, 1947c

440. THE INFLUENCE OF A TRAVERSE MAGNETIC FIELD ON THE CONDUCTIVITY OF THIN METALLIC FILMS
Sondheimer, E. H.
The Physical Review, v. 80, no. 3, pp. 401–406, November 1, 1950

441. MAGNETIZATION HYSTERESIS LOOP TRACER FOR LONG SPECIMENS OF EXTREMELY SMALL CROSS SECTION
Crittenden, E. C., Jr., Hudimac, A. A. and Strough, R. I.
Review of Scientific Instruments, v. 22, pp. 872–877, December 1951

Low frequency magnetic properties of thin layers are considered and an instrument for measuring is described.

442. MAGNETIC PROPERTIES OF THIN METALLIC FILMS
Colombani, A.
Memorial des Sciences Physiques, no. 58, 1954 (in French)

A discussion is given of the hysteretic and related properties of thin films prepared by electrolytic deposition, thermal evaporation and cathode sputtering (including an account of the properties of thin films of hexagonal nickel). The spin wave theory of the spontaneous magnetization of films (Klein and Smith) is outlined and its experimental verification discussed. The theory of the magnetic properties of single domains is described and applied. (*PA*, 1955, #2877)

443. TORSION METHOD MEASUREMENTS OF THE MAGNETIZATION CURVES OF THIN FERROMAGNETIC FILMS
Brož, J. and Sternberk, J.
Czechoslovak Journal of Physics, v. 5, no. 1, pp. 96–98, February 1955 (in Russian) (*PA*, 1955, #4802)

444. RESEARCH AND DEVELOPMENT ON MAGNETIC FILMS
Doherty, J. T.
Servomechanisms, Inc., Western Division, El Segundo, California
(Contract AF-33(616)-3039) Scientific Report Number 1, May 16–August 31, 1955
(ASTIA AD-70,990)

Work of the first quarter is discussed. This discussion includes a detailed survey of work on magnetic films which has been completed at the Naval Ordnance Laboratory at Corona, California (Project Order Number 27808). A description of preliminary work to establish

evaporation techniques for coating iron films on glass substrates, using an electron bombardment method of evaporation, is also included.

445. TORSION BALANCE FOR A SINGLE MICROSCOPIC MAGNETIC PARTICLE

Yu, S. P. and Morrish, A. H.

***Review of Scientific Instruments*, v. 27, no. 1, pp. 9–11, January 1956**

The construction and principle of operation of a new type of quartz fibre torsion balance are described. The quartz suspension fibre used can be as small as 0.5 micron diam. This enables magnetic measurements to be made on an individual microscopic magnetic particle of about 1-micron diam. (*PA*, 1956, #946)

446. MAGNETIC PROPERTIES OF FINE PARTICLES

Wohlfarth, E. P.

***The Scientific Journal of the Royal College of Scientists*, v. 26, pp. 19–43, 1956**

A review of the following topics: magnetization of single-domain particles, permanent-magnet alloys, powder magnets (MnBi, Ferroxdure, iron), other applications (magnetic recording wires and tapes, rock magnetism, dilute ferromagnetic alloys), particle shape variations and interactions, thermal fluctuations, multidomain particles, other results (thermal changes and hysteresis loss, remanence curves, transverse susceptibility, rotational hysteresis), Morrish and Yu's experiment. (50 references) (*PA*, 1957, #6338)

447. RAPID METHOD FOR MEASURING COERCIVE FORCE AND OTHER FERROMAGNETIC PROPERTIES OF VERY SMALL SAMPLES

Van Oosterhout, G. W.

***Applied Scientific Research*, Section B, v. 6, no. 1–2, pp. 101–104, 1956**

Technique for quantitative investigation of permanent magnetic properties, especially coercive force, of samples of about 1 mg: method is based essentially on measurement of alternating emf, generated by letting sample vibrate in search coil, with sensitive voltmeter; for measurement of magnetic moments, instrument has to be calibrated. (*EI*, 1957)

448. RÉSUMÉ OF THE PRINCIPAL WORK ON THE MAGNETIC PROPERTIES OF THIN METALLIC LAYERS

Colombani, A.

***Journal de physique et le Radium*, vol. 17, no. 3, pp. 263–269, March 1956 (in French)**

Influence of temperature and structure of the deposit on the production of ferromagnetism in thin metallic layers is considered, together with the fact that, for very thin layers, the coercitive field of the deposit can reach a value greater than that of the solid metal. This second fact has originated many researches on the ferromagnetic alloys, for example. Both theory and experimental results show that, if the temperature is low enough, even a monoatomic layer should be ferromagnetic. These three important facts have only been established after much research, of which the most important results were: Maurain's, the first to be reproducible, and showing the existence of rectangular cycles and the phenomena of remote magnetization; the author's, showing the influence of temperature and structure on the production of ferromagnetism; and those of Crittenden. The last seem to agree with the Klein and Smith theory, issued from the Bloch method, though valid only for very low temperatures. (*PA*, 1956, #6777)

449. EXTENSION OF THE "THIN-SAMPLE METHOD" FOR THE MEASUREMENT OF INITIAL COMPLEX PERMEABILITY AND PERMITTIVITY

Conrad, E. E., Porter, C. S., Doctor, N. J., and Franklin, P. J.

***Journal of Applied Physics*, v. 27, no. 4, pp. 346–350, April 1956**

A summary is given of the theory of measurement of complex relative permeability and permittivity of low conductivity materials by the thin-sample method using a slotted transmission line. The equations from which to calculate the electrical properties from the measured parameters are extended to apply to a commercial slotted line and thus to a more complex system than that used by other workers. Some errors of the measurements are discussed and various correctional equations derived by other workers are given. (*PA*, 1956, #7374)

450. A STUDY OF BITTER FIGURES USING THE ELECTRON MICROSCOPE
Craik, D. J.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 6, pp. 647–650, June 1956**

The Bitter figure technique is modified to give patterns in the form of thin films which can be removed from the specimen and examined by high power phase-contrast microscopy and by electron microscopy. This makes possible the observation of extremely fine detail and direct measurement of the width of domain walls. (*PA*, 1956, #7531)

451. MAGNETIC DOMAINS IN THIN FIBERS BY THE FARADAY EFFECT
Fowler, C. A. and Fryer, E. M.
***The Physical Review*, v. 104, pp. 552–553, October 1956**

452. RESONANCE AND REVERSAL PHENOMENA IN FERROMAGNETIC FILMS
Conger, R. L. and Essig, F. C.
***The Physical Review*, v. 104, p. 915, 1956**

453. MAGNETIC GRANULOMETRY AND SUPER-PARAMAGNETISM
Bean, C. P. and Jacobs, I. S.
***Journal of Applied Physics*, v. 27, no. 12, pp. 1448–1452, December 1956**

The magnetic technique of particle size measurement based on the work of Elmore consists of a comparison of a modified Langevin curve with the observed magnetization curve for an appropriate system of ferromagnetic particles. The average magnetic moment per particle is obtained from this analysis, and the average particle size is thus determined. The prediction by Néel of thermal relaxation in single-domain ferromagnetic particles broadens the range of applicability of the granulometry method, with special emphasis on the size range from 20 Å to about 100 Å. A possible objection to the method, arising from evidence for an abnormal temperature dependence of the saturation magnetization of very small magnetic particles, is re-examined experimentally and found to be invalid. Several examples are presented that demonstrate the predicted thermal relaxation and that point to a wide utilization of the granulometry technique. (*PA*, 1957, #4794)

454. MAGNETOSTRICTIVE ELECTRICITY IN STRAIN GAUGES
Vigness, I.
***Review of Scientific Instruments*, v. 27, no. 12, pp. 1012–1014, December 1956**

Ferromagnetic wires that have been suitably conditioned generate electrical potentials when subjected to changes in elastic strain. Conditioning the wires involves alignment of the circumferential component of the magnetic field, due to domains in a preferred direction. This is accomplished by the magnetic field associated with a current passed through the wire. A disturbance which changes this established circumferential field causes a potential to appear between the ends of the wire. (*PA*, 1957, #2154)

455. FERROMAGNETIC RESONANCE ABSORPTION BY THIN CONDUCTING FILMS IN CAVITIES
Artman, J. O.
***Journal of Applied Physics*, v. 28, no. 2, pp. 277, February 1957**

This report gives an analysis of the energy absorbed in a ferromagnetic film deposited on a metal substratum, and on a dielectric substratum, in a cavity. (*PA*, 1957, #6339)

456. FERROMAGNETIC GRANULAR STRUCTURES
Prache, P. M.
***Câbles et Transmission*, v. 11, no. 2, pp. 128–166, April 1957 (in French)**

457. MAGNETIC DOMAIN PATTERNS ON THIN FILTERS
Williams, H. J. and Sherwood, R. C.
***Journal of Applied Physics*, v. 28, pp. 548–555, May 1957**

458. ZUR BESTIMMUNG DER MAGNETISIERUNG AUF TONBAND
Schmidbauer, O.
***Elektronische Rundschau*, v. 11, no. 10, pp. 302–305, October 1957**

Measurement of magnetization of magnetic sound tape; method for measurement of magnetization of tape by short-circuit flux; possible error sources and means for their elimination; two methods for traverse magnetization measurement of pilot sound track; electronic fluxmeter for measurement of residual flux according to subtraction method. (*EI*, 1958)

459. FINE PARTICLE MAGNETS
Paine, T. O., Mendelsohn, L. I., and Luborsky, F. E.
***Electrical Engineering*, v. 76, no. 10, pp. 851–857, October, 1957**

Physical picture of structure of fine particle magnets and basic factors which determine their behavior; permanent magnet properties of fine particles summarized and compared with those predicted from theoretical considerations. (*EI*, 1958)

460. REMANENT MAGNETIZATION OF SINGLE DOMAIN FERROMAGNETIC PARTICLES
Wohlfarth, E. P. and Tonge, D. G.
***The Philosophical Magazine*, Eighth Series, v. 2, no. 23, pp. 1333–1344, November 1957**

Remanent magnetization is calculated for particles with number of equivalent easy directions of magnetization, and also for particles with mixed uniaxal anisotropies; application is made to variety of materials; magnetization curves for particles with unidirectional anisotropy are calculated. (*EI*, 1958)

461. MAGNETIC ANISOTROPY MEASUREMENT WITH AN OSCILLATION MAGNETOMETER
Macdonald, J. R.
***British Journal of Applied Physics*, v. 9, no. 3, pp. 116–119, March 1958**

A method of using an oscillation magnetometer to determine magnetic anisotropy factors in the plane of a thin-disk shaped sample lying in the X–Z-plane is described. Both the saturation magnetization, M_0 and the factor $(N_x - N_z)M_0$ may be obtained independently. N_x, N_y and N_z are demagnetization factors which include all contributions to magnetic anisotropy such as those arising from stress, magnetocrystalline anisotropy and shape. These results are correlated with previous work on a somewhat different type of oscillation magnetometer used to determine $(N_y - N_z)M_0$, and it is shown that a correction must be applied for both types of magnetometer when the oscillation amplitude exceeds a degree or two. Finally, it is shown that the oscillation magnetometer can be employed to determine the details of any angular dependence of magnetic anisotropy in the plane of the sample if such anisotropy is sufficiently large. These measurement techniques are particularly applicable to the determination of any dependence of M_0 on film thickness in thin ferromagnetic evaporated films, and to the determination of magnetic anisotropy in thin films evaporated and/or annealed in a magnetic field. (*PA*, 1957, #1775)

462. RESEARCH ON FINE-PARTICLE PERMANENT MAGNET MATERIALS (Period covered: March 1, 1957–February 28, 1958)
Berkowitz, A. E. and Schuele, W. J.
Franklin Institute, Philadelphia, Pa.
AF-33(616)-5041, R-F-A-2033-1, April 1958
(ASTIA AD-155,760)

Ferromagnetic and ferrimagnetic fine particles were prepared by suitably heat-treating co-precipitated oxalates (Co-Fe, Ni-Fe, and Cu-Fe systems in a wide range of compositions). X-ray diffraction was used to determine the phases present in the oxalates and their heat-treated products.

463. FURTHER OBSERVATIONS ON REVERSIBLE ROTATION IN MAGNETIC FILMS
Sanders, R. M.
***Journal of Applied Physics*, v. 29, no. 6, pp. 1003–1004, June 1958**

464. THE MAGNETIC PROPERTIES OF THIN FILMS
Goodenough, J. B. and Smith, D. O.
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
TR-197, January 27, 1959
(ASTIA AD-210,730)

The present knowledge of the magnetic properties of thin films is reviewed. The discussion is principally concerned with permalloy films, but mention is also made of

MnBi films which have their easy-magnetization axis perpendicular to the plane of the film. The engineering parameters of importance for high speed memory applications are defined and related to the fundamental properties of the materials.

465. SELECTIVE TRANSPARENCY OF FERROMAGNETIC FILMS
Kaganov, M. I.
***Fizika Metallov i Metallovedeniya*, v. 7, no. 2, p. 288, 1959**

466. QUARTERLY RESEARCH REVIEW NO. 20 (Period covered: November 1, 1958–January 31, 1959)
Army Dept., Army Rocket and Guided Missile Agency, Huntsville, Alabama
R-ARGMA-TN-1-C2ON-1, March 1, 1959

The following projects are discussed: strength behavior of a simple pin joint in a thermoplastic plate; investigation with the Van de Graaff accelerator; nuclear spectroscopy; magnetic properties of thin films; a method for mounting substrates for use in the electron microscope; electrical conductivity and temperature of partially ionized argon at 1 cm Hg; low temperature chemistry; effect of driven oscillations on rate of heat transfer; and notes on asymmetrical aging in space travel.

467. MAGNETIC DOMAIN OBSERVATIONS BY ELECTRON MICROSCOPY
Hale, M. E., Fuller, H. W., and Rubinstein, H.
***Journal of Applied Physics*, v. 30, no. 5, pp. 789–790, May 1959**

Experiment with films is reported.

468. QUARTERLY RESEARCH REVIEW NO. 21 (Period covered: February 1–April 30, 1959)
Army Dept., Army Rocket and Guided Missile Agency, Huntsville, Alabama
TN-1-C216-1, June 11, 1959

The sections of this review deal with heat transfer, nuclear spectroscopy materials testing, plasma contaminants, ablation, and magnetic properties of thin films in addition to other subjects.

469. THIN FILM MAGNETIZATION ANALYSIS
Chu, K., and Singer, J. R.
***Proceedings of the IRE*, v. 47, no. 7, pp. 1237–1244, July 1959**

A graphical method is used for analysis of magnetization direction in terms of magnetic energy, and for prediction of hysteresis loop shape of ferromagnetic thin films. Conditions with fields applied at 90 deg, 180 deg, and both 90 and 180 deg are considered.

(See also references: 481, 504, 558, 581, 587, 607, 621, 622, 623, and 626)

B. General

470. SPONTANEOUS AND INDUCED MAGNETIZATION IN FERROMAGNETIC BODIES
Frenkel, J. and Dorfman, J.
***Nature*, v. 126, pp. 274–275, 1930**

471. ELASTISCHE SPANNUNGEN UND MAGNETISCHE EIGENSCHAFTEN
Becker, R.
***Zeitschrift für angewandte Mathematik und Physik*, v. 33, pp. 905–913, 1932**

472. MAGNETIC PROPERTIES OF THE METALLIC STATE AND ENERGY OF INTERACTION BETWEEN MAGNETIC ATOMS
Néel, L.
***Annales de physique*, Paris, v. 5, pp. 232–279, 1936 (in French)**

473. DIRECTIONAL FERROMAGNETIC PROPERTIES OF METALS
Bozorth, R. M.
***Journal of Applied Physics*, v. 8, pp. 575–588, 1937**

474. THE MAGNETIZATION OF FERROMAGNETIC COLLOIDS
Elmore, W. C.
***The Physical Review*, v. 54, pp. 1092–1095, 1938**

475. THEORY OF THE OPTICAL AND MAGNETIC PROPERTIES OF FERROMAGNETIC SUSPENSIONS
Elmore, W. C.
The Physical Review, v. 60, pp. 593–596, October 15, 1941

476. QUELQUES PROPRIETES DES PAROIS DE DOMAINES ELEMENTAIRES FERROMAGNETIQUES
Néel, L.
Cahiers de Physique, v. 25, pp. 1–20, 1944a

477. EFFET DES CAVITES ET DES INCLUSIONS SUR LE CHAMP COERCITIF
Néel, L.
Cahiers de Physique, v. 25, pp. 21–44, 1944b

478. DEMAGNETIZING FACTORS OF THE GENERAL ELLIPSOID
Osborn, J. A.
The Physical Review, v. 67, pp. 351–357, 1945

479. DIRECTOR OF DOMAIN MAGNETIZATION IN POWDER PATTERNS
Williams, H. J.
The Physical Review, v. 71, p. 646, 1947

480. ON THE DOMAIN STRUCTURE OF FERROMAGNETIC BODIES IN THE PRESENCE OF A MAGNETIC FIELD
Kholodenko, L.
Journal of Experimental and Theoretical Physics, USSR, v. 17, pp. 698–707, 1947 (in Russian)

481. VARIATION DU CHAMP COERCITIF EN FONCTION DE LA DENSITE DE POUDRES FERROMAGNETIQUES AGGLOMEREES
Weil, L.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 225, pp. 229–230, 1947

482. INTERPRETATION OF HIGH COERCIVITY IN FERROMAGNETIC MATERIALS
Stoner, E. C. and Wohlfarth, E. P.
Nature, v. 160, p. 650, 1947

483. FERROMAGNETIC DOMAIN OBSERVATION
Marton, L.
The Physical Review, v. 73, no. 12, p. 1475, June 15, 1948

484. ON MAGNETIC REMANENCE
Bozorth, R. M.
Zeitschrift für angewandte Mathematik und Physik, v. 124, pp. 519–527, 1948

485. GYROMAGNETIC RATIOS AND SPLITTING FACTORS OF FERROMAGNETIC SUBSTANCES
Kittel, C.
The Physical Review, v. 76, p. 743, 1949a

486. MAGNETIC MATERIALS
Brailsford, F.
Methuen, London; John Wiley and Sons, N.Y., 1951

487. SOME MAGNETIC PROPERTIES OF METALS. I. GENERAL INTRODUCTION, AND PROPERTIES OF LARGE SYSTEMS OF ELECTRONS
Dingle, R. B.
Proceedings of the Royal Society of London, Series A, v. 211, pp. 500–516, 1952

A general introduction surveying the problems to be examined in a series of papers is followed by a detailed treatment of the magnetic behavior of a large system of electrons. The Schrodinger equation is solved on the assumption that the system is unbounded. An expression is obtained for the density of states and the free energy of the system found. The magnetic susceptibility, thermodynamic potential and specific heat are discussed.

488. SOME MAGNETIC PROPERTIES OF METALS. II. THE INFLUENCE OF COLLISIONS ON THE MAGNETIC BEHAVIOR OF LARGE SYSTEMS
Dingle, R. B.
Proceedings of the Royal Society of London, Series A, v. 211, pp. 517–525, 1952

A discussion of the effect of collisions on the magnetic properties of a large system of free electrons shows that the nonperiodic term in the susceptibility is hardly af-

fected, but that the periodic terms are reduced in magnitude by a factor exp $(-hp/\gamma\beta H)$, where p is the harmonic considered, γ is the mean collision time, and $\beta = eh/2\pi mc$.

489. FERROMAGNETIC PROPERTIES OF METALS AND ALLOYS
Hoselitz, K.
Clarendon Press, Oxford, 1952

490. A REVIEW OF NEW MAGNETIC PHENOMENA
Alley, R. E., Jr.
***Bell System Technical Journal*, v. 32, pp. 1155–1172, September 1953**

491. MAGNETIC ALLOYS AND FERRITES
Say, M. G., editor
George Mewnes, Ltd., London, 1954

492. MAGNETIC DOMAINS BY THE LONGITUDINAL KERR EFFECT
Fowler, C. A. and Fryer, E. M.
***The Physical Review*, v. 94, no. 1, pp. 52–56, April 1, 1954**

493. INVESTIGATIONS OF IRREVERSIBLE MAGNETIZATION CHANGES AND AFTER-EFFECT
Kranz, J.
***Zeitschrift für angewandte Mathematik und Physik*, v. 139, no. 5, pp. 619–637, 1954 (in German)**

Describes an experimental arrangement (the impulses induced in a solenoid surrounding the specimen are amplified and counted) for observing Barkhausen discontinuities in several ferromagnetic substances (steel, Perminvar, 75% Ni 25% Cu alloy, carbonyl Ni). Statistical analysis of the results shows that, independently of the rate of change of the field, the distribution of discontinuities does not obey a Gaussian law; this is believed to be due to the concidence of several smaller discontinuities which cannot be resolved by the counters. It is found that discontinuities are "coupled" and this coupling is measured by the Lexis ratio Q^2 (the ratio of the variance to the mean number of discontinuities); Q^2 values of over 20 were observed for some specimens. This coupling also influences the irreversible aftereffect which, for large Q^2 values, rapidly approaches a logarithmic time dependence. (*PA*, 1955, #2012)

494. REDUCTION OF PHOTOGRAPHIC NOISE
Fowler, C. A. and Fryer, E. M.
***Journal of the Optical Society of America*, v. 44, p. 256, March 1954**

A noise reduction scheme, used in a Kerr magneto-optical method of ferromagnetic domain observation, is described. A photographic positive superimposed on the negative cancels some unwanted noise.

495. EXPERIMENTAL INVESTIGATION OF THE TOPOGRAPHY OF THE MAGNETIC FIELD OF NATURAL SURFACE DEFECTS IN FERROMAGNETIC SOLIDS
Zatsepin, N. N.
***Zhurnal Teknicheskoi Fiziki*, v. 24, no. 7, pp. 1224–1228, 1954 (in Russian)**

By contradistinction to the case of artificial defects, the magnetic fields of natural surface defects of ferromagnetic solids, hair cracks, are never measured. The author shows that despite experimental difficulties such measurements can be carried out with a modest accuracy. The sensitivity of the bismuth wire as indicator of the magnetic field was increased by carrying through the measurements in a Dewar vessel at liquid nitrogen temperature. The results obtained could be confirmed by metallographic microsections which are reproduced in the paper in magnifications of $\times$ 90 and $\times$ 210, respectively. (*PA*, 1955, #6292)

496. LES MATERIAUX MAGNETIQUES
Vautier, R.
***Metaux* (*Corrosion Industries*), v. 29, no. 349, pp. 347–360, September 1954**

Magnetic materials: fundamentals; composition and magnetic properties of various alloys and powders; mild alloy with high permeability; ferrites and silicon sheets. (*EI*, 1955)

497. ON THE QUANTITATIVE MEASUREMENT OF BARKHAUSEN DISCONTINUITIES

Wotruba, K.
Czechoslovak Journal of Physics, v. 4, no. 3, pp. 377–379, September 1954 (in Russian)

To compare results of investigations carried out with sinusoidal and rectangular wave current, it is necessary to know the relation between their peak values. It is shown that calibration with sinusoidal wave current is equivalent to calibration with rectangular wave current of the same peak value. (*PA*, 1955, #7197)

498. FOUNDATIONAL RESEARCH PROJECTS

Naval Ordnance Laboratory, Corona, Calif.
Report NOL-Corona-R-211, QR, November 1954

Progress is reported on ferromagnetic resonance as well as other projects.

499. RAPID METHOD OF EVALUATING MAGNETOSTRICTIVE MATERIALS FOR ELECTROMECHANICAL TRANSDUCERS

Pigott, M. T. and Kendig, P. M.
Journal of the Acoustical Society of America, v. 62, no. 6, pp. 974–976, November 1954

A method about 30 times as rapid as the usual "bridge" method for evaluating magnetostrictive samples is described. The formula $k^2\chi_R = 1 - (\omega_1/\omega_0)^2$ is employed, where k, χ_R, $\omega_1/2\pi$ and $\omega_0/2\pi$ are, respectively, the electromechanical coupling coefficient, the real part of the eddy-current factor, the resonant frequency and the frequency of maximum efficiency. The frequency $\omega_1/2\pi$ is determined by means of a constant-current circuit and $\omega_0/2\pi$ is determined by means of a constant-voltage circuit. The design of the circuits is based on the fact that the modulus of the motional impedance takes on its maximum at the frequency $\omega_1/2\pi$, and the modulus of the motional admittance takes on its maximum at the frequency $\omega_0/2\pi$. Measurements of $\omega_1/2\pi$ and $\omega_0/2\pi$ obtained by this method agree closely with those obtained from an admittance bridge. The accuracy of the method depends on two facts: (1) the percent uncertainty in $k^2\chi_R$ is about twice the present uncertainty in $(\omega_0 - \omega_1)$, and (2) $\omega_1/2\pi$ and $\omega_0/2\pi$ can be determined to within one cps. (*PA*, 1955, #1630)

500. MUTUAL INDUCTANCE BRIDGE AND CRYOSTAT FOR LOW-TEMPERATURE MEASUREMENTS

Erickson, R. A., Roberts, L. D. and Dabbs, J. W. T.
Review of Scientific Instruments, v. 25, no. 12, pp. 1178–1182, December 1954

A mutual inductance bridge and cryostat are described which may be used to measure susceptibilities from 77°K with liquid nitrogen, down to adiabatic demagnetization temperatures. In addition to the sensitivity necessary for measurements over such a temperature interval, the apparatus provides the following features: a usable frequency range of 5 kc/s, for the study of paramagnetic relaxation and paramagnetic specific heat; measurement of longitudinal susceptibilities in fields up to 3,000 oersted, and transverse susceptibilities in fields up to 13,000 oersted; a single method for changing samples with a minimum dismantling of the equipment. (*PA*, 1955, #3873)

501. A SIMPLE METHOD OF OBSERVING ELEMENTARY MAGNETIC DOMAINS USING DRY POWDER

Andrá, W. and Schwabe, E.
Annalen der Physik, Leipzig, v. 17, no. 1, pp. 55–56, 1955 (in German)

The iron oxide powder used to study the domain structure of cobalt was produced by oxidation of carbonyl iron. The pattern is compared with that obtained by using a colloidal suspension, which gives better resolution. (*PA*, 1956, #1357)

502. APPARATUS FOR THE MEASUREMENT OF MAGNETOSTRICTION BY MEANS OF A VARIABLE CAPACITY

Wotruba, K.
Czechoslovak Journal of Physics, v. 5, no. 1, pp. 102–103, February 1955 (in German)

A schematic description of an apparatus of the electrical ultramicrometer type, arranged so as to allow the actual length of the specimen, as well as changes in length, to be measured. The sensitivity quoted is 1700c/s per micron, and a short period stability of 15c/s is claimed. (*PA*, 1955, #5506)

503. REPRESENTATION OF THE DOMAINS OF A FERROMAGNETIC BY THE ELECTRON-OPTICAL METHOD

Spivak, G. V., Kanavina, N. G., Sbitnikova, L. S. and Dombrovskaya, T. N.
***Doklady Akademii Nauk*, SSSR, v. 105, no. 4, pp. 706–708, 1955 (in Russian)**

The method of reproducing magnetic inhomogeneities of a metal surface by the focusing effect of magnetic "micro-lenses" enables regions of inhomogeneous magnetization of the size of 0.1 mm to be investigated. Different contrast effects are obtained according to the choice of the plane of focusing. The pictures shown were obtained on a cobalt monocrystal used as cathode and correspond closely to a domain-representation obtained by the powder method and used for comparison. (*PA*, 1956, #4496)

504. EIN BETRIEBSGERAET ZUR SCHNELLEN UND GENAUEN MESSUNG DER KOERZITIVKRAFT

Foerster, F.
***Zeitschrift für Metallkunde*, v. 46, no. 4, pp. 297–302, April 1955**

Apparatus for rapid and accurate measurement of coercive force and its dependence on temperature; high sensitivity and other characteristics of instrument which may be used for measuring coercive force of very small specimens; applications in metallography. (*EI*, 1955)

505. AN AUTOMATIC RECORDING TORSIONAL MAGNETIC SUSCEPTIBILITY BALANCE

Croft, G. T., Donahoe, F. J., and Love, W. F.
***Review of Scientific Instruments*, v. 26, no 4, pp. 360–363, April 1955**

A torsional magnetic susceptibility balance suitable for studying the de Haas–van Alphen effect has been developed in which the torque and magnetic field are recorded continuously while the magnet current is reduced automatically. The torque is recorded as a bucking current to a galvanometer suspension supporting the sample, and the magnetic field is obtained from a recording of the magnet current. A circuit for stabilizing the magnet current is also described. (*PA*, 1955, #5508)

506. STAND DER ENTWICKLUNG MAGNETISCHER WERKSTOFFE

Mueller, H. G.
***Technische Hochschule–Wissenshaftliche Zeitschrift*, Dresden, v. 5, no. 2, pp. 111–123, 1955**

State of development of magnetic materials; magnetic behavior of matter; magnetic materials in electrical engineering; materials for permanent magnets; properties of ferrite semiconductors. (*EI*, 1956)

507. MEASUREMENTS ON DIELECTRIC AND FERROMAGNETIC MATERIALS AT FREQUENCIES AROUND 10^4 Mc/s

Klatte, G.
***Fernmeldetchnische Zeitschrift*, v. 8, no. 5, pp. 256–261, May 1955 (in German)**

Describes methods using a standing wave indicator for measuring the complex relative dielectric constant of solid materials in the temperature range 20–160°C, and for measuring the complex relative permeability of ferromagnetic materials at room temperature. The results of dielectric measurements on six plastic materials and three magnetic materials are given in tables and graphs. (*PA*, 1955, #8729)

508. REALIZATION OF A HIGH-SENSITIVITY APPARATUS FOR PARAMAGNETIC ELECTRON RESONANCE AT 9200 Mc/s

Uebersfeld, J.
***Ondé électrique*, v. 35, pp. 492–494, May 1955 (in French)**

The principle of the method is to observe the variation in Q of a resonant cavity containing the paramagnetic substance and immersed in a magnetic field. The cavity is connected to a magic T fed from a klystron with stable supplies. The reflected power from the cavity is amplified and applied to the Y-plates of a c.r.o. The X-deflection is isochronous with the small modulating magnetic field which explores the sample. The minimum number of detectable paramagnetic centers is about 10^{16}. (*PA*, 1956, #4511)

509. MAGNETIC CONTRAST IN AN ELECTRON MIRROR AND OBSERVATION OF THE DOMAINS OF A FERROMAGNETIC

Spivak, G. V., Prilezhaeva, I. N. and Azovtsev, V. K.
***Doklady Academii Nauk*, SSSR, v. 105, no. 5, pp. 965–967, 1955 (in Russian)**

An interesting new development of the method of the electron mirror was used by the authors for investigations of contrast effects between ferromagnetics and non-

magnetic materials (magnetic contrast effects) and also for investigations of the domain structure of ferromagnetics. Very clear pictures are obtainable at magnifications up to 150 x; four such pictures are reproduced in the paper. (*PA*, 1956, #4497)

510. EIN VERFAHREN ZUR MESSUNG VON MAGNETISCHEN GLEICHFELDERN UND GLEICHFELDDIFFERENZEN
Foerster, F.
***Zeitschrift für Metallkunde*, v. 46, no. 5, pp. 358–370, May 1955**

Foerster probe method for measuring constant magnetic fields and constant field differences and its application to metallurgical research and practice; determination of ferromagnetic admixtures in nonferrous metals; residual field measurements; theory of Foerster probe effect; application to nondestructive testing of metals. (*EI*, 1955)

511. APPARATUS FOR STUDYING PARAMAGNETIC AND FERROMAGNETIC RESONANCE AT 9000 Mc/s
Paulevé, J.
***Ondé électrique*, v. 35, pp. 494–495, May 1955 (in French)**

A frequency-stabilized 2K25 klystron feeds a magic T one arm of which carries a detector and another a resonant cavity. The cavity contains a small spherical sample and is subject to a steady polarizing field. The klystron output is amplitude-modulated to a depth of about 20% at 300 cps by a crystal shunting the waveguide. A synchronous detector is also switched at 300 cps and the output recorded. A ferrite sample 0.05 mm diam. causes an absorption which is detected as a change in Q of 1%. Variations of Q of 1 part in 10^4 are detectable. (*PA* 1956, #4492)

512. THE INFLUENCE AND THE ELIMINATION OF THE FERROMAGNETIC SUSCEPTIBILITY IN MAGNETO-CHEMICAL INVESTIGATIONS BY THE CYLINDER METHOD
Knappwost, A.
***Zeitschrift für Elektrochemie*, v. 59, no. 6, pp. 561–564, 1955 (in German)**

It is shown that in all cases of not too high concentrations of ferromagnetic impurities the cylinder method of measuring the susceptibility of a substance can be retained if appropriate corrections are applied to the plot of κ against $1/H_{max}$. The method gives results in excellent agreement with the more experimentally difficult field difference method. (*PA*, 1955, #10051)

513. UEBER EIN NEUES ASTATISCHES MAGNETOMETER
Mellentin, K. and Lange, H.
***Zeitschrift für Metallkunde*, v. 46, no. 6, pp. 450–456, June 1955**

New astatic magnetometer for measurement of ferromagnetic sheet specimens in direct and alternating fields; design and operation of instrument; application to measurement of a-c losses. (*EI*, 1955)

514. NEW METHOD FOR DETERMINING THE HYSTERESIS LOOP OF A FERROMAGNETIC BODY SUBJECTED TO AN ALTERNATING MAGNETIC FIELD. II. EXPERIMENTAL
Garcia, S. J. and Page, M. A.
***Anales de la Real Sociedad Española de Física y Química*, Madrid, Series A, no. 5–6, pp. 107–114, May–June 1955 (in Spanish)**

Presents and discusses experimental results of (a) variation of zero error with heater current in the pentode valves, and a simple compensation arrangement, (b) calibration of the apparatus, and (c) some measurements on a silicon iron specimen. The overall accuracy is believed to be within 1.5%. (*PA*, 1955, #8920)

515. THE PROBLEM OF THE GALVANO-MAGNETIC EFFECTS IN FERROMAGNETICS
Koch, K. M.
***Zietschrift für Naturforschung*, v. 10a, no. 6, pp. 496–498, 1955 (in German)**

516. MAGNETISCHE WAAGE ZUR MESSUNG DER SUSZEPTIBILITAET
Beisswenger, H. and Wachtel, E.
***Zeitschrift für Metallkunde*, v. 46, no. 7, pp. 504–507, July 1955**

Magnetic balance for measurement of susceptibility in metals testing; design of electromagnet; pendulum balance permits separation of paramagnetic and ferromagnetic constituents of specimen. (*EI*, 1955)

517. COMPORTAMENTE DEL MATERIALI A CICLO RETTANGOLARO IN PROVINI TOROIDALI

Biorci, G. and Pescetti, D.

***Elettrotecínca*, v. 42, no. 7, pp. 354–359, July 1955**

Behavior of rectangular magnetic materials in toroidal test specimens; study of deformation of normal magnetization curve and of hysteresis cycles of materials. (*EI*, 1955)

518. ACCURATE ELECTRONIC TRACER FOR DYNAMIC CHARACTERISTICS OF MAGNETIC MATERIALS

Kittel, E.

***Transactions of the American Institute of Electrical Engineers*, v. 74, Part 1, no. 20, pp. 407–418, September 1955**

Equipment enabling accurate determination of magnetic characteristics needed for magnetic amplifier design; hysteresis loop and time functions of H, B, and dB/dt can be measured point by point or continuously recorded on x-y recorder by automatic electronic a-c compensator which transforms a-c signal for given time instant into equivalent direct voltage. (*EI*, 1956)

519. THE DIRECT SEPARATION OF THE REVERSIBLE AND IRREVERSIBLE COMPONENTS OF THE MAGNETOTHERMAL EFFECT

Bates, L. F. and Sherry, N. P. R.

***Proceedings of the Physical Society*, London, Section B, v. 68, Part 9, pp. 642–648, September 1955**

A new method is described for separating reversible and irreversible components of the magnetothermal effect by carrying out small, "backward" increments in magnetization at given points on the hysteresis cycle. With the sensitivity of the existing apparatus this method is of limited application, but with increased sensitivity it could be applied generally. Results for the reversible and irreversible heat changes measured with a cobalt specimen, confirm that if reversible thermal effects alone are measured, the b'' coefficient, as defined in the Stoner and Rhodes theory, remains constant over the hysteresis cycle. (*PA*, 1955, #8921)

520. AN IMPROVED METHOD OF MEASURING THE ABSOLUTE SUSCEPTIBILITIES OF SINGLE CRYSTALS OVER WIDE RANGES OF TEMPERATURES

Dutta Roy, S. K.

***Indian Journal of Physics*, v. 29, no. 9, pp. 429–445, September 1955**

An accurate, convenient method has been developed for the measurement of magnetic susceptibilities of single-crystal powders and solutions over wide ranges of temperatures. This is based on the Curie method in which various sources of errors have been individually and collectively eliminated to give an accuracy of not less than 0.2%. The present paper gives a detailed description of the balance and a gas-flow type horizontal cryostat for temperature variation. The calibration of the balance and the Cu–constantan thermocouple temperature scale have also been compared against the existing Leiden, Strasbourg and Calcutta measurements, on standard paramagnetic substances, e.g., Cr^{+++} alum, Fe^{+++} alum and $NiSO_4 \cdot 6H_2O$, the first two of which provide the magnetic scale of extreme low temperatures. (*PA*, 1956, #5997)

521. THE THERMAL EFFECTS ASSOCIATED WITH THE MAGNETIZATION OF HIGH-COERCIVITY MATERIALS

Bates, L. F. and Simpson, A. W.

***Proceedings of the Physical Society*, London, Section B, v. 68, Part 11, pp. 849–858, November 1955**

The heat changes accompanying magnetization processes in materials of high coercivity, over a field of 4000 oersted, have been studied by a new method. The results are in good agreement with the Stoner and Rhodes theory of magnetization processes in such materials. (*PA*, 1956, #2251)

522. A PRECISION MEASURING ARRANGEMENT FOR RESEARCH ON THE AGEING OF PERMANENT MAGNETS

Tenzer, R. K.

***Archives für technisches Messen und industrielle Messtechnik*, no. 239, pp. 285–288, December 1955 (in German)**

A null method, using a ballistic galvanometer or fluxmeter, for the measurement of magnetic flux. The voltage pulse as the search coil is removed from the specimen is

opposed by a similar pulse produced by a change of current in the primary coil of a mutual inductor, the secondary coil of which is in series with the search coil. The current change in the primary coil is so timed as to minimize the effects of the differing pulse shapes. An accuracy of 1 in 10^4 is claimed. (*PA*, 1956, #3028)

523. ON THE MEASUREMENT OF THE MAGNETIC PERMEABILITY OF METALS BY MEANS OF A CAVITY RESONATOR AND THE PERMEABILITY OF IRON IN THE REGION OF FERROMAGNETIC RESONANCE. II
Reich, K. H.
***Frequenz*, vol. 9, no. 12, pp. 414–422, December 1955 (in German)**

A brief review of available methods of permeability measurement in the frequency range from 100 Mc/s to 3 Gc/s, followed by a detailed account of a cavity resonator method. The application of the method to the measurement of the permeability of iron as a function of field strength is discussed. Sources of error are considered and suggestions made for improving the method. (*PA*, 1956, #2237)

524. TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY IN CUBIC CRYSTALS
Keffer, F.
***The Physical Review*, v. 100, p. 1692, December 15, 1955**

525. ELECTRON OPTICAL METHOD OF STUDYING DYNAMIC THERMAL PROCESSES IN OPAQUE MEDIA
Spivak, G. V. and Dombrovskaya, T. N.
***Doklady Academii Nauk*, SSSR, v. 106, no. 1, pp. 39–41, 1956 (in Russian)**

A ferro- or paramagnetic specimen is used as a secondary emitting cathode in the field of a magnetic lens. As the temperature of the cathode is raised through the Curie point a "temperature wave" is seen to travel across the secondary emission image due to the local influence of changing magnetic field associated with the magnetic transformation of the specimen. (*PA*, 1956, #6770)

526. NOMOGRAM OF THE FUNCTION $2J_1(z)/zJ_0(z)$ FOR THE STUDY OF THE INITIAL COMPLEX PERMEABILITY OF CIRCULAR CONDUCTORS AT HIGH FREQUENCIES
Benoit, J. and Naschke, E.
***le Journal de physique et le Radium*, v. 17, no. 1, pp. 77–78, January 1956 (in French)**

The formula for the impedance of a circular conductor is given. A graphical method, based on this, is described for calculating permeability rapidly.

527. EFFECTS OF PROCESSING ON MAGNETIC ALLOYS
Trapp, R. H.
***Electrical Manufacturing*, v. 57, no. 1, pp. 110–113, January 1956**

Physical and magnetic properties determined by close control of variables during all processing steps; pilot plant development allows rapid conversion of test tube products to feasible commercial materials. (*EI*, 1956)

528. THE MEASUREMENT OF SMALL FORCES BY MEANS OF A MOVING COIL METER WITH AN APPLICATION TO MAGNETIC SUSCEPTIBILITY MEASUREMENTS
Poulis, J. A., Poldervaart, L. J. and Teunissen, P.
***Applied Scientific Research*, Section B, v. 6, no. 1–2, pp. 124–128, 1956**

A method is described for the measurements of small forces (10^{-5}–10^{-3} Newton) on a sample weighing a few grams. This sample is placed on a bar which is fixed on the turning coil of an ordinary switchboard current meter. The force on the sample can be compensated by the Lorentz force on the current through the coil. This method avoids a great many of the usual constructional difficulties of such apparatus and leads to a robust instrument which is easy to handle and to automatize, thus being of interest for use outside the laboratory. This possibility in particular led to the choice of a magnetic susceptibility balance as an example. For magnets of field strength up to 20,000 oersted the precision obtained for the measured susceptibility amounts to one tenth of a percent. (*PA*, 1957, #1433)

529. ELECTRONIC APPARATUS FOR THE MEASUREMENT OF MAGNETIC SUSCEPTIBILITIES
Joussot-Dubien, J., Lemanceau, B. and Picault, A.
***Journal of Chemical Physics*, v. 53, no. 2, pp. 198–205, February 1956 (in French)**

A simple, compact electronic arrangement for magnetic susceptibility determination is described. Diamagnetic susceptibility measurements on a number of organic substances give values in close agreement with those determined by the classical method using a high constant magnetic field. (*PA*, 1956, #3839)

530. PHYSICS OF MAGNETIC MATERIALS
Bozorth, R. M.
***Electrical Engineering*, v. 75, no. 2, pp. 134–150, February 1956**

Explanations of many phenomena of magnetic materials shows number of practical engineering developments; atomic structure and interaction; ferrites; h-f phenomena; domains and permanent magnets; iron silicon alloys; iron nickel alloys. (*EI*, 1956)

531. AN IMPROVEMENT IN THE METHOD OF TRACING HYSTERESIS LOOPS WITH AN ILIOVICI PERMEAMETER
Dehors, R. and Garde, L.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 6, pp. 751–753, February 6, 1956 (in French)**

With the standard Iliovici permeameter arrangement it is difficult to obtain many points in the second and fourth quadrants of the B–H diagram since, for these portions of the B–H loop, the magnetizing and compensating currents need to be in opposition. An improved commutator to enable compensation to be maintained in these regions is suggested. (*PA*, 1956, # 3841)

532. RE-ENTRANT CAVITY FOR MEASUREMENT OF COMPLEX PERMEABILITY IN VERY-HIGH-FREQUENCY REGION
Harrington, R. D., Powell, R. C. and Haas, P. H.
***Journal of Research of the National Bureau of Standards*, v. 56, no. 3, pp. 129–134, March 1956**

Development of re-entrant resonant cavity for measurement of initial complex permeability of toroids in frequency range of 60 to 180 Mc; measurement methods and calibration techniques used in determination of permeability with this instrument. (*EI*, 1956)

533. NEW METHOD OF MEASURING SUSCEPTIBILITY OF PARAMAGNETIC AND DIAMAGNETIC SUBSTANCES
Vilim, F.
***Engineer's Digest*, v. 17, no. 4, pp. 141–142, April 1956**

Advantages and disadvantages of Curie-Cheneveau and Terry torsion balances; to eliminate disadvantages of these instruments, compensation of deviation of specimen caused by magnetic field has been carried out electrostatically; advantages of instrument with electrostatic compensation demonstrated. (*EI*, 1956)

534. METHODS OF DETERMINING THE CONSTANT S_v OF THE IRREVERSIBLE MAGNETIC AFTER-EFFECT
Yamada, O. and Hahlbohm, H. D.
***Zeitschrift für Angewandte Mathematik und Physik*, v. 8, no. 4, pp. 205–208, 1956 (in German)**

After reviewing various methods it is suggested that the most reliable results are obtained by measuring the apparent total and reversible differential susceptibilities of a specimen with known demagnetizing factor, as well as the magnetization change in a given time interval. (*PA*, 1956, #4502)

535. TRANSLATIONAL MOTION OF A SPHERE IN A MAGNETIC FIELD
Rosenstock, H. B. and Chubb, T. A.
***The American Journal of Physics*, v. 24, no. 5, p. 413, May 1956 (*PA*, 1956, #5255)**

536. THE MEASUREMENT OF THE MAGNETIC CHARACTERISTICS OF ROCKS (UNIVERSAL TORSION MAGNETOMETER METHOD)
Kalashnikov, A. G.
***Doklady Academii Nauk*, SSSR, v. 110, no. 5, pp. 776–779, 1956 (in Russian)**

A cubical specimen of the rock is placed on one arm of a torsion balance. Two pairs of coils with their planes vertical and parallel to the balance arm, are set up on opposite sides of the specimen. Current supplies to the two pairs of coils are independent of one another, one pair is arranged as a Helmholtz uniform field arrangement and the other pair is used to provide a linearly variable field. The apparatus allows the magnetic susceptibility, residual magnetization and coercive force of the specimen to be determined for fields ranging from 0.5 to 5 oersteds. The theory of the instrument is given. (*PA*, 1957, #4530)

537. DEVELOPMENT OF A VIBRATING-COIL MAGNETOMETER
Smith, D. O.
***Review of Scientific Instruments*, v. 27, no. 5, pp. 261–268, May 1956**

The vibrating-coil magnetometer measures the magnetization of a small sample of magnetic material placed in an external magnetizing field by converting the dipole field of the sample into an a c electrical signal. To allow space for temperature- or pressure-generating apparatus around the sample, the measurement is made at distances up to 2 cm from the sample. The measurement is continuous and can be recorded on a chart as a function of time, temperature, crystollographic orientation, or magnetizing field. The present stable sensitivity is such as to provide one per cent accuracy for a dipole moment of 8.56×10^{-4} amp-m^2 (the saturation moment at room temperature of a nickel sphere 1.5 mm in diameter). (*PA*, 1956, #7510)

538. BALANCE FOR MEASUREMENT OF MAGNETIZATION FROM 1.4°K TO ROOM TEMPERATURE
Conte, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 21, pp. 2528–2531, May 23, 1956 (in French)**

A pendulum type of magnetic balance is described for measuring the magnetic moment of specimens in a field up to 17,000 *g*. The comparative accuracy claimed is 0.1%. (*PA*, 1956, #7509)

539. FERROMAGNETIC RESONANCE IN METAL CRYSTALS
Artman, J. O.
Harvard University, Laboratory of Applied Physics, Mass.
Report SR-3, June 11, 1956

540. AN INSTRUMENT FOR THE AUTOMATIC RECORDING OF HYSTERESIS LOOPS
Gall, D. C. and Watson, J. D.
***Journal of Scientific Instruments*, v. 33, no. 7, pp. 265–268, July 1956**

The cycle of magnetization is carried out in about fifteen minutes. The induction of the specimen is measured by electro-mechanical integration of the induced electromotive force in a search coil, by a miniature electric motor having accurate proportionality between speed of rotation and applied voltage. The apparatus so far has been applied only to ring specimens in which the value of magnetizing force is directly dependent on the magnetizing current. The magnetizing force, in the case of the ring specimens used, is measured in terms of the voltage drop across a shunt carrying the magnetizing current. Novel features of the design are the method of integrating the search coil voltage, and the incorporation of automatic control of the magnetizing current, with the object of maintaining the search coil electromotive force within the range of the integrator motor at all times. (*PA*, 1956, #6763)

541. FERROMAGNETIC RESONANCE IN METAL SINGLE CRYSTALS
Artman, J. O.
Harvard University, Gordon McKay Laboratory, Mass., July 1956
(*The Physical Review*, v. 105, no. 1, pp. 74–84, January 1, 1957)

Microwave susceptibility expressions for ferromagnetic resonance have been derived for metal single crystals possessing crystalline anisotropy. Crystals of uniaxial and cubic magnetic symmetry are considered. Multidomain structures are considered. Comparisons are made with previous measurements and theories.

542. VIBRATING SAMPLE MAGNETOMETER
Foner, S.
***Review of Scientific Instruments*, v. 27, no. 7, p. 548, July 1956**

Describes a magnetometer based on the detection of the dipole field from an oscillating magnetic sample placed in a uniform magnetic field. Positioning of the detection coils is discussed and a null detector described. Measurements of the magnetic moment of a 1.2 mm diameter nickel sphere have been made to 0.5%. (*PA*, 1957, #1434)

543. NEW EXPERIMENTS ON THE MAGNETO-MECHANICAL PHENOMENON
Misek, K.
***Czechoslovak Journal of Physics*, v. 6, no. 4, pp. 330–340, August 1956**

A description is given of new experiments on magneto-mechanical effect, observed on torsionally oscillating specimens on a number of ferromagnetic materials and additional data are given for nickel. The question is discussed whether irreversible magnetic processes fundamentally influence the origin of the observed internal friction peak. (*PA*, 1957, #4557)

544. DEMAGNETIZATION OF MAGNETS DUE TO CONTACT WITH FERROMAGNETIC BODIES
McCaig, M.
***Journal of Scientific Instruments*, v. 33, no. 8, pp. 311–312, August 1956**

Circumstances in which permanent magnets are partially demagnetized by repeated contacts with ferromagnetic bodies investigated; if bar magnet is placed a few times on a block of mild steel and removed by sliding motion parallel to its length, loss of magnetization of order 40% may occur; over 3 mm thickness of protective material is necessary to keep losses below 1%. (*EI*, 1956)

545. INVESTIGATION OF ALTERNATING-CURRENT BRIDGE FOR MEASUREMENT OF CORE LOSSES IN FERROMAGNETIC MATERIALS AT HIGH FLUX DENSITIES
Cooter, I. L. and Harris, W. P.
***National Bureau of Standards Journal of Research*, v. 57, no. 2, pp. 103–112, August 1956**

Bridge methods have generally been restricted to measurements at low flux density; it is shown that accurate values can be obtained at higher flux densities if they are corrected by application of term derived from harmonic components of exciting current. (*EI*, 1956)

546. MAGNETIC MEASUREMENTS
Webb, C. E.
***Metallurgia*, v. 54, no. 322, pp. 57–66, August 1956**

Basic principles of ballistic, slowly varying flux, and alternating current methods for determining properties of ferromagnetic materials; testing of permanent magnets by standard and comparative methods; conditions necessary to ensure reliable test results; methods of measuring field strength; accuracy attainable in magnetic measurements. (*EI*, 1956)

547. MAGNETIC-SWITCH B-H LOOP TRACER
Geyger, W. A.
***Electronics*, v. 29, no. 10, pp. 167–169, October 1956**

Instrument traces dynamic hysteresis loops of magnetic materials at supply frequencies as high as 20,000 cps by means of silicon junction diode chopper circuits, synchronously operated from magnetic switch, which replace phase sensitive mechanical rectifiers; B-H loop tracer uses no electron tubes and can provide for either point to point loop tracing or automatic recording using x-y plotter; circuit diagrams. (*EI*, 1956)

548. THE MEASUREMENT OF MAGNETO-STRICTION BY MEANS OF STRAIN GAUGE
Takaki, H. and Tsuji, T.
***Journal of the Physical Society of Japan*, v. 11, no. 11, pp. 1153–1157, November 1956**

For the purpose of studying the relation of magnetostriction to technical magnetization, a strain gauge was used to measure the magnetostriction of long-rod single crystals of 3.2% Si-steel, and the results were compared with those obtained on the same samples by using a mechano-optical lever. The latter method was applied in measuring the overall elongation of a rod sample, while the strain gauge recorded the local magnetostriction. In some of the samples, these two methods often gave remarkable difference in the results. This is mainly due to the fact that the sample is not uniformly magnetized, especially in lower magnetic field; the magnetostriction measured by the optical lever method showed only the

mean change of length even if the magnetization is not uniform, while the result obtained by the strain gauge corresponds rather well to the local magnetization. The latter method is, therefore, more appropriate for relating the magnetostriction to the magnetization. The magnetostriction constants were determined and found to be slightly different from previous results. (*PA*, 1957, #4553)

549. SIMPLE 60-CPS HYSTERESIS LOOP TRACER FOR MAGNETIC MATERIALS OF HIGH OR LOW PERMEABILITY

Howling, D. H.

***Review of Scientific Instruments*, v. 27, no. 11, pp. 952–956, November 1956**

Instrument is simple but stable form of B-H meters described by D. E. Wiegan, W. W. Hanson, et al; by including differential form of balance control, all 60-cps voltage present in leads and pickup coils, prior to insertion of magnetic specimen into field coils, may be completely balanced out; sensitivity is sufficient to provide 1 in. peak-peak deflection on Dumont oscilloscope for 0.1 Maxwell flux change. (*EI*, 1957)

550. MICROINHOMOGENEITIES IN MAGNETIC FIELDS

Brown, H. H., Jr. and Bitter, F.

***Review of Scientific Instruments*, v. 27, no. 12, pp. 1009–1012, December 1956**

Small variations in the fields of magnets, caused by structures or domains in the pole faces, were investigated by moving a small coil in a circular path. It was found that for a given pole face the variations in the field were all about the same size, and decreased exponentially from the pole face. None of the materials tested as pole faces produced strikingly better fields than another. (*PA*, 1957, #4549)

551. OBSERVATION OF THE DOMAIN STRUCTURE OF A FERROMAGNETIC USING PHOTOELECTRONS

Spivak, G. V., Dombrovskaya, T. N. and Sedov, N. N.

***Doklady Academii Nauk*, SSSR, v. 113, no. 1, pp. 78–81, 1957 (in Russian)**

The apparatus consists of a glass model of the emission microscope with continuous evacuation. The source of photoelectrons in the microscope is a Sb–Cs cathode layer on the specimen of ferromagnetic being studied. Round the outside of the tube at this point is the coil of the cathode electron lens. Emission of photo-electrons is caused by directing the beam from an electric lamp on to the specimen. The direction in which the electrons move off is governed by the interaction of the cathode electron lens field and the microfields of the domain structure of the specimen. (*PA*, 1957, #7231)

552. EQUIPMENT FOR THE PRECISE MEASUREMENT OF THE COERCIVE FORCE IN THE RANGE 10^{-2}–10^{-3} OERSTED

Malek, Z.

***Czechoslovak Journal of Physics*, v. 7, no. 1, pp. 97–101, 1957 (in Russian)**

The coercive force can be determined with an accuracy of 0.9% on samples weighing more than 1 g. The magnetic field is designed to be homogeneous and is calibrated by the method of paramagnetic resonance of free radicals. Zero magnetization is measured by a rotating probe composed of two small coils connected in antiphase. (*PA*, 1959, #8276)

553. THE TEMPERATURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF ELEMENTS

Verkin, B. I.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 1, pp. 156–157, 1957 (in Russian)**

Normally substances are classified magnetically in terms of the sign of the experimentally measured susceptibility. A study of the variation of the susceptibility of elements with temperature in weak fields makes possible the division of the elements into four simple groups as follows: (a) elements with paramagnetism independent of temperature (e.g. alkali and alkali earth metals), (b) elements with paramagnetism dependent in temperature (e.g. rare earths and transition elements), (c) elements with diamagnetism increasing with fall of temperature (e.g. groups II, III, IV, V subgroups A), and (d) elements with diamagnetism independent of temperature (e.g. noble gases). The relation of these new groupings to the de Hass–van Alphen effect is discussed. (*PA*, 1957, #6344)

554. PERMEABILITY MEASUREMENTS IN THE CENTIMETRE WAVE REGION

Breitenhuber, L.

Acta Physica, v. 11, no. 1, pp. 88–100, 1957 (in German)

The measurement of complex permeability of ferromagnetic materials by tuning and damping experiments using cavity resonators or Lecher wires is described and its importance in studies of relaxation and resonance phenomena is discussed. The perturbation theory equations of Ledinegg show that the results of these measurements are subject to certain errors but a null method is described which can avoid them. The wavelength changes to be expected in the case of the electrical fundamental oscillation of a cylindrical cavity resonator with an inner conductor are calculated. (*PA*, 1957, #6343)

555. BALLISTISCHE MESSUNG DER SAETTIGUNGSMAGNETISIERUNG AN PROBEN UNBESTIMMTER FORM
von Klitzing, K. H.
Zeitschrift für Instrumentenkunde, v. 65, no. 1, pp. 4–6, January 1957

Ballistic measurement of magnetic saturation on samples of indefinite form; method and device for measuring saturation moment of ferromagnetic samples by drawing them out of air gap of permanent magnets. (*EI*, 1957)

556. STRUCTURES GRANULAIRES FERROMAGNETIQUES
Prache, P. M.
Dunod, Paris, 1957

557. SOLID-STATE RESEARCH
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
AF 19(122)-458, Group 35-QPR, February 1, 1957

Progress is reported on the following projects: semiconductor device design; chemistry; metallurgy of materials; band structure of solids; ferrite applications; and microwave and magnetic properties of matter.

558. AN IMPROVED INDUCTANCE METHOD FOR MEASURING SUSCEPTIBILITIES OF SMALL PARAMAGNETIC SPECIMENS AT LOW TEMPERATURES
McKim, F. R. and Wolf, W. P.
Journal of Scientific Instruments, v. 34, no. 2, pp. 64–67, February 1957

An apparatus is described with which the susceptibilities of small paramagnetic specimens can be determined at temperatures between 77 and 1.8°K. The measurements are made in terms of the change of mutual inductance produced by moving a specimen inside a coil system, using a Hartshorn bridge operating at 175 cps to measure the inductance. The chief advantage of this type of apparatus is its simplicity of operation, since it involves no delicate moving parts. The sensitivity and reproducibility of the apparatus were investigated using a specimen of manganous ammonium sulphate and it was found that susceptibilities of the order of 3×10^{-6} c.g.s units could be measured to an accuracy of 1%. Sources of error are discussed. (*PA*, 1957, #4522)

559. ON THE DETERMINATION OF THE TIME CONSTANTS OF MAGNETIC AFTER-EFFECT DUE TO DIFFUSION
Brissonneau, P.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 244, no. 9, pp. 1174–1177, February 25, 1957 (in French)

Gives some experimental results on the spectrum of diffusion time constants for comparison with calculated curves. (*PA*, 1957, #7227)

560. A SPECTROMETER FOR STUDYING PARAMAGNETIC AND FERROMAGNETIC RESONANCE IN THE 8700–9500 MHz BAND
Frait, Z.
Czechoslovak Journal of Physics, v. 7, no. 2, pp. 222–233, 1957 (in Russian with English summary)

561. PRINCIPLE FOR NULL DETERMINATION OF MAGNETIZATION AND ITS APPLICATION TO CRYOGENIC MEASUREMENTS
Arrott, A. and Goldman, J. E.
Review of Scientific Instruments, v. 28, no. 2, pp. 99–102, February 1957

A principle of measurement of magnetization is described which uses a sample in a uniform magnetic field such that the sample does not affect the uniformity of the field and the sample itself is uniformly magnetized. The measurement is absolute in that it requires only a measurement of a current and dimensions. The method uses a cylindrical specimen on which a small pitch fine wire coil is wound. The proper current through the coil

required to restore the uniformity of the field in all space gives a direct measurement of the magnetization. Uniformity of the field is detected by an induction technique. The method is suitable for most magnetic measurements but in the case of strongly ferromagnetic materials and superconductors requires currents in the coil that are too large. This principle has been incorporated in an apparatus for measurements of magnetizations from liquid helium temperatures to room temperature. (*PA*, 1957, #4521)

562. VERFAHREN ZUR BESTIMMUNG DER MAGNETISCHEN KRISTALLENERGIE
Mueller, H. G. and Muth, P.
***Hochschule für Verkehrswesen–Wissenshaftliche Zeitschrift*, Dresden, v. 5, no. 2, pp. 305-318, 1957**

Procedure for determination of magnetic crystal energy; determination of anisotropy constant from magnetization curves of ferromagnetic crystals; use of spin curves and oscillation tests; interpretation of crystal energy. (*EI*, 1957)

563. PERMANENT MAGNETS
Edwards, A.
***Electrical Energy*, v. 1, no. 5, 6, pp. 146–151, January 1957, pp. 178–185, February 1957**

Trend in employment of permanent magnets in place of electromagnets is discussed with reference to saving in size and weight achieved with modern permanent magnets; present day uses of permanent magnets; history of development of magnetic materials outlined and properties tabulated; iron-less magnets, ferrites and magnets composed of fine particles of pure iron. (*EI*, 1957)

564. STABILNOST IZMERITELNYKH PROBOROV S MAGNIKO I ALNIKO
Shramkov, E. G., Metkevich, A. V. and Kovalev, N. B.
***Elektrichestvo*, v. 77, no. 3, pp. 62–67, March 1957**

Stability of measuring instruments with Magnico and Alnico; report on tests for measuring flux variations of magnetic alloys subject to various kinds of heat treatment; two new instruments used for tests, one based on magnetic balance principle, other on astatic electrodynamic measuring system; application of method for investigation of other systems. (*EI*, 1957)

565. MAGNETIC PROPERTIES OF METALS
Van Vleck, J. H.
***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 857–886, 1957**

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959 #395)

566. MAGNETIC PROPERTIES OF SUPERCONDUCTORS
Gorter, C. J.
***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 1168–1176, 1957**

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #392)

567. HALL EFFECT IN FERROMAGNETICS
Smit, J.
***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 1177–1182, 1957**

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #1576)

568. CRITICAL SCATTERING OF NEUTRONS FROM FERROMAGNETS
Marshall, W.
***Il Nuovo Cimento*, Supplement, v. 6, no. 3, pp. 1183–1185, 1957**

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #408)

569. CALCULATION OF THE INDUCED MAGNETIC MOMENT OF A FERROMAGNETIC ELLIPSOID OF REVOLUTION IN AN ALTERNATING MAGNETIC FIELD.
Gelbukh, L. A.
***Zhurnal Tekhnicheskoi Fiziki*, v. 27, no. 3, pp. 548–559, 1957 (in Russian)**

An approximate method of calculating the induced magnetic moment is put forward for the case of a ferromagnetic ellipsoid of revolution in a homogeneous alternating magnetic field. Relations are obtained which completely determine the longitudinal and transverse components of the induced moment. For zero frequency of alternation and a long ellipsoid the results reduce to the case of a static field. (*PA*, 1957, #9274)

570. ON THE DETERMINATION OF MAGNETO-CRYSTALLINE ANISOTROPY CONSTANTS FROM TORQUE MEASUREMENTS

Kouvel, J. S. and Graham, C. D., Jr.

***Journal of Applied Physics*, v. 28, no. 3, pp. 340–343, March 1957**

According to simple theory, torque measurements on cubic single single-crystal disks should give values for the crystal anisotropy constants, K_1 and K_2, that are independent of field above some minimum saturating field. Experiments on {100} and {110} disks of 3¼% silicon-iron show that this theory is inadequate. In a more refined theory it is assumed that the edges of the disk are not saturated even in high fields. The observed increase in the peak values of the torque with increasing field can be attributed to a very small variation of the net magnetization I as the disk is rotated in the field. This variation must be such that I is largest in the hard directions of magnetization and smallest in the easy directions. Direct observation of the domain patterns on a {100} disk appears to confirm these assumptions. For both {100} and {110} disks, K_1' (the effective value of K_1) varies as $1 - \sqrt{H}$ over the range of 1000 to 20,000 oersteds. The corresponding K_2' values for the {110} disk show a more complicated dependence on H. Values of K_1' found from torque peaks differ somewhat from those obtained from torque slopes; the difference between the smaller K_2' values is much more serious. The discrepancy is attributed to the particular way in which I varies with disk rotation. (*PA*, 1957, #6327)

571. LAS PROPIEDADES MAGNETICAS Y LA TEMPERATURA

de Andres Sanz, M. P.

***Institute del Hierro y del Acero*, v. 10, no. 51, pp. 80–96, January–March 1957**

Relation between magnetic properties and temperature; magnetic saturation in study of transformations in solids, ferromagnetic materials in particular, and in powder metallurgy. (*EI*, 1957)

572. THE FORCE OF AN ANISOTROPIC PARAMAGNETIC CRYSTAL IN AN INHOMOGENEOUS MAGNETIC FIELD

Wolf, W. P.

Harvard University, Gordon McKay Laboratory, Mass.

AF 19(604)-1084, SR-7, April 1, 1957

(ASTIA AD-117,056)

A simple expression is derived for the force exerted on an anisotropic paramagnetic crystal by a magnetic field having gradients in two perpendicular directions. It shows that there is in general no direct relation between the force of an isotropic and an anisotropic sample in the same field, so that care must be exercised in interpreting the results of susceptibility measurements on anisotropic crystals by the Faraday method.

573. DER EINFLUSS DER RINGKERNDIMENSIONEN AUF DIE MAGNETISCHEN EIGENSCHAFTEN VON BANDRINGKERNEN

Ackerman, F. W.

***Technischi Mitteilungen Krupp*, v. 15, no. 1, pp. 8–12, April 1957**

Influence of ring core dimensions on magnetic properties of band ring cores; theoretical and experimental study of influence on magnetic properties of relation *D*-radius of inside circle/radius of outside circle; effect of *D* on permeability and Watt losses; influence of *D* on magnetic properties of materials with rectangular magnetization loop. (*EI*, 1957)

574. SIMPLE INSTRUMENT FOR COMPARISON OF MAGNETIC PERMEABILITIES

Burgess, F. R.

***Metallurgia*, v. 55, no. 330, pp. 209–210, April 1957**

Instrument developed for determination of magnetic permeability of low permeability materials; tester is portable and can be applied to irregularly shaped pieces. (*EI*, 1957)

575. SOLID-STATE RESEARCH QUARTERLY PROGRESS REPORT (Period covered: January 1–March 31, 1957)

Massachusetts Institute of Technology

Lincoln Laboratory, Lexington

AF 19(122)-458, Group 35-OPR, May 1, 1957

Progress is reported on the following projects: semiconductor device design; chemistry connected with solid-

state physics; metallurgy of materials; band structure of solids; ferrite applications; and microwave and magnetic properties of matter.

576. THE DETERMINATION OF THE PERMEABILITY OF FERROMAGNETIC MATERIALS FROM THE THERMAL NOISE-VOLTAGE OF A COIL
Nonnenmacher, W. and Schweitzer, L.
Zeitschrift für angewandte Physik, v. 9, no. 5, pp. 239–245, May 1957 (in German)

The inductance and effective resistance of a coil containing a ferromagnetic specimen are deduced from the noise spectrum of a resonant circuit which includes the coil. The components of the complex permeability, at the low magnetizing fields corresponding to the thermal-noise currents in the coil, are calculated from the results, and show good agreement with values obtained by extrapolating to zero measuring field the results of bridge measurements on the same specimens. The noise spectrum method is also compared with the bridge method for different intensities of magnetization, with good agreement. (*PA*, 1958, #8917)

577. PREPARATION OF PERMANENT THREE-DIMENSIONAL VIEWS OF MAGNETIC FIELDS
Crump, L. R.
Journal of Applied Physics, v. 28, no. 5, pp. 530–531, May 1957

A method has been developed for obtaining a permanent three-dimensional view of the flux pattern of a magnetic field by suspending microscopic, magnetically-responsive particles in a transparent plastic solution, applying the magnetic force to form the particles into a definitive pattern of the field, and allowing the plastic to set. After the plastic solidifies, the specimen may be cut and polished for observation and later study or reference. A variation of this technique provides for the preparation of views on transparent plates. The process lends itself readily to the study and resolution of problems in magnetics encountered in research and development. It also has possible applications in the fabrication of magnetic and electronic components. (*PA*, 1958, #3225)

578. THE CONNECTION BETWEEN THE COERCIVE FORCE AND THE INITIAL SUSCEPTIBILITY OF PLASTICALLY DEFORMED FERROMAGNETICS
Wotruba, K.
Czechoslovak Journal of Physics, v. 7, no. 5, pp. 568–576, 1957

Measurements on four ferromagnetic materials, plastically deformed in broad limits, show that between the coercive force and the inverse value of the initial susceptibility there exists a linear correlation. With two of the given materials this correlation can be explained on the basis of the Becker-Kersten theory of coercive force and initial permeability. The paper also describes the experimental equipment used and gives practical principles in the construction of the coercimeter and permeameter. It also gives a method of determining the influence of the skin-effect of the magnetic field on the results of measurement. (*PA*, 1959, #8296)

579. A DEVICE FOR STUDYING MAGNETIC ANISOTROPY
Timofeev, B. B.
Elektrichestvo, no. 5, pp. 72–74, 1957 (in Russian)

Based on an observaton previously made by the author, a vertical probe is applied to the surface of a large slab of material under investigation. By this means an alternating current is fed into the material. Attached to the vertical rod by a loose collar is a small coil in the form of a sector and containing a large number of turns. The connections to the coil are taken to an amplifier on the Y-plates of a c.r.o. The X-deflection has a voltage proportional to the current in the probe. It will be observed from the screen of the c.r.o. when the net excitation in the sector coil is zero. An appendix analyzes the situation and shows how the method defines the regions of different permeability and the lines along which the maxima and minima occur. To overcome the lack of uniformity of the surface an improved version is also described in which four sector coils, each covering 90 deg, are used. (*PA*, 1958, #3230)

580. CRITERION FOR FERROMAGNETISM FROM OBSERVATIONS OF MAGNETIC ISOTHERMS
Arrott, A.
The Physical Review, v. 108, no. 6, pp. 1394–1396, 1957

Criterion proposed for determining onset of ferromagnetism in material as its temperature drops from region in which linearity of its magnetic moment vs field isotherm indicates paramagnetism; redetermination of Curie point of nickel Fe_2O, and dilute alloys of iron in gold. (*EI*, 1958)

581. ON THE UTILIZATION OF MEASUREMENTS ON FERROMAGNETIC MINERALS
Gerlach, W. and Kranz, J.
***Annalen der Physik*, v. 20, no. 1–6, pp. 280–282, 1957 (in German)**

Describes a procedure for determining the specific magnetization and the concentration of ferromagnetic particles in a nonmagnetic matrix. (*PA*, 1959, #1583)

582. NEW METHOD OF OBSERVING MAGNETIC TRANSFORMATIONS
Blackman, M., Haigh, G. and Lisgarten, N. D.
***Nature*, v. 179, no. 4573, pp. 1288–1290, June 22, 1957**

Experiments are described whereby it is possible to demonstrate magnetic transformations visually on fluorescent screen of electron diffraction camera, and to photograph various stages in transformation; examples of data obtained by these means for hematite, magnetite, pyrrhotite crystals and other specimens. (*EI*, 1957)

583. SOLID-STATE RESEARCH QUARTERLY PROGRESS REPORT
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
AF 19(122)-458, Group 310-QPR, August 1, 1957

Progress is reported on research in the following fields: semiconductor device design; chemistry; metallurgy of materials; band structure of solids; microwave and ferrite applications; and microwave and magnetic properties of matter.

584. A NEW COLLOID FOR USE WITH THE BITTER FIGURE TECHNIQUE
Craik, D. J. and Griffiths, P. M.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 10, pp. 1000-1001, October 1957**

A recipe is given for a colloid which does not stain the metal surface and can thus be used for long periods of observation. (*PA*, 1958, #1770)

585. PROGRESS REPORT XXII
Massachusetts Institute of Technology, Insulation Research Laboratory, Lexington
AT (30-1)-1937, AF 30(635)-2872, Nonr-1841(10), PR-XXII, December 1957

The section headings of this report are: Dielectric Spectroscopy; Excitation, Conduction, and Breakdown; Ferroelectrics and Ferromagnetics; Single Crystals; and Ceramics. The research studies are diversified, although they all reflect a general interest in the electric and magnetic properties of matter.

586. MAGNETIC ANALYSIS OF ALLOYS BY ELECTRON DIFFRACTION
Yamaguchi, S.
***Journal of Chemical Physics*, v. 27, no. 6, pp. 1310–1311, December 1957**

Electron diffraction patterns obtained from ferromagnetic substances (Cu–Ni and stainless steel) are influenced by the magnetic fields of the substances. The results obtained are of use for magnetochemical analysis of ferromagnetic alloys. (*PA*, 1958, #6038)

587. NEW TECHNIQUE FOR MEASURING ROTATIONAL HYSTERESIS IN FERROMAGNETIC MATERIALS
Kelly, J. M., Jr.
***Review of Scientific Instruments*, v. 28, no. 12, pp. 1038–1040, December 1957**

A new experimental technique for measuring rotational hysteresis losses over the frequency range from 3 to 30 cps is described. A sample disk of ferromagnetic material is mounted on a top. The top is caused to spin about a vertical axis normal to the plane of the disk and of the magnetic field provided by an electromagnet. After removal of the driving force, the top dissipates its stored energy in losses in the sample and in bearing and windage losses. The bearing and windage losses are obtained also by performing the experiment in a magnetic field-free region. The rate of change of rotational energy of the top is determined by measuring the angular velocity of the top as a function of time. (*PA*, 1958, #8137)

588. PROGRESS ACHIEVED WITH MAGNETIC MATERIALS AND THEIR APPLICATION
Pawlek, F. and Reichel, K.
***A.E.G. Progress*, v. 4, pp. 149–161, 1957**

Paper is essentially supplement to F. Pawlek's book "Magnetische Werkstoffe," and covers developments in magnetic materials since appearance of book in 1950, with particular attention to theory, research, and manufacture of semiconducting ceramic oxide materials (ferrites and oxide permanent magnets). (*EI*, 1957)

589. DIAMAGNETISM AND PARAMAGNETISM
Foex, G.
PARAMAGNETIC RELAXATION
Gorter, C. J. and Smits, L. J.
Paris: Masson et Cie, 317 pp., 1957

Complete compilation up to 1956 of magnetic susceptibilities, Curie temperatures, atomic moments, etc. for elements, alloys, inorganic and organic compounds, mixtures, free radicals etc, expressed in tabular form with references. Also a brief section on paramagnetic relaxation results up to 1950 is included. (*PA*, 1958, #2410)

590. METHOD FOR MEASURING SATURATION MAGNETIZATION IN RING SAMPLES
Graham, C. D., Jr.
***Journal of Applied Physics*, v. 29, no. 1, pp. 68–70, January 1958**

This method permits the measurement of saturation and of low field magnetic properties in the same sample, and consists of saturating the sample in a strong field directed perpendicular to the plane of the ring, changing the direction of the magnetization slightly with a circumferential field, and measuring the resultant flux change in the ring. The procedure also gives an accurate value for the cross-section area of the secondary winding on the specimen. (*PA*, 1958, #8923)

591. A MICROWAVE ELECTRON SPIN RESONANCE SPECTROMETER
Palma-Vittorelli, M. B. and Palma, M. U.
***Il Nuovo Cimento*, Supplement, v. 7, no. 1, pp. 139–154, 1958**

A sensitive microwave electron spin resonance spectrometer is described which gives, at room temperature, a signal-to-noise ratio of 4/1 with about 10^{13} ΔH magnetic centres (where ΔH is the line width). The magnetic field homogeneity is 3×10^{-4}% over the sample volume and 10^{-2}% over the whole cavity; it is stabilized to 2×10^{-4}% short-term, and 5×10^{-3}% long-term. The klystron frequency is stabilized to 10^{-4}%. A detailed description of the circuits and experimental arrangement is given. (*PA*, 1958, #6052)

592. THE USE OF ELECTRON DIFFRACTION FOR MAGNETIC ANALYSIS
Yamaguchi, S.
***Naturwissenschaften*, v. 45, no. 1, pp. 7–8, 1958 (in German)**

The passage of an electron beam through a magnetized body causes a deflection of the electron beam, and, hence, of the electron diffraction pattern compared with that from gold. This effect can be exploited in the study of ferromagnetic materials in electron diffraction instruments. (*PA*, 1958, #8477)

593. UNTERSUCHUNG FERROMAGNETISCHER SUBSTANZEN DURCH ELEKTRONEN-BEUGUNG
Yamaguchi, S.
***Zeitschrift für Metallkunde*, v. 49, no. 1, pp. 52–54, January 1958**

Investigation of ferromagnetic materials by electron diffraction; it is shown that ferromagnetic materials may be analyzed crystallographically as well as magneto-chemically by means of electron diffraction; electron beam is polarized when penetrating ferromagnetic body; this phenomenon may be used for investigation of magnetic materials. (*EI*, 1958)

594. B-H TESTER MEASURES MEMORY CORE PARAMETERS
Bonn, T. H., Torrey, R. D. and Bernstein, F.
***Electronics*, v. 31, no. 3, pp. 76–80, January 17, 1958**

Test instrument measures hysteresis properties of small magnetic toroids used in coincident current memories and high-speed magnetic amplifiers; flux, drive current, remanent flux to maximum flux ratio, squareness ratio and ratio of coercive force to maximum magnetizing force are read directly from window potentiometers as B-H loop is presented on crt; accuracy of tester is within 1% on magnetic parameters of core whose saturation flux is 1 maxwell; schematic diagrams. (*EI*, 1958)

595. A MAGNETIC GAUGE UTILIZING THE MAGNETRON EFFECT
Fulop, W.
Journal of Scientific Instruments, v. 35, no. 2, pp. 52–55, February 1958

The cut off region of a magnetron diode is shown to be an accurate, though relative, measure of the magnetic field. This magnetron effect is utilized to calibrate a subminiature diode to serve as a fluxmeter. Only simple ancillary apparatus is required and accuracies greater than 1% are easily attainable. Conditions which such a fluxmeter has to fulfill for satisfactory operation are stated, and experiments prove these to be met. (*PA*, 1958, #3226)

596. REMARKS ON THE MEASUREMENT OF THE HALL EFFECT IN FERROMAGNETICS
Koch, K. M., Rindner, W. and Strnat, K.
Zeitschrift für Naturforschung, v. 13a, no. 2, pp. 113–116, February 1958 (in German)

It is pointed out that, if the magnetic field is misaligned in a Hall effect test, the magnetization vector within the specimens will deviate far more from the nominal direction (normal to the plane of the specimen) than the external field does. This can cause appreciable errors in the Hall voltage. The calculation is confirmed by experiments on nickel and on an iron alloy. (*PA*, 1959, #447)

597. ELEKTRONISCHE MESSRECHNER ZUR AUTOMATISIERUNG UND RATIONALISIERUNG FERROMAGNETISCHER MESSUNGEN
Frings, W.
Zeitschrift für Instrumentenkunde, v. 66, no. 2, pp. 19–25, February 1958

Electronic circuits for automation and rationalization of ferromagnetic measurements; description of circuits for measurements of core losses, a-c permeability, coercive force, and remanence of ferromagnetic materials; applications. (*EI*, 1958)

598. METHOD OF MEASURING MAGNETOSTRICTION CORRECTED FOR INITIAL DOMAIN DISTRIBUTION AND ITS APPLICATION TO NICKEL AND IRON
Stauss, H. E.
Journal of Applied Physics, v. 29, no. 2, pp. 182–184, February 1958

A method has been developed for the measurement of magnetostrictive strain that overcomes the effect of initial domain distribution in isotropic materials. A cubic specimen is used, placed between two iron rods of the same cross section. The combination is put along the common axis of two like solenoids connected in series. Strain is measured with a resistance strain gauge, once parallel to the magnetic field, and a second time normal to the field after the specimen has been rotated 90 deg. At saturation the algebraic difference gives 3/2 of the saturation magnetostriction. Use of the difference eliminates or reduces a number of experimental errors in addition to that arising from nonrandomness of initial domain distribution. The method has been applied to grade A nickel and Armco iron.

599. MAGNETIC ANALYSIS WITH ELECTRON BEAMS
Yamaguchi, S.
Zeitschrift für Angewandte Physik, v. 10, no. 3, pp. 138–140, March 1958 (in German)

Magnetized ferromagnetic substances cause a deflection of the electron beam in an electron diffraction camera and hence a displacement of the diffraction pattern. By measuring this displacement the remanence and other magnetic properties of a specimen may be determined. (*PA*, 1959, #5882)

600. RESONANT MODES OF FERROMAGNETIC SPHEROIDS
Walker, L. R.
Journal of Applied Physics, v. 29, no. 3, pp. 318–323, March 1958

The spectrum of modes of oscillation of a ferromagnetic spheroid situated in a uniform dc magnetic field is discussed. It is shown that, for the size of sample usually used in microwave experiments, a part of the spectrum consists of magnetostatic modes for which exchange and propagation may be ignored. The behavior of these modes is discussed at some length and it is shown that the analysis gives a satisfactory description of the observed absorption curves. (*PA*, 1958, #8863)

601. MAGNETOMETALLURGY—APPLICATIONS AND TECHNIQUES
Arrott, A.
Journal of Applied Physics, v. 29, no. 3, pp. 508–512, March 1958

The use of measurements of intrinsic magnetic properties—susceptibility, saturation magnetization, and transition temperature—in solving problems in metallurgy is discussed. Applications to phase-diagram determinations, precipitation studies, kinetics, detection of inhomogeneities, and quantitative analysis are considered. (*PA*, 1958, #9198)

602. PYROMAGNETIC EFFECT: METHOD FOR DETERMINING CURIE POINTS
Chynoweth, A. G.
Journal of Applied Physics, v. 29, no. 3, pp. 563–565, March 1958

Examples of gadolinium iron garnet to show how study of pyromagnetic effect yields information about state of magnetization of crystal in nondestructive way and without externally applied magnetic fields; use of method for locating Curie points for slow switching studies and in study of behavior of magnetic coefficient at low temperatures. (*EI*, 1958)

603. CALCULATION OF THE ENERGY LOSS IN MAGNETIC SHEET MATERIALS USING A DOMAIN MODEL
Pry R. H. and Bean C. P.
Journal of Applied Physics, v. 29, no. 3, pp. 532–533, March 1958

The energy loss resulting from eddy currents is calculated for magnetic sheet materials with a simple domain configuration. The domain model used is considered to be applicable for any induction up to saturation and for the frequency range up to that used in most electrical power applications. The eddy current losses have been calculated explicitly for the case of sinusoidal induction excitation, and expressed in terms of the ratio of domain wall spacing to sheet thickness. The results are in a form more suitable for quantitative comparison with measured values on materials, such as grain oriented silicon iron, than have been available.

604. FERROMAGNETIC RESONANCE IN UNIAXIAL POLYCRYSTALLINE MATERIALS
Morrison, C. A. and Karayianis, N.
Journal of Applied Physics v. 29, no. 3, pp. 339–340, March 1958

A theoretical determination is made of the resonance curve of a nonconducting polycrystalline ferromagnetic material with uniaxial crystalline anisotropy. A finite intrinsic line width is assumed for the single crystal, and effects of grain boundaries, impurities, inhomogeneities, and volume and surface divergence of the magnetization are ignored. The results are compared qualitatively with experiment.

605. APPLYING HALL EFFECT TO PRACTICAL TESTING
Henning, G. R.
Electrical Manufacturing, v. 61, no. 4, pp. 132–136, April 1958

Use of small indium-arsenide probes with low temperature coefficient that generate Hall voltages linear within plus or minus 1% in magnetic fields up to 10,000 oersted for simplified precision magnetic measurements, such as of airgap flux densities, flux distribution patterns, long axial fields, and coercivity; detection of magnet inhomogeneities, demagnetization and hysteresis curves; magnet assembly calibration. (*EI*, 1958)

606. AN ELECTRODELESS METHOD FOR THE MEASUREMENT OF ELECTROLYTIC CONDUCTIVITY AND MAGNETIC SUSCEPTIBILITY
Myers, W. R.
Journal of Scientific Instruments, v. 35, no. 5, pp. 173–175, May 1958

Simultaneous measurement of electrolytic conductivity and magnetic susceptibility is achieved by observing the changes in output voltage of a transformer when its air core is filled with a specimen. Conductivity measurements for strong electrolytes were obtained in which departures from accepted values are less than 0.07 mho m^{-1} in the range from 1 to 30 mho m^{-1}. The magnetic measurements generally have less precision, and errors of 2% occur for susceptibilities of the order of 10^{-11} H/m. (*PA*, 1958, #3541)

607. QUARTZ HELIX MAGNETIC SUSCEPTIBILITY BALANCE USING THE CURIE–CHENEVEAU PRINCIPLE
Senftle, F. E., Lee, M. D., Monkewicz, A. A., Mayo, J. W. and Pankey, T.
***Review of Scientific Instruments*, v. 29, no. 5, pp. 129–132, May 1958**

A quartz spring-balance is described which can be used to measure the magnetic susceptibility of submilligram amounts of sample. The magnetic field is supplied by a moving permanent magnet, and the susceptibility is determined by the deflection of the spring which is observed in a measuring microscope. The apparatus is calibrated by a comparison standard (platinum) and results are shown for platinum, nickel aluminate, lead, manganese and sucrose. A precision of better than 2% can be obtained on submilligram amounts of paramagnetic substances having a magnetic susceptibility of from 1 to 50×10^{-6} emu./g. On weakly paramagnetic or diamagnetic substances comparable precision can be obtained on less than 10 mg amounts of sample. (*PA*, 1958, #6025)

608. IMPROVED BRIDGE METHOD FOR MEASUREMENT OF CORE LOSSES IN FERROMAGNETIC MATERIALS AT HIGH FLUX DENSITIES
Harris, W. P. and Cooter, I. L.
***Journal of Research of the National Bureau of Standards*, v. 60, no. 5, pp. 509–516, May 1958**

Accurate measurements made by bridge methods when power dissipated in primary circuit at harmonic frequencies is measured and subtracted from apparent power dissipated in ferromagnetic material at fundamental frequency; amplifier having negative output resistance was devised, allowing accurate compensation for harmonic power dissipation. (*EI*, 1958)

609. RADIATION EFFECTS IN MAGNETIC MATERIALS
Gordon, D. I., Sery, R. S., and Fischell, R. E.
***Nucleonics*, v. 16, no. 6, pp. 73–77, June 1958**

Seven different toroidal cores wound using radiation resistant insulators were exposed to an integrated fast flux of 10^{17}n/cm^3. Magnetic properties measured during irradiation included permeability, coercive force and magnetization curves at 60 and 400 cps. Measurements of loss factor and magnetostriction were made before and after irradiation. The effects observed are due to changes in the degree of ordering in the samples. The largest changes were shown by 5–79 molybdenum permalloy, and its use as a fast neutron dosimeter is suggested. (*PA*, 1958, #8115)

610. NEW TECHNIQUES FOR THE STUDY OF BITTER FIGURES
Craik, D. J. and Griffiths, P. M.
***British Journal of Applied Physics*, v. 9, no. 7, pp. 276, 277; 279–282, July 1958**

Techniques employing optical and electron microscopy are described. In the case of the optical microscope an improved resolution and clarity is achieved. The method for the electron microscope is a modification of that previously published. Examples of the use of the methods are given. (*PA*, 1958, #6035)

611. THE USE OF THE KERR EFFECT FOR STUDYING THE MAGNETIZATION OF A REFLECTING SURFACE
Lee, E. W., Callaby, D. R., and Lynch, A. C.
***Proceedings of the Physical Society*, London, v. 72, Part 2, pp. 233–243, August 1958**

If a moving domain wall crosses a small illuminated area, the reflection coefficient may change and the plane of polarization of the reflected light may be rotated. If the wall moves in an alternating field, the change can be detected by collecting the light on a photomultiplier cell and amplifying the alternating component of its output signal. Using a specimen of a magnetically annealed Perminvar-type alloy, the variation of the output signal and of the signal-to-noise ratio with the angle of polarization was shown to agree closely with that predicted by theory, both for longitudinal and transverse magnetizations. It is unnecessary to use both a polarizer and an analyzer; indeed, an effect is observable with neither. (*PA*, 1958, #8141)

612. NON-MAGNETIC IONS IN AN ANTIFERROMAGNETIC
Niessen, K. F.
***Philips Research Reports*, v. 13, no. 4, pp. 327–334, August 1958**

An experimental method is described for determining the distribution of a relatively small number of foreign non-magnetic ions between the two sublattices of an antiferromagnetic, in which they replace the same number of original magnetic ions. The influence of the foreign ions on several measurable quantities is investigated. This influence can be used to determine some specific constants of the antiferromagnetic. In the anisotropy energy, besides the usual terms, an interaction term between the two sublattices is taken into account. Use is made of the spontaneous magnetization, the parallel and perpendicular susceptibilities, the critical field strength and the antiferromagnetic resonance. (*PA*, 1959, #442)

613. MEASUREMENT OF MAGNETIZATION CURVES IN HIGH PULSED MAGNETIC FIELDS

Jacobs, I. S. and Lawrence, P. E.
***Review of Scientific Instruments*, v. 29, no. 8, pp. 713–714, August 1958**

Extension of techniques enabling direct measurement of magnetization curves. M vs. H, in high-pulsed magnetic field (H larger than about 100 koe); magnetization M of about 30 emu or volume susceptibility of about 5×10^{-4} can be detected with reasonable but not high accuracy; method is suited to nonlinear magnetization curves, and useful in studying metamagnetics and weak antiferromagnetics. (*EI*, 1958)

614. CUBE ORIENTED MAGNETIC SHEET MAJOR ADVANCE IN MAGNETIC MATERIALS

Wiener, G. W. and Detert, K.
***Journal of Metals*, v. 10, no. 8, pp. 507–508, August 1958**

Nature and uses of new material developed by Westinghouse; random, singly oriented, and cube oriented magnetic materials compared; advantages of cube oriented materials with regard to transformer performance. (*EI*, 1958)

615. MATERIALS USED IN RADIO AND ELECTRONIC ENGINEERING

***Journal of the British Institute of Radio Engineers*, v. 18, no. 8, pp. 449–464, August 1958**

Summary of magnetic materials currently available in Great Britain; extensive tables give magnetic properties, composition, applications, etc. for cast and sintered high grade magnets, rolled, forged and micropowder low grade magnets, moderate permeability soft magnetic materials, high permeability sheet materials, bonded, sintered and compressed iron powder materials, and magnetically soft ferrites. (*EI*, 1958)

616. A PERMEAMETER CONTROLLER FOR MAGNETIC MEASUREMENTS

Swan, M. J.
***Journal of Scientific Instruments*, v. 35, no. 9, pp. 344–346, September 1958**

Determinations of the magnetic properties of materials by the ballistic method often involves complicated switching of the magnetizing currents. A semi-automatic controller was built which carries out the switching operations and ensures that the material is maintained in a cyclic magnetic state. The N.P.L. permeameter is also briefly described. (*PA*, 1958, #7192)

617. A NEW METHOD OF MEASURING SUSCEPTIBILITY

Hilsum, C. and Rose-Innes, A. C.
***Nature*, v. 182, p. 1082, October 18, 1958**

A magnetic circuit analogous to a Wheatstone bridge was constructed, using four air gaps as the main reluctances, a permanent magnet as the source of magnetomotive force and an indium antimonide Hall-effect unit as the flux detector. Since a field of 1500 oersted is obtained in each gap and the Hall-effect unit can detect fields smaller than 10^{-4} oersted, a detectable change in the balance occurs if a sample with a susceptibility greater than 10^{-6} c.g.s. units is introduced into any air gap. The electronics are transistorized and the whole equipment is portable. (*PA*, 1959, #2480)

618. DETERMINATION OF THE MAGNETIC ANISOTROPY OF SINGLE CRYSTALS FROM MAGNETIC TORQUES MEASURED WITH QUARTZ FIBERS

Gordon, D. A.
***Review of Scientific Instruments*, v. 29, no. 11, pp. 929–934, November 1958**

The method of investigating the magnetic anisotropy

of single crystals by observing the torque exerted on a crystal by a homogeneous magnetic field was found to be subject to several sources of error which were of particular importance when small differences of susceptibility were involved. Several changes in design of the equipment and in the experimental procedure were introduced, resulting in a great improvement in the reproducibility of the measurements; these changes included the introduction of effective draft shielding, the use of high magnetic fields to saturate ferromagnetic impurities, and the use of graphical method of data analysis. The method of determining the torsion constants of thin quartz fibres from the period of oscillation of a torsion pendulum was also investigated; for accurate values it is necessary that the oscillating pendulum be under high vacuum and shielded from static electricity. A slight decrease in the torsion constants of quartz fibres left under tension for long periods of time was observed. A systematic method of mounting and orienting the crystal specimens was also devised. (*PA*, 1959, #3636)

619. MAGNETIC PROPERTIES OF METALS AND ALLOYS

***American Society for Metals*, Cleveland, Ohio, 1959**

620. ACCURATE MAGNETIC FIELD AND FIELD GRADIENT MEASURING INSTRUMENT FOR DYNAMIC LOW FIELDS IN A SYNCHROTRON MAGNET

Nysiter, H. M.

***Nuclear Instruments*, v. 4, no. 1, pp. 44–49, January 1959**

Two biased peaking strips are combined into a differential magnetic probe. The pulses from the two peaking strips are displayed on an oscilloscope screen with a time separation, for the same bias field, given by the field difference between the locations of the two strips. At the bias current corresponding to the chosen field level, the two peaking strips are given slightly different bias, so as to cancel the time lag between pulses. The field difference is read directly as a d.c. current. The magnetic field itself is measured with one of the peaking strips, as its d.c. bias current. With careful calibration, the accuracy in gradient divided by field (n-value) was estimated to be of the order of 1% in a nearly linear synchrotron field of 25 g, varying by 4% per cm and 0.15 $g/\mu s$. The instrument, when applied to the Cambridge (Mass.) electron accelerator magnets, confirmed the feasibility of an injection field as low as 25 g, although at the magnet ends sharp peaks occur in the field and gradient distributions, apparently a remanent field contribution. (*PA*, 1959, #7146)

621. MAGNETIC PERMEABILITY FOR MAGNETIZATION BY A ROTATING ALTERNATING FIELD IN THE PRESENCE OF A LONGITUDINAL DIRECT FIELD

Tutovan, V.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 248, no. 7, pp. 940–943, February 16, 1959 (in French)**

The permeability, defined as the ratio of induction to alternating field strength H_a, was measured for a wire specimen as a function of H_a, the strength of the direct field and the applied stress. (*PA*, 1959, #7159)

622. METHOD OF MEASURING THE DISTRIBUTION OF THE EASY AXES OF UNIAXIAL FERROMAGNETICS

Frei, E. H., Shirikman, S. and Treves, D.

***Journal of Applied Physics*, v. 30, no. 3, p. 443, March 1959**

In connection with the interpretation of the experimental behavior of aligned assemblies of uniaxial ferromagnetic particles it is important to know the spatial distribution of their axes. It is the purpose of this letter to present a new simple method of measuring this distribution for an assembly of uniaxial single-domain particles (not necessarily identical) for which interparticle interaction can be neglected. It is further assumed that the distribution has rotational symmetry. This assumption follows from the routine generally used to align particles.

623. HARD MAGNETIC MATERIALS

Wohlfarth, E. P.

***Advance in Physics*, v. 8, pp. 87–224, April 1959**

A comprehensive review of the following topics: theoretical considerations, particularly fine particle theory; metallic powder materials; iron oxide and related powder materials; magnetically hard ferrites; ferromagnetism and superparamagnetism of dilute alloys; Alnico-type permanent magnet alloys; other permanent magnet alloys. (*PA*, 1959, #8284)

624. DEMONSTRATION OF MAGNETIC DOMAINS
Dillon, J. F., Jr. and Earl, H. E.
American Journal of Physics, v. 27, no. 4, pp. 201–208, April 1959

The advent of transparent ferrimagnetic materials has made possible the direct observation of magnetic domains with a polarizing microscope. A description is given of a simple self-contained polarizing microscope suitable for demonstrating the behaviour of domains. The procurement of crystals and the actual specimen preparation are discussed. With this demonstration one can observe many of the properties of magnetic domains; the influence of external fields, of changes in magnetization, and the influence of imperfections on domain structure, to name a few. The authors suggest that the use of such a demonstration microscope as an instructional aid should facilitate greatly the teaching of magnetism on a relatively fundamental plane. (*PA*, 1959, #4795)

625. EQUIPMENT FOR THE DETERMINATION OF MAGNETIC SUSCEPTIBILITIES
McMillan, J. A.
American Journal of Physics, v. 27, no. 5, pp. 352–354, May 1959

Equipment for the determination of magnetic susceptibilities by the Gouy method utilizing an electromagnet and a Westphal specific gravity balance is described. Using Mohr's salt as a standard, the paramagnetism of salts like pentahydrated copper sulphate can be determined within 4%. The diamagnetism of some substances, such as water, can also be measured to one significant figure. Experimental results are given. (*PA*, 1959, #7145)

626. A NULL-COIL MAGNETOMETER
Jongenburger, P. and Berghout, C. W.
Applied Scientific Research, Section B, v. 7, no. 5, pp. 366–378, 1959

A magnetometer has been developed in which the saturation-magnetization of small samples of ferromagnetic materials can be measured. The sample, which is situated at the centre of a small coil, is placed in an inhomogeneous magnetic field. The current through the coil is adjusted to such a value that the forces on coil and sample balance each other. Then under certain conditions the magnetic moment of the sample equals the magnetic moment of the coil; these conditions are discussed. The method is suitable for use in ordinary laboratory magnets and in solenoids, and also at low temperatures. With a second version of this magnetometer it is possible to measure para- and even diamagnetism. (*PA*, 1959, #8275)

627. FERRIMAGNETIC RESONANCE MODES IN SPHERES
Fletcher, P. C. and Bell, R. O.
Journal of Applied Physics, v. 30, no. 5, pp. 687–698, May 1959

The magnetostatic solutions of ferrimagnetic resonance in ferrite spheres are briefly derived. General and specific solutions are given for values of n up to five for the magnetostatic potentials, r.f. distributions of magnetization, and fields for resonance. Some experimental results are given and compared with the theory.

628. ELECTRON MIRROR MICROSCOPY OF MAGNETIC STRAY FIELDS ON GRAIN BOUNDARIES
Mayer, L.
Journal of Applied Physics, v. 30, no. 7, pp. 1101-1104, July 1959

Experimental evidence is presented that electron mirror microscopy is particularly well suited for direct visual observation of magnetic stray fields at grain boundaries in magnetic materials. Silicon–iron disks were used as specimens. By mounting these specimens on a special magnetic stage of axial symmetry, the appearance and the growth of magnetic stray fields with increasing external applied magnetic fields could be observed directly, and motion picture recordings were taken from the viewing screen of the microscope. A series of electron mirror micrographs shown demonstrates that grain boundaries behave quite differently stray field-wise. The fact that magnetic stray fields on grain boundaries are now accessible to direct visual observation is considered valuable for many magnetic investigations. The still controversial subject of grain size effects on the magnetic properties of such important magnetic materials as silicon–iron is one subject which might profit from these potentialities inherent in electron mirror microscopy. This electronic observation method might also be helpful in grain boundary studies concerned with the basic physics of magnetics in such narrow regions of distorted order. (*PA*, 1959, #8301)

IV. MAGNETIC PROPERTIES OF FERROUS METALS AND ALLOYS

A. Films, Thin Layers, Particles, Whiskers and Wires

629. EXPERIMENTAL STUDY OF THE COERCIVE FORCE OF FINE PARTICLES
Meiklejohn, W. H.
Reviews of Modern Physics, v. 25, no. 1, pp. 302–306, January 1953

Particles of Fe, Co, and Ni of size 100-2000 Å were tested.

630. AN ELASTOMAGNETIC EFFECT
Gale, G. O.
Proceedings of the Iowa Academy of Science, v. 61, pp. 330–333, 1954

This article reports measurements on iron and nickel wires surrounded by a solenoid. The sudden application or removal of tension to the wire causes voltages of the order $10\mu v$ to be induced in the coil, these voltages being believed to be due to Barkhausen discontinuities. The effect can be reversed by application of a direct current. (*PA*, 1955, #4804)

631. LONGITUDINAL MAGNETO-RESISTANCE EFFECT OF NARROW SINGLE CRYSTAL STRIPS OF IRON
Kuwahara, I. K.
Journal of Science of the Hiroshima University, Series A, v. 18, no. 1, pp. 87–94, June 1954

Describes measurements of the magnetic resistance change of long, narrow iron single-crystal specimens, the [100] axis lying parallel to their lengths and the (100) or (110) crystal planes lying parallel to the surface; specimens with other orientations were also investigated. The effect was found to depend markedly on the orientation. (*PA*, 1955, #7184)

632. ISOTROPIC MAGNETOSTRICTION OF SMALL IRON SAMPLES
Wotruba, K.
Letter in *Czechoslovak Journal of Physics*, v. 4, no. 3, pp. 372–374, September, 1954 (in Russian)
(*PA*, 1955, #4791)

633. EXPERIMENTAL INVESTIGATION OF THE VARIATION OF THE MAGNETIC FLUX IN A WIRE WHEN A SINGLE DOMAIN IS REMAGNETIZED
Grachev, A. A., Goronina, K. A., Kolachevskii, N. N., and Andrianova, I. A.
Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki, v. 27, no. 3 (9), pp. 313–317, 1954 (in Russian)

The remagnetization of a ferromagnetic specimen by a periodic field sets up an e.m.f. in the indicator coil wound round the specimen, the spectrum of which has line and continuous character, the latter due to the irreversibility of the remagnetization e.m.f. This fraction of it may be called the noise voltage. The noises of a cyclic remagnetization in two sections of a wire are partly correlated. This correlation is actually of two different kinds which may be separated by two indicator coils placed near enough to each other on the specimen, and may be distinguished as flux and domain correlation. In a specially treated carbon steel wire it was possible to select a section which contained a large domain (volume about 10^{-5} cm^3) and many small ones (10^{-9} cm^3). The section containing this large domain was covered by a magnetizing coil of 2 mm length, so that remagnetization affected only this single large domain. An analysis of the effects of remagnetization obtained with a moving and a series-connected fixed indicator coil feeding into separate c.r.o.'s enabled the flux variations due to the remagnetization of the large domain to be separated from those of the small domains. The distribution of the field of the domain along the wire coincided within 10 per cent with Rȳtov's theoretical curve obtained on the assumption of a dipole character of the magnetic domains. (*PA*, 1955, #4800)

634. JORDAN-TYPE AFTER-EFFECT IN FERROMAGNETIC SHEETS
Feldtkeller, R. and Sorger, G.
***Zeitschrift für angewandte Physik*, v. 6, no. 9, pp. 390–396, 1954 (in German)**

Results are given of measurements of the complex permeability of thin (0.15–0.35 mm) laminations of an alloy with 36% Ni, 64% Fe and an alloy with 2·45% Si, as a function of frequency (up to 4·8 kc/s), field strength (currents up to 12 mA/cm) and temperature (80° to 300°K). The results are interpreted on the basis of Néel's theory of irreversible magnetic viscosity in terms of thermal fluctuations of the magnetization. (*PA*, 1955, #1992)

635. THE MANIFESTATION OF NUCLEI OF REVERSE MAGNETIZATION OF IRON–NICKEL WIRES UNDER TENSION BY MEANS OF BITTER PATTERNS
Greiner, C.
***Annalen der Physik*, Leipzig, v. 16, no. 3–4, pp. 176–180, 1955 (in German)**

These experiments show that the nuclei originate at crystal grain boundaries. (*PA*, 1955, #9764)

636. MAGNETIZATION REVERSAL IN THIN FILMS
Conger, R. L.
***The Physical Review*, v. 98, no. 6, pp. 1752–1754, June 15, 1955**

An experiment has been performed which indicates that magnetization reversal in evaporated films of 80% Ni, 20% Fe, 2×10^{-5} cm thick takes place by domain rotation rather than by the motion of 180 deg domain walls. (*PA*, 1955, #7195)

637. PREPARATION OF THIN MAGNETIC FILMS AND THEIR PROPERTIES
Blois, M. S., Jr.
***Journal of Applied Physics*, v. 26, no. 8, pp. 975–981, August 1955**

Techniques for the preparation by vacuum evaporation of single thin layers and laminated structures of ferromagnetic alloys (principally in the iron–nickel system) are described. The magnetic properties are related to those parameters of the process which may be chosen to yield materials having desired characteristics. A method for producing films with extreme hysteresis loop rectangularity is described. Questions of suitable substrate materials, evaporable dielectrics for use in insulating multilayer deposits, and control of alloy composition are considered in detail. (*PA*, 1955, #8311)

638. PERMANENT-MAGNET PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON PARTICLES
Mendelsohn, L. I., Luborsky, F. E., and Paine, T. O.
***Journal of Applied Physics*, v. 26, no. 10, pp. 1274–1281, October 1955**

Previously described fine-particle magnets have been based upon crystal anisotropy; this paper reports permanent-magnet properties derived from the shape anisotropy of substantially elongated single-domain iron particles. The shape anisotropy of these particles overcomes the limitation imposed on the energy of previous fine-particle iron magnets by the low crystal anisotropy of iron. The predicted and observed properties of crystal anisotropy fine-particle magnets are reviewed and compared with an ideal fine-particle iron magnet based upon the shape-anisotropy model of Stoner and Wohlfarth. Experimental results are reported for magnets made by aligning and compacting single-domain iron particles 150 Å units in diameter, with a median length-to-diameter ratio of three to one, and an intrinsic coercive force before packing of 1600 oersted. The effect of particle alignment and packing fraction on magnetic properties is described, and energy products above three million gauss-oersted are reported. These results are compared with properties predicted from theoretical considerations, and with existing permanent-magnet materials. (*PA*, 1956, #493)

639. MAGNETIC DOMAINS IN THIN FILMS OF IRON–NICKEL
Fowler, C. A., Jr. and Fryer, E. M.
***The Physical Review*, v. 100, no. 2, pp. 746, 747, October 5, 1955**

Reports observations using the Kerr effect on an evaporated 80% Ni–Fe film of thickness 5×10^3 Å. The pattern consists of a number of antiparallel surface domains several mm wide and separated near some film edges by dagger-like domains of varying lengths. Application of weak fields causes domain wall movement. Surface domains are absent in thicker films ($1 - 2 \times 10^4$ Å). (*PA*, 1956, #476)

640. EFFECT OF SHAPE ANISOTROPY ON THE COERCIVE FORCE OF ELONGATED SINGLE-MAGNETIC-DOMAIN IRON PARTICLES

Paine, T. O., Mendelsohn, L. I., and Luborsky, F. E.
***The Physical Review*, v. 100, no. 4, pp. 1055–1059, November 15, 1955**

Elongated single-magnetic-domain iron particles, 150 Å units in diameter, have been prepared with properties that definitely confirm the existence of a shape anisotropy effect on coercive force. This conclusion is based upon four observations: (1) Torque curve analysis shows the predominating anisotropy effect to be uniaxial. (2) With increasing particle elongation, the temperature coefficient of coercive force departs from the temperature coefficient of crystal anisotropy and approaches the temperature coefficient of saturation induction. (3) Coercive forces greater than 2000 oersted for iron have been measured. (4) A direct correlation is observed between particle coercive force and elongation. (*PA*, 1956, #2235)

641. TECHNICAL PROPERTIES OF IRON POWDER MAGNETS

Carman, E. H.
***British Journal of Applied Physics*, v. 6, no. 12, pp. 426–429, December 1955**

Coercive force, remanence and maximum-energy product of compacts of iron are measured as functions of density of packing (d/d_0) and X-ray particle size (L). The iron is prepared by hydrogen reduction of ferric oxide and for the grade used optimum technical properties are: $B_r = 5200$ gauss, $(B \cdot H)_{max} = 0.82 \times 10^5$ gauss-oersted, and ${}_BH_c = 400$ oersted when $L = 300$ Å and $d/d_0 = 0.5$. Maximum coercive force obtained is 610 oersted when $d/d_0 = 0.3$. For d/d_0 fixed the three magnetic quantities increase with decreasing particle size, the increase being greatest with B_r and $(B \cdot H)_{max}$. The increase in remanence is discussed in terms of its ratio to saturation magnetization and it is suggested that the observed increase is related to packing effects. Measurement of the influence of oxygen impurity indicates that the presence of a few per cent of oxide does not appreciably affect the quality of the magnets. (*PA*, 1956, #3012)

642. THE DOMAIN STRUCTURE OF THIN IRON FILMS

Elschner, B. and Unangst, D.
***Zeitschrift für Naturforschung*, v. 11a, no. 1, p. 98, 1956 (in German)**

Powder patterns on evaporated films of thickness above 850 Å show dagger-like domains, separated by 90 deg walls, at film edges and imperfections. The effect of an applied magnetic field was also investigated. (*PA*, 1956, #3007)

643. SOME MAGNETIC PROPERTIES OF DILUTE ANISOTROPIC FERROMAGNETIC ALLOYS

Sucksmith, W.
British Electrical and Allied Industries Research Association, London, Technical Report N/T74, 1956

This article discusses magnetic properties of very small particles of iron which are precipitated out of dilute solid solution in copper: apparatus for measuring resonance and coercivity in very low intensities of magnetization encountered; development of anisotropic alloys with high coercivities produced by cold drawing of alloys. (*EI*, 1957)

644. INVESTIGATIONS OF THE INTERNAL DEMAGNETIZING FACTOR

Vogler, G.
***Annalen der Physik*, Leipzig, v. 19, no. 3–5, pp. 229–232, 1956 (in German)**

This is measured from the angle of shear of the hysteresis curve for spherical carbonyl iron particles embedded in a nonmagnetic medium. The factor depends on the magnitude of the applied field, but tends to be a linearly decreasing function of the iron concentration at high fields. This relation is also derived theoretically for an assembly of plate-shaped particles. (*PA*, 1957, #9275)

645. ON THE STRUCTURE OF THE MAGNETICALLY ORIENTED GRANULES IN ALNICO IN THE PERMANENT MAGNET CONDITION

Schulze, D.
***Experimentelle Technik der Physik*, v. 4, no. 5, pp. 193–204, 1956 (in German)**

An electron microscope investigation reveals that the magnetically oriented particles have dimensions approximately 360 × 1200 Å. (*PA*, 1959, #5884)

646. THE INFLUENCE OF THE CRYSTALLITE SIZE ON THE COERCIVITY OF ELECTROLYTICALLY DEPOSITED AND EVAPORATED FILMS OF NICKEL AND IRON

Reimer, L.
***Zeitschrift für Naturforschung*, v. 11a, no. 8, pp. 649–655, August 1956 (in German)**

The crystallite size of electrolytically deposited layers is determined by the crystal structure of the substrate, while with evaporated layers it is determined by the crucible temperature. Both types of layer were examined in an electron microscope and the coercivities of the layers were measured. By extrapolating back to a single-domain layer the coercivity values for the materials could be determined, as suggested by Néel and Kittel. (*PA*, 1957, #2434)

647. MOTION OF FERROMAGNETIC DOMAIN WALLS IN 48 Ni–Fe TAPES

Cole, R. W.
***Journal of Applied Physics*, v. 27, no. 9, p. 1104, September 1956**

This report gives results of Sixtus–Tonks type experiments on cold-rolled and annealed strips under tension, and draws conclusions as to the shape of the wall. Critical field values H_0 obtained are about 4–6 oersted for cold-rolled and 0.3–0.5 oersted for annealed specimens. (*PA*, 1956, #8866)

648. EFFECT OF MAGNETIC FIELD STRENGTH DURING CONDENSATION ON THE COERCIVITY AND FORM OF VAPOR-DEPOSITED IRON

Griest, A. J., Libsch, J. F. and Conard, G. P.
***Journal of Applied Physics*, v. 27, no. 9, pp. 1022–1024, September 1956**

The coercivity and form of iron deposited from the vapor were found to be influenced by the strength of a magnetic field applied during condensation. The intrinsic coercivities of powders deposited at $-196°C$ and at $-78°C$ in fields of 800 to 900 oersted were about 120 oersted. The greater fraction of particle diameters ranged from 10 to 20μ. No appreciable quantity of submicron particles was detected in several samples examined by electron microscopy. Line-broadening in the diffraction patterns of the vapor-deposited iron was attributed to strain, the magnitude of which was theoretically sufficient to account for the observant coercivities. (*PA*, 1956, #8864)

649. THE MAGNETIZATION CURVES OF THIN IRON FILMS

Zaveta, K.
***Czechoslovak Journal of Physics*, v. 6, no. 5, pp. 473–486, October 1956**

The magnetization curves of evaporated iron films 125–7870 Å thick were measured. A torsion magnetometer was used for the magnetic measurements. In the neighborhood of 1100 Å an anomaly was found in the dependence of the work of magnetization and a quantity which replaces remanence, on the thickness of the film. Decreased density of the film in comparison with the density of bulk metal was found by weighing. (*PA*, 1957, #4552)

650. MAGNETIC DOMAINS IN THIN FILMS BY THE FARADAY EFFECT

Fowler, C. A. Jr. and Fryer, E. M.
***The Physical Review*, v. 104, no. 2, p. 552, October 15, 1956**

This report gives results of measurements on a transparent Ni–Fe film of thickness 500 Å, using a transmission method and the Faraday effect. Improved contrast is obtained as compared with results obtained by the Kerr magneto-optic reflection technique (*PA*, 1957, #2418)

651. MAGNETIC DOMAINS IN EVAPORATED THIN FILMS OF NICKEL–IRON

Fowler, C. A. Jr., Fryer, E. M., and Stevens, J. R.
***The Physical Review*, v. 104, no. 3, pp. 645–649, November 1, 1956**

A discussion is given of the use of longitudinal Kerr magneto-optic technique to study domains in ferromagnetic thin films; domain patterns shown in films as thin as 500 Å. Structural features of domains were in some cases similar to those seen in bulk single crystals. (*EI*, 1958)

652. MAGNETIZATION REVERSAL IN THIN FILMS

Smith, D. O.
***The Physical Review*, v. 104, no. 5, pp. 1280–1281, December 1, 1956**

The magnetization reversal of thin films ($\cong$ 1000 Å thick) of 80–20 permalloy has been studied in a strip transmission line. These films are evaporated onto a heated glass substrate in the presence of an orienting field. Magnetization reversal along the axis of initial orientation takes place in times less than 20 mμsec in any reversing field large enough to overcome the orienting energy. The switching coefficient S_w is defined by $S_w = H_m \tau$, with τ the reversal time and H_m the reversing

field. The experiment gives $H_m = 1$ oersted and $\tau \leq 2 \times 10^{-8}$ sec, from which $S_w \leqq 2 \times 10^{-8}$ oersted/sec. Reversal by rotation of the magnetization as a whole in the plane of the film yields a model which is consistent with the observed reversal times. Preliminary measurements of the initial permeability perpendicular to the orientation axis have been carried out to 2000 Mc and do not yet reveal the expected frequency dispersion of the initial permeability. This is an indication that S_w may be another order of magnitude smaller than reported here. (*PA*, 1957, #2430)

653. BITTER PATTERNS ON THIN SHEETS OF A 16% Al–Fe ALLOY

Gengnagel, H.

***Naturwissenschaften*, v. 43, no. 23, pp. 534–535, 1956 (in German)**

Experiments on a single grain of a polycrystalline sheet (90μ) show that a uniaxial strain anisotropy is active even after prolonged annealing. Experiments on the sheet under external stresses enable the strain in the single grain to be estimated. (*PA*, 1957, #8022)

654. MANIFESTATION OF INTERNAL STRESSES IN THE ALLOY 50Ni–50Fe BY MEANS OF BITTER PATTERNS

Greiner, C.

***Naturwissenschaften*, v. 44, no. 1, pp. 8–9, 1957 (in German)**

Describes results of experiments on thin wires in the neighborhood of imperfections (holes, scratches) and for a drawn specimen. The appearance of the patterns is a result of strain anisotropy. (*PA*, 1957, #8010)

655. THE CREATION OF A MAGNETIC STRUCTURE BY A MAGNETIC FIELD IN THIN LAYERS OF IRON, OBTAINED BY AN ELECTROLYTIC METHOD

Kotelnikov, N. V.

***Doklady Akademii Nauk SSSR*, v. 113, no. 1, pp. 97–99, 1957 (in Russian)**

When depositing iron electrolytically a magnetic field can set up a uniaxial structure in the deposit with the axis of weak magnetization following the direction of the applied field. Since electrolysis normally takes place at low temperatures it is unlikely that the magnetic phenomenon of electrolytic iron is explainable by plastic strain. The present paper shows how a magnetic structure can be accounted for taking into consideration the magnetostriction anisotropy of the separate little crystals and the process of formation of a polycrystalline deposit from them. A maximum ordered state is achieved for a field of several hundred oersted, fields greater or less appear to be less effective. The anisotropic energy of a film obtained in the critical field may attain a magnitude of $5 \times 10^4 - 6 \times 10^4$ erg/cm^3. (*PA*, 1957, #8020)

656. FERROMAGNETIC RESONANCE IN THIN FILMS OF PERMALLOY

Tannenwald, P. E. and Seavey, M. H., Jr.

***The Physical Review*, v. 105, no. 2, pp. 377–378, January 15, 1957**

Microwave resonance measurements have been made in evaporated (82% Ni, 18% Fe) films of thickness 760 Å to 1600 Å. The longest relaxation, as measured by the line width, gives $T_2 = 3 \times 10^{-8}$ sec. The sample thickness was equal to or less than the skin depth, resulting in a Lorentzian-type line. Multiple resonances were obtained according to shape anisotropy theory. (*PA*, 1957, #3443)

657. REPRODUCING PROPERTIES OF ALNICO PERMANENT MAGNET ALLOYS WITH ELONGATED SINGLE-DOMAIN COBALT-IRON PARTICLES

Luborsky, F. E., Mendelsohn, L. I., and Paine, T. O.

***Journal of Applied Physics*, v. 28, no. 3, pp. 344–351, March 1957**

Single-domain particles of 40:60 cobalt–iron alloy were prepared with median diameter of 200 Å median elongation of 5.4:1, and intrinsic coercive force of 1950 oersted; by compacting these particles to various packing densities and degrees of alignment, shape anisotropy fine-particle magnets have been made with magnetic properties of Alnico alloys. (*EI*, 1957)

658. ALLIAGES A CYCLE D'HYSTERESIS RECTANGULAIRE

Villachon, A.

***Onde électrique*, v. 37, no. 360, pp. 259–261, March 1957**

Alloys with rectangular hysteresis loops, magnetic properties of 50% Fe 50% Ni alloys relating to rectangular hysteresis loops suitability of 78% Ni alloy for high fre-

quencies, treated under certain conditions to give rectangular hysteresis loop: this alloy, in form of small toroids made up as very thin strip, is of interest whenever very short response time is required. (*EI*, 1957)

659. INVESTIGATIONS OF THE MAGNETIC PROPERTIES OF EVAPORATED IRON FILMS BY MEANS OF THE FARADAY EFFECT

Reimer, L.

***Zeitschrift für Physik*, v. 148, no. 4, pp. 527–532, 1957 (in German)**

Measurements of the coercive force by this method (checked ballistically in a few cases) are reported for Fe films from 20 to 800 Å thick, evaporated onto glass and to rocksalt at 20°, 200° and 350°C. The results at the higher temperatures show a coercivity maximum at about 100 Å. The crystallite character of the films was investigated by electron microscopy, and crystallites of dimensions about 700 Å were observed for a film evaporated at 350°C. The coercivity is believed to depend on the single domain character of the crystallites in the film, if this is below a certain thickness. Electron diffraction measurements are also reported. (*PA*, 1958, #3240)

660. MAGNETIC ANISOTROPY AND ROTATIONAL HYSTERESIS IN ELONGATED FINE-PARTICLE MAGNETS

Jacobs, I. S. and Luborsky, F. E.

***Journal of Applied Physics*, v. 28, no. 4, pp. 467–473, April, 1957**

Various aspects of anisotropy of electrodeposited elongated single domain Fe and FeCo alloy particles examined with view to better understanding process of magnetization; initial increase of coercivity with increase of angle between alignment direction and measuring field is in qualitative accord with prediction of chain of spheres model with fanning. (*EI*, 1957)

661. THE MAGNETOSTRICTIVE DISPLACEMENT OF THE FERROMAGNETIC RESONANCE IN Ni–Fe WIRES

Zehler, V.

***Zeitschrift für Naturforschung*, v. 12a, no. 5, pp. 441–443, 1957 (in German)**

Ferromagnetic resonance occurs in smaller magnetic fields when a tension is applied to the wire. It is shown that the displacement can be accounted for in terms of the effect of the tension on the free energy of the spins, and it is suggested that the effect forms the basis of a useful method of measuring magnetostriction. (*PA*, 1957, #5903)

662. THE DAMPING OF FERROMAGNETIC RESONANCE IN Ni–Fe WIRES

Zehler, V.

***Zeitschrift für Naturforschung*, v. 12a, no. 5, pp. 437–440, May 1957 (in German)**

The cavity resonator described was used to investigate the damping of ferromagnetic resonance in Ni – Fe wires containing 68.75% Ni. Marked difference in the dispersion and absorption curves for the cavity resonator were observed using a wire successively annealed, electropolished, strained and re-annealed. (*PA*, 1959, #4810)

663. MAGNETIC PROPERTIES OF THIN ELECTROLYTICALLY DEPOSITED AND EVAPORATED NICKEL AND IRON FILMS

Reimer, L.

***Zeitschrift für Naturforschung*, v. 12a, no. 7, pp. 550–557, 1957 (in German)**

Gives the results of measurements of saturation magnetization, remanence, permeability and the reversible work of magnetization. There is good agreement with theoretical predictions based on single domain structures for electrolytically deposited films and films evaporated onto a hot substrate, but there are discrepancies in the case of films evaporated onto cold substrates. (*PA*, 1959, #5888)

664. MAGNETIC DOMAIN PATTERNS ON SINGLE-CRYSTAL IRON WHISKERS

Coleman, R. V. and Scott, G. G.

***The Physical Review*, v. 107, no. 5, pp. 1276–1280, September 1, 1957**

Ferromagnetic domain patterns on single-crystal whiskers of pure iron were studied by using the Bitter powder technique. Patterns were observed on both magnetized and unmagnetized specimens and in both cases straightforward interpretations of the patterns can be given. Whiskers with axes along the [111] and [100]

directions were studied and observations indicate that crystals with perfect geometry have a very simple domain structure in the unmagnetized state. (*PA*, 1958, #1771)

665. DOMAIN CHANGES DURING LONGITUDINAL MAGNETIZATION OF IRON WHISKERS

Scott, G. G. and Coleman, R. V.
***Journal of Applied Physics*, v. 28, no. 12, pp. 1512–1513, December 1957**

The simple domain structure (one 180 deg wall + closure domain) can be altered, so as to produce a cube-shaped closure domain at the center, by transverse magnetization. Longitudinal magnetization in fields up to 200 oersted distorts and finally removes this closure domain as saturation is reached. The end effects are more complicated. (*PA*, 1958, #3255)

666. MAGNETIC PROPERTIES AND ELECTRON MICROSCOPICAL STRUCTURE OF ELECTRODEPOSITED THIN FILMS OF NICKEL–IRON ALLOYS

Reimer, L.
***Zeitschrift für Physik*, v. 150, no. 1, pp. 99–105, 1958 (in German)**

The electron microscope observations reveal a very fine-grained structure in very thin apparently single-domain films. The coercivities of the more iron-rich (77% – 60% Ni) films, being proportional to the saturation magnetization, are thought to be governed by a very weak shape anisotropy. For films above 500 Å coercivities are interpreted in terms of strains. (*PA*, 1958, #7175)

667. LOSS OF EXCHANGE COUPLING IN SURFACE LAYERS OF FERROMAGNETIC PARTICLES

Luborsky, F. E.
***The Physical Review*, v. 109, no. 1, January 1, 1958, pp. 40–42**

Experiments with spherical iron particles 28 to 265 Å in diam. show proposed nonferromagnetic layer to be less than 1 Å thick; analysis is based on comparison of ferromagnetic iron indicated by magnetic saturation and by chemical analysis of total iron present. (*EI*, 1958)

668. FERROMAGNETIC RESONANCE AT U.H.F. IN THIN FILMS

Kingston, R. H. and Tannenwald, P. E.
***Journal of Applied Physics*, v. 109, no. 2, pp. 232–233, February 1958**

Previous observations were extended to 80–20 permalloy films of thickness 5600 Å at frequencies between 2×10^3 and 4×10^2 Mc. The magnetic field was applied in the plane of the film both parallel and perpendicular to the easy axis. In both cases the resonance frequency varied with the applied field in the expected manner. Line widths were $\sim$ 200 oersted, the spin-spin relaxation time was $\sim 5 \times 10^{-10}$ sec, and the spin-lattice relaxation time, obtained using pulsed r.f. sources was 2×10^{-9} sec. (*PA*, 1958, #3241)

669. FLUX REVERSAL IN THIN FILMS OF 82% Ni, 18% Fe

Olson, C. D. and Pohm, A. V.
***Journal of Applied Physics*, v. 29, no. 3, pp. 274–282, March 1958**

The magnetization reversal process of iron–nickel films (nominally 82% Ni–18% Fe) deposited in the presence of a magnetic field to a thickness of about 1000 Å to 4000 Å have been examined by the application of appropriate fields. Experimental results indicate that at least two different magnetization reversal mechanisms are effective. The first, characterized by relatively long remagnetization periods, involves domain-wall movement; the second, characterized by relatively short remagnetization periods, is consistent with the rotation of the magnetization in the plane of the film. The threshold for the rotational process is altered by the application of transverse magnetic field in a manner consistent with a simple energy model. (*PA*, 1959, #420)

670. TRANSVERSE FLUX CHANGE IN SOFT FERROMAGNETICS

Humphrey, F. B.
***Journal of Applied Physics*, v. 29, no. 3, pp. 284–285, March 1958**

Results of an investigation of magnetic flux change in the direction perpendicular to the direction of the applied field indicate that the maximum flux in the transverse direction does not occur at the time when the sample is half reversed. From these data, taken on thin evaporated films of iron–nickel, it is concluded that a coherent rota-

tion theory which assumes a single magnetization vector to represent the entire sample is not adequate to explain the results. It is suggested that, when a small transverse field is present, the magnetization starts to reverse by coherent rotation but soon loses phase throughout the sample so that the reversal is completed by noncoherent rotation. With no transverse field, the coherence is never established and the reversal is completely by noncoherent rotation. Added evidence for this suggestion is presented in the form of a comparison of thin films with ferrite and permalloy tape cores. In both the normal and transverse directions, the observations are similar, supporting the view that the reversal of films and cores is by the same general mechanism. (*PA*, 1958, #8881)

671. EFFECTS OF HEAT TREATMENT OF THIN FERROMAGNETIC FILMS AT INTERMEDIATE TEMPERATURES

Mitchell, E. N.

***Journal of Applied Physics*, v. 29, no. 3, pp. 286–287, March 1958**

Iron–nickel films deposited *in vacuo* in the presence of a magnetic field have been annealed in an inert environment. It has been established that, when the annealing is performed in an orienting field of 30 oersted, initial magnetic properties of these films can be altered provided that the initial temperature is high enough. If a field is applied at right angles to the original preferred direction and in the plane of the film, the magnitude of the magnetic anisotropy can be reduced without changing the preferred direction; the preferred direction of magnetization can be changed if the anneal temperature is sufficiently high. This last effect confirms the observations of Williams and Sherwood. (*PA*, 1958, #3882)

672. REVERSIBLE ROTATION IN MAGNETIC FILMS

Sanders, R. M. and Rossing, T. D.

***Journal of Applied Physics*, v. 29, no. 3, pp. 288–289, March 1958**

The magnetization of permalloy films of 0.1 to 0.3 μ thickness vacuum-deposited in a magnetic field is reversibly rotated by a pulsed external field applied at right angles to the direction of easy magnetization. The total angle of rotation is deduced from the amplitude of the detected signal or from the strength of the applied drive field. Reversible rotations of 60 or more are repeated for at least 10^6 cycles in some films. An excessive drive field results in a loss of remanent magnetization after a few rotations. High wall-motion coercivity is a necessary but not sufficient condition for large reversible rotation angles. Films giving a large rotation tend to have open hysteresis loops in the difficult direction. (*PA*, 1958, #8883)

673. STEADY-STATE AND PULSE MEASUREMENT TECHNIQUES FOR THIN MAGNETIC FILMS IN THE VHF-UHF RANGE

Smith, D. O. and Weiss, G. P.

***Journal of Applied Physics*, v. 29, no. 3, pp. 290–291, March 1958**

A vhf-uhf bridge consisting of two loops placed symmetrically in a rectangular coaxial cavity has been used to study steady-state and pulse relaxation in thin ($\sim$ 1000 Å) permalloy films. For steady-state measurements a coaxial transformer converts the bridge output from balanced-to-ground to unbalanced-to-ground; measurements from 100 to 1500 Mc are currently possible. Pulse measurements utilize the ungrounded deflection plates of a wide-band traveling-wave oscilloscope; pulse response to 2 mμsec can be resolved. Drive-pulse calibration is accomplished unambiguously by using some of the unique switching properties of films which have uniaxial anisotropy. (*PA*, 1958, #8856)

674. FERROMAGNETIC RESONANCE IN ULTRA-THIN FILMS

Seavey, M. H. Jr. and Tannenwald, P. E.

***Journal of Applied Physics*, v. 29, no. 3, pp. 292–293, March 1958**

A ferromagnetic film may be arbitrarily considered as "ultra-thin" when its thickness is less than 100 Å. Microwave resonance absorption was observed in permalloy films down to approximately 15 Å thickness. The magnetization drops sharply near 60 Å, and ferromagnetism disappears between 8 Å and 12 Å. Line shape and width and g factor were also measured. (*PA*, 1958, #8877)

675. DOMAIN-WALL STRUCTURE IN PERMALLOY FILMS

Huber, E. E. Jr., Smith, D. O., and Goodenough, J. B.

***Journal of Applied Physics*, v. 29, no. 3, pp. 294–295, March 1958**

Domain-wall structure in permalloy films in the thickness range from 25 to 2000 Å was studied by the Bitter technique. A new type of 180 deg wall was observed: the

main wall is cut at regular intervals by short, right-angle "cross ties" which terminate in free, single ends. The cross-tie period and length are dependent on film thickness, each becoming shorter with decreasing thickness. These patterns can be understood in terms of a new model for the structure of domain walls in thin films of low-anisotropy material. In the conventional model the atomic moments within the wall rotate about an axis perpendicular to the wall. In a thin film such a configuration leads to a large energy contribution from the large demagnetization factor normal to the film. In the new model, the axis of rotation is itself thought to rotate about the axis of the wall to give a "corkscrew" configuration of spins and a large decrease in associated magnetostatic energy. Of several experiments which were performed which support this model, one is briefly described. (*PA*, 1959, #4211)

676. LOSS OF EXCHANGE COUPLING IN THE SURFACE LAYERS OF FERROMAGNETIC PARTICLES

Luborsky, F. E.

***Journal of Applied Physics*, v. 29, no. 3, pp. 309–310, March 1958**

Experiments with spherical iron particles 28 Å to 265 Å in diameter demonstrate that the proposed nonferromagnetic surface layer on an iron particle must be less than 1 Å thick, i.e., about one atomic radius. This conclusion is based upon a comparison of the ferromagnetic iron calculated from the magnetic saturation, and the total amount of iron as determined by chemical analysis. The $1/H$ extrapolation of the magnetic induction appears adequate to obtain the saturation induction at room temperature of particles greater than about 100 Å in diam. For particles less than this size, in the superparamagnetic size range, the Langevin function must be used taking into account the size distribution of the particles in the sample. Thus, there will be a negligible decrease in saturation induction due to the loss of exchange coupling at the surface of iron particles in the size range above 100 Å of interest for fine-particle permanent magnets. (*PA*, 1958, #8886)

677. PHYSICAL AND MAGNETIC PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON AND IRON-COBALT PERMANENT MAGNETS

Lever, R. C., Yamartino, E. J., and Falk, R. B.

***Journal of Applied Physics*, v. 29, no. 3, pp. 304–305, March 1958**

The physical and magnetic properties of permanent magnets compacted from elongated single-domain particles with metal and organic matrices are described. Their unique properties which make possible novel design and application possibilities include: demagnetization curve flexibility; high-energy and energy-to-weight ratio; uniformity of pole face flux; low-temperature coefficient of remanence; precise dimensional tolerances; excellent machinability; solderability; low critical material content; and short radioactive half-lite. Compacts have been prepared from iron and iron-cobalt particles with energies of 3.5 million and 5 million gauss-oersteds, respectively. Compacts exposed to 100°C for over one year were observed to change remanence less than 1 percent. (*PA*, 1958, #8885)

678. CUBE TEXTURE IN BODY CENTERED MAGNETIC ALLOYS

Wiener, G., Albert, P. A., Trapp, R. H., and Littman, M. F.

***Journal of Applied Physics*, v. 29, no. 3, pp. 366–367, March 1958**

Cube oriented, (100) [001], iron silicon alloys were prepared in thickness ranging from 0.8 mil to 11.0 mils. Both ac and dc magnetic properties are given for the alloys. The data show that comparable properties to commercial singly oriented steel of the (110) [001] texture are obtained both parallel and perpendicular to the rolling direction. The magnetic properties are sensitive to both the amount of cube oriented grains and the distribution of the directions about the rolling directions of the sheet. (*PA*, 1958, #8895)

679. LOW RESIDUAL INDUCTION IN HIGH-ALUMINUM IRON ALLOYS

Pavlovic, D. and Foster, K.

***Journal of Applied Physics*, v. 29, no. 3, pp. 368–369, March 1958**

Low values of residual induction were observed for different heat treatments in 0.007 and 0.014 in. thick sheets of aluminum–iron alloys containing 10 to 16 weight percent aluminum. For these materials the ratio of residual induction (B_r) to induction at 100 oersted (B_{100}) gave values of 0.05 to 0.1. These low residual induction values apparently occur at compositions having zero crystal anisotropy for both furnace-cooled and water-

quenched alloys. Domain patterns were observed in these low B_r alloys but, in general, no evidence of domain patterns was observed in the same alloys when the B_r/B_{100} ratio was increased, through suitable heat treatment, to a value greater than about 0.2. The fairly high magnetostriction of the alloys around the Fe_2Al composition and the stress produced by cooling through differently ordered regions may be considered to produce a high "stress anisotropy" resulting in pronounced domain patterns and perhaps also to contribute to the lowering of the residual induction of these alloys. (*PA*, 1958, #8896)

680. MAGNETIC DOMAIN PATTERNS ON IRON WHISKERS

Coleman, R. V. and Scott, G. G.

***Journal of Applied Physics*, v. 29, no. 3, pp. 526–527, March 1958**

Magnetic domain patterns were observed on iron whiskers growing in [111], [100], and [110] directions. In most cases the patterns on unmagnetized whiskers are very simple and subject to straightforward interpretation. Patterns on {100} faces were observed to change after annealing above the Curie temperature. Domain arrangements were observed which produce intersecting boundaries at the crystal surface which do not collect magnetite. Dagger patterns which form on {110} surfaces under application of normal fields were studied and the effect of misoriented surfaces on these patterns was investigated. (*PA*, 1959, #457)

681. DOMAIN OBSERVATIONS ON IRON WHISKERS

DeBlois, R. W. and Graham, C. D., Jr.

***Journal of Applied Physics*, v. 29, no. 3, pp. 528–529, March 1958**

The appearance in iron whiskers of domain walls which apparently violate the restriction that the normal component of magnetization must remain constant across the wall is confirmed. These walls sometimes have a dotted or serrated appearance. Such walls were found in a closure domain structure which permits the calculation of an approximate value for the surface energy of the serrated wall; this energy is approximately ten times the energy of a normal 90 deg wall or five times the energy of a normal 180 deg wall. It is concluded that the serrated wall contains an inner structure which largely eliminates any free poles. (*PA*, 1959, #458)

682. STATIC AND DYNAMIC BEHAVIOR OF THIN PERMALLOY FILMS

Smith, D. O.

***Journal of Applied Physics*, v. 29, no. 3, pp. 264–273, March 1958**

Thin magnetic films (~ 1000 Å) evaporated onto a heated glass substrate in the presence of a dc magnetic field develop a uniaxial magnetic anisotropy energy of the form $E_k = K \sin^2 \phi$, with ϕ measured from the deposition field. Such films promise to outperform ferrite cores in digital-computer memory systems by several orders of magnitude. A detailed static and dynamic theory based on the above anisotropy energy and the Landau-Lifshitz dynamical equation is presented. The static theory contains the unique feature of the coercive force parallel to the easy axis being dependent on a field in the plane of the film and perpendicular to the easy axis. Experimental verification of the theory is given.

The dynamic theory considers both steady-state and pulse response. The steady-state solution is well known; the pulse solution must take very careful account of all the important torques acting in a switching experiment, and numerical results are obtained by the use of a digital computer. Experimentally, steady-state resonance is measured from 100 to 10,000 Mc and pulse switching down to 3 mμsec. Both types of experiment are in good agreement with each other and with the theory.

683. DOMAIN WALL MOTION IN METALS

R. W. DeBlois

***Journal of Applied Physics*, v. 29, no. 3, pp. 459–467, March 1958**

A brief review on the ferromagnetic domain wall is first presented, touching on its energy and thickness, its coercive force, and its motion in metal loops, tapes, and wires, as governed by eddy currents and by relaxation processes. Next to be presented are the experimental results of an extension of the Sixtus-Tonks experiment to axial domain wall velocities over 50 km/sec, made possible by use of nearly perfect iron whiskers. Plots of axial velocity vs. applied field are nonlinear and in some cases show velocity discontinuities at room temperature in the region 3 to 8.5 km/sec. At 77°K velocity discontinuities beginning at 2 km/sec are observed. Nucleating fields of over 250 oersted are indicated. Data analysis yields a relaxation damping coefficient, $\beta_r \approx 10$ g/sec cm^2 for normal domain wall motion.

684. MAGNETIZATION MECHANISM OF MULTIDOMAIN PARTICLES
Amar, H.
March 1958
Franklin Institute, Philadelphia, Pa.
Research and Development Labs.
AF 33(616)-5041
Report WADC-TR-58-134
(ASTIA AD-155,764)

The free energy of a two-domain single crystal cube of iron is considered with and without an applied magnetic field. In the absence of a field, the two-domain configuration may exist only beyond a definite critical size (200 Å), the wall characteristics are size dependent, and their values are substantially different from the values calculated for bulk material. The displacement of the wall in the presence of an applied field is considered, and it is found that magnetization by wall motion is a hard process, contrary to the case of bulk material.

685. SIZE DEPENDENCE OF THE WALL CHARACTERISTICS IN A TWO-DOMAIN IRON PARTICLE
Amar, H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 542–543, March 1958**

The study of the energy per unit volume vs. wall width in a cubic two-domain iron particle leads to the following results: (1) The width and energy per unit area of the wall have values considerably different from their values in bulk iron. (2) The width of the wall slowly rises with increasing size of the cube while the energy decreases. (3) The two-domain configuration is energetically unstable when the cube edge is less than 200 Å, in fair agreement with current single domain criteria. (*PA*, 1958, #8929)

686. ORIENTATION STUDY OF ULTRA-THIN MOLYBDENUM PERMALLOY TAPE
Koh, P. K.
***Journal of Applied Physics*, v. 29, no. 4, pp. 636–657, April 1958**

Quantitative pole density stereograms of {111}, {220}, {200}, and {113} poles of ⅛-mil molybdenum permalloy tape were developed in order to establish its cold-rolled deformation texture and annealed textures. Cold rolling the tape induced multiple slip common to all face-centered-cubic metals and developed (110)[335] and (110)[335] end orientations which deviate 5 deg about [110] from the recognized {110} ⟨112⟩ brass deformation texture. On annealing at 771°C the cold-rolled tape was found to develop (120)[001] + (210)[001] and (113)[785] + (113) [785] orientations as components of the annealed texture which bear in general at 35°-45° rotation orientation relationship about ⟨111⟩ with the cold-rolled end orientations. Annealing at 1160°C developed the same texture as that obtained after 771°C annealing. From the pole figures made on 927°C annealed tape, the same annealed texture prevailed whether the pole figure was made on its full ⅛-mil thickness or on its central 0.00005 in. section. Hysteresis loop tracings made on the cold-rolled tape revealed an apparent direction of easy magnetization along the rolling direction. No easy magnetization direction was revealed in the rolling plane on the annealed tapes. These findings support the deductions from the corresponding pole figures. (*PA*, 1959, #916)

687. MAGNETIC ANALYSIS OF FERRO-MAGNETIC INCLUSION FOUND IN 18/8 STAINLESS STEEL
Yamaguchi, S.
***Iron and Steel Institute Journal*, v. 188, pp. 351–352, April 1958**

688. COERCIVE FORCE vs. THICKNESS FOR THIN FILMS OF NICKEL–IRON
Tiller, C. O. and Clark, G. W.
***The Physical Review*, v. 110, no. 2, pp. 583–585, April 15, 1958**

Films of composition 82%Ni:18%Fe and thickness between 2000 and 3000 Å were evaporated onto a glass substrate in an orienting field. A series of thinner films were prepared by successive etching processes and the coercive force measured, the thickness at each stage being obtained by interferometry. The coercivity was found to be inversely proportional to the thickness contradicting the Néel theory. (*PA*, 1958, #6057)

689. PRODUCTION OF MAGNETIC TEXTURE BY MEANS OF A MAGNETIC FIELD IN THIN LAYERS OF IRON, OBTAINED BY THE ELECTROLYTIC METHOD
Kotelnikov, N. V.
***Fizika Metallov i Metallovedenie*, v. 6, no. 2, pp. 222–228, 1958 (in Russian)**

This experimental study of the texture of deposits was based on the measurement (with the anisometer of Akulov–Bryukhatov) of the anisotropy of energy in Fe films obtained from aqueous solutions of Fe salts. It was found that, in electrolytically obtained ferromagnetic deposits, internal stresses are likely to produce texture; this texture depends on the following factors: material of the support, treatment of its surface prior to deposit formation, structure and material of the deposit, and the magnetic field. The texture of deposits, produced by the magnetic field, has a maximum when the field reaches several hundred oersted; beyond this critical value the degree of texture again decreases. The energy of film anisotropy at the critical field value amounts to 5×10^4 to 6×10^4 erg/cm^3. When a magnetic field is applied during electrolysis along the surface of deposition of ferromagnetic films, the quality of coating is improved and its bonding with the support becomes stronger. (*PA*, 1959, #5887)

690. RELATION BETWEEN CRYSTALLITE ORIENTATION AND MAGNETIC PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON PARTICLES

Luborsky, F. E., Fullam, E. F., and Hallgren, D. S.

***Journal of Applied Physics*, v. 29, no. 6, pp. 989–993, June 1958**

Analysis by selected area electron diffraction of aligned elongated single-domain iron particles, each about 150 Å by 500 Å, indicates that the long axis of the particle is coincident with the [111] crystallographic direction. Diffuse diffraction rings and elongated spots were attributed to a considerable degree of random crystallite orientation. These results confirm predictions based on particle morphology and on the temperature coefficient of coercive force of iron and iron–cobalt alloy particles. This [111] orientation offers an explanation for the increase in coercive force with increase in temperature observed for single domain iron–cobalt alloy particles and suggests a related explanation for the Alnico type alloys. (*PA*, 1959, #436)

691. DOMAIN OBSERVATIONS ON IRON WHISKERS

DeBlois, R. W. and Graham, C. D., Jr.

***Journal of Applied Physics*, v. 29, no. 6, pp. 931–939, June 1958**

Ferromagnetic domain walls were observed by standard methods on iron whiskers. The whiskers are square in cross section, generally 20 to 60 μ on a side, and up to one cm long. The whiskers are single crystals with the axis in a ⟨100⟩ direction and the faces nearly perfect {100} planes. The domain patterns are exceptionally clear and simple. Several characteristic patterns are described and represented with three-dimensional models; a feature common to many patterns is the *V* line, which consists of two plane walls meeting in a *V* with its apex at the whisker surface. The effects of applied fields and applied stresses on the domain structures were studied, and some observations made on whiskers small enough to approach a single-domain state. (*PA*, 1959, #459)

692. FURTHER OBSERVATIONS ON REVERSIBLE ROTATION IN MAGNETIC FILMS

Sanders, R. M.

***Journal of Applied Physics*, v. 29, no. 6, pp. 1003–1004, June 1958**

It has previously been reported positive and negative output signals of unequal amplitudes were observed with some permalloy films driven with a pulsed field in the transverse direction, the detection of the flux change being made in the easy direction. It was then assumed that the unbalance was caused by the Earth's field normal to the specimen, but it has now been shown that this is not correct, and that the unbalance is associated with the method of setting up the specimens. (*PA*, 1958, #8884)

693. SINGLE CRYSTAL IRON WHISKERS ADAPTED TO BASIC STUDY OF MAGNETIC DOMAINS

Scott, G. G. and Coleman, R. V.

***General Motors Engineering Journal*, v. 5, no. 3, pp. 34–37, July, August, September 1958**

Magnetic domains are radically affected by shape and size of specimen, crystal orientation, and internal strain; to obtain basic knowledge on processes of magnetization, General Motors Research Staff adapted whiskers which are readily grown in laboratory by hydrogen reduction of ferrous chloride; strain-free crystals are of ideal size, shape, and orientation for magnetic investigation. (*EI*, 1958)

694. GEOMETRIC DEPENDENCE OF MAGNETIC ANISOTROPY IN THIN IRON FILMS
Knoer, T. G. and Hoffman, R. W.
Atomic Energy Commission, Oak Ridge, Tennessee, Technical Report 3, September 1958

695. COMMENTS ON A THEORY OF DOUBLE BLOCH WALLS IN THIN FILMS
Behringen, R. E.
Letters to the Editor: *Journal of Applied Physics*, v. 29, no. 9, pp. 1380–1381, September 1958

Permalloy and cobalt are considered.

696. DIRECT OBSERVATIONS OF SPIN-WAVE RESONANCE
Seavey, M. H., Jr. and Tannenwald, P. E.
***Physical Review Letters*, v. 1, no. 5, pp. 168–169, September 1, 1958**

The effect of exchange interactions in ferromagnetic resonance is experimentally shown by means of a uniform microwave field (8890) Mc) absorbed in a film 80%-20% permalloy 5600 Å thick.

The resonances at various magnetic field values are interpreted as spin waves obeying a dispersion law $\omega = (2A\gamma/M)k^2 + \omega_0$ and the Kittel condition for spin-wave resonance $k = p\pi/L$. A is the exchange coupling constant which can thus be obtained from the location of the spin-wave peaks, L the film thickness and p an integer. (*PA*, 1959, #4808)

697. THE PREPARATION AND CHARACTERISTICS OF THIN FERROMAGNETIC FILMS
Edelman, F. H., et al.
Final Engineering Report, 1 August 1957–31 August 1958, Contract AF 19(604)-2659, AFCRC-TR-58-187, November 1958
(ASTIA AD-160, 845)

This report is a theoretical and experimental study of the physical, chemical, and magnetic properties of thin ferromagnetic films prepared by chemical methods. Thin nickel-iron films with a wide range of compositions and thicknesses were prepared by electrodeposition. Films of 21- to 22-percent iron content, about 5000 Å in thickness, yielded the lowest coercivity (1.2 oersted) and the highest B_r/B_m value (0.95). The best substrates, electrolytes, and anodes were determined. Films prepared by thermal decomposition of acetyl acetonates over a wide range of compositions demonstrated rectangular hysteresis loops in all directions; some of them were isotropic. Some films had a coercivity below 2 oersted. The best samples had a lower switching constant than some vacuum-deposited films. The isotropic films can be switched 90 deg in one-fourth the time of 180-deg switching. Further chemical studies are required to reduce coercivity and improve reproducibility. Test equipment was developed to measure magnetic properties and switching time, and to study domain structure.

698. MAGNETIZATION REVERSAL BY ROTATION AND WALL MOTION IN THIN FILMS OF NICKEL–IRON ALLOYS
Bradley, E. M. and Prutton, M.
***Journal of Electronics and Control*, v. 6, no. 1, pp. 81–96, January 1959**

The magnetization reversal process in specially prepared uniaxial thin films of nickel–iron alloy is studied by measurements of the 400 cps hysteresis loops. The results indicate that both coherent rotation and domain wall motion can occur in the same film, but in different proportions according to the orientation of the anisotropy axis with respect to the applied field and the thickness of the film. Special properties of these films are discussed for fields applied normal to the anisotropy axis. (*PA*, 1959, #3646)

699. DEPENDENCE OF GEOMETRIC MAGNETIC ANISOTROPY IN THIN IRON FILMS
Knorr, T. G. and Hoffman, R. W.
***The Physical Review*, v. 113, no. 4, pp. 1039–1046, February 15, 1959**

Thin iron films produced by vacuum deposition are observed to display a magnetic anisotropy dependent on the geometric location of the evaporating filament. A fiber axis structure is induced during the evaporation. If the direction of incidence of the metallic flux varies from a normal to the substrate this fiber axis tilts in a similar direction. As soon as the fiber axis is no longer normal to the plane of the film, magnetic anisotropy is produced. The variation of the tilt of the fiber axis correlates with and can be shown to account for the geometric dependence of the observed anisotropy. Calculations of the magnetic anisotropy expected in a film with a fiber axis structure and an anisotropic tensile stress in the plane of the film agree with the experimental observations for those films which show only rotational switching. Anisot-

ropies of 3×10^4 ergs/cm^3 were observed in iron films about 350 Å thick prepared without the use of applied magnetic fields either during deposition or during a subsequent thermal anneal. (*PA*, 1959, #5877)

700. ANISOTROPY IN PERMALLOY FILMS
Smith, D. O.
***Journal of Applied Physics*, v. 30, p. 264S, April 1959 Supplement.**

701. THIN MAGNETIC FILMS
Webley, R. S.
***Nature*, v. 183, pp. 999–1000, April 4, 1959**

Films of nickel–iron alloys were prepared by evaporation onto glass, and the low-frequency hysteresis loop observed during the preparation. As the thickness increased from 150 to 1500 Å the coercivity remained constant at 1-2 oersted, and it then either increased suddenly to 10-20 oersted, or decreased slowly to 0.5 oersted as the evaporation continued. Different behavior was observed when other substrate materials were used. (*PA*, 1959, #7165)

702. FINE IRON FILAMENTS MAGNETS
Levi, F. P.
***Nature*, v. 183, pp. 1251–1252, May 2, 1959**

Outlines a technique for obtaining parallel, equally spaced filaments of iron, to obtain high coercive force. Results obtained are shown graphically. (*PA*, 1959, #7168)

703. MAGNETIC DOMAIN OBSERVATIONS BY ELECTRON MICROSCOPY
Hale, M. E., Fuller, H. W., and Rubenstein, H.
***Journal of Applied Physics*, v. 30, no. 5, pp. 789–791, May 1959**

Preliminary observations of domain patterns, by transmission, in thin films of iron, 50/50% iron–nickel alloy and permalloy are reported. (*PA*, 1959, #8298)

(See also references: 729, 745, 754, 767, 805, 812, 833, 840, 886, 890, 897, 915, 922)

B. General

704. MAGNETIZATION OF SINGLE CRYSTALS OF IRON
Honda, H. and Kaya, S.
***Science Reports of the Tôhoku University*, v. 15, pp. 721–753, 1926**

705. FERROMAGNETISME DES ALLIAGES DE FER
Fallot, M.
***Annales de Physique*, v. 6, pp. 305–387, 1936**

706. ON THE MAGNETIC STRUCTURE OF IRON
Lifshitz, E.
***Journal of Physics*, USSR, v. 8, pp. 337–346, 1944**

707. LES LOIS DE L'AIMANTATION ET DE LA SUBDIVISION EN DOMAINES ELEMENTAIRES D'UN MONOCRISTAL DE FER
Néel, L.
***Journal de physique et le Radium*, v. 5, pp. 241–251, 265–276, 1944 c**

708. MAGNETO-RESISTANCE AND DOMAIN THEORY OF IRON–NICKEL ALLOYS
Bozorth, R. M.
***The Physical Review*, v. 70, p. 923, 1946**

709. MAGNETIC DOMAIN PATTERNS ON SINGLE CRYSTALS OF SILICON IRON
Williams, H. J., Bozorth, R. M., and Shockley, W.
***The Physical Review*, v. 75, pp. 155–178, January 1949**

710. A SIMPLE DOMAIN STRUCTURE IN AN IRON CRYSTAL SHOWING A DIRECT CORRELATION WITH THE MAGNETIZATION
Williams, H. J. and Shockley, W.
***The Physical Review*, v. 75, pp. 178–183, 1949**

711. STUDIES OF THE PROPAGATION VELOCITY OF A FERROMAGNETIC DOMAIN BOUNDARY
Williams, H. J., Shockley, W., and Kittel, C.
***The Physical Review*, v. 80, no. 6, pp. 1090–1094, December 15, 1950**

Experimental results with silicon iron are given.

712. ON THE CHANGE OF MAGNETIZATION DUE TO A SMALL STRESS
Gondo, Y.
***Science Reports of the Yokohama National University*, Section II, no. 1, pp. 39–45, March 1952**

In these measurements the (H, σ) method was used. In iron the change of magnetization is divided into a reversible decrease, which occurs at $\sigma > 800$ g/mm^2, and an irreversible increase, which is saturated at $\sigma = 2$ kg/mm^2. Then from the reversible and irreversible strain sensitivities obtained here and a simple distribution of the internal stress assumed, the internal stress of annealed pure iron is estimated to be 660 g/mm^2. The results for iron–nickel alloys are also outlined briefly. (*PA*, 1955, #6310)

713. MAGNETIC DOMAINS ON SILICON IRON BY THE LONGITUDINAL KERR EFFECT

Fowler, C. A. and Fryer, E. M.
***The Physical Review*, v. 86, no. 3, pp. 426–427, May 1, 1952**

714. (NO TITLE)

Fowler, C. A. and Fryer, E. M.
***Reviews of Modern Physics*, v. 25, p. 33, 1953**

A short discussion is presented of the use of the Kerr magneto-optic effect for obtaining photographs of domains in the (100) surface of a large crystal of silicon iron.

715. MAGNETIC POWDER PATTERNS ON MARTENSITE

Andra, W.
***Annalen der Physik*, Leipzig, v. 15, no. 1, pp. 31–34, 1954 (in German)**

This report gives results for a steel specimen containing large martensite inclusions in an austenitic matrix. The patterns were obtained after mechanical and electrolytic polishing; the effect of application and reversal of a magnetic field perpendicular to the specimen surface was also investigated. The patterns show no presence of domain boundaries, and it is suggested that the martensite inclusions have single easy axes of magnetization with high magnetocrystalline anisotropy, as in cobalt. (*PA*, 1955, #1047)

716. ZUR FRAGE MAGNETISCH GERICHTETER GEFUEGE IN DAUERMAGNETEN

Kronenberg, K. J.
***Zeitschrift für Metallkunde*, v. 45, no. 7, pp. 440–447, July 1954**

Problem of magnetically oriented structures in permanent magnets; electron microscopic examination of Alnico magnets; obtained structure seems to confirm the result reached previously by R. D. Heidenreich, and E. A. Nesbitt. (*EI*, 1955)

717. ERHOEHUNG DER ANFANGESPERMEABILITAET VON NIEDRIGLEGIERTEN EISEN-SILIZIUM- UND EISEN-ALUMINIUM-LEGIERUNGEN DURCH OXYDIERENDES GLUEHEN

Fahlenbrach, H. and Houdremont, E.
***Archiv für das Eisenhuettenwesen*, v. 25, no. 7–8, pp. 377–381, July, August 1954**

This report discusses increasing initial permeability of low-alloy iron silicon and iron–aluminum alloys by oxidizing annealing at low temperatures; tests to determine increases of permeability in these and other transformer sheet steels. (*EI*, 1955)

718. THE PREPARATION OF VERY PURE IRON AND THE EVALUATION OF ITS PURITY ACCORDING TO SOME PHYSICAL PROPERTIES

Bednár, J., Brož, J., Smirous, K., and Trousil, Z.
***Czechoslovak Journal of Physics*, v. 4, no. 3, pp. 345–349 September 1954**

Pure iron has been prepared by electrolysis of ferrous chloride as well as by reduction of ferric oxide. The material thus obtained was refined in solid state by moist hydrogen. Its magnetic and electrical properties were measured and its thermal conductivity determined. By comparing the data gained in this way with the data obtained by other authors conclusions about the purity of this iron are drawn.

"A Comment on the Work on Pure Iron," F. Vicena. *Ibid.*, 5, No. 1, 105–106, Feb 1955.

"Reply to the Comment on the Work on Pure Iron," J. Bednar, J. Broz, K. Smirous and Z. Trousil. *Ibid.*, 5, No. 1, 107–109, Feb. 1955.

"On the Question of Very Pure Iron," L. Špaček. *Ibid.*, 5, No. 1, 110–111, Feb. 1955 (in Russian).
(*PA*, 1955, #4782)

719. INFLUENCE OF PLASTIC DEFORMATION ON THE BARKHAUSEN EFFECT

Wotruba, K.
Letters in *Czechoslovak Journal of Physics*, v. 4, no. 3, pp. 375–377, September 1954 (in Russian)

The number and size of discontinuities were measured on mu-metal plates subjected to various degrees of cold rolling (down to 41 per cent of the original thickness), (a) with, and (b) without subsequent annealing. The effect was over 10 times more pronounced in specimens (b) than in specimens (a). (*PA*, 1955, #7196)

720. THE MAGNETIC PROPERTIES AND THEIR TEMPERATURE DEPENDENCE OF FERROMAGNETIC ALLOYS WITH AN ORDER-DISORDER TRANSFORMATION. I. NiFe

Taoka, T. and Ohtsuka, T.

***Journal of the Physical Society of Japan*, v. 9, no. 5, pp. 712–722, September–October 1954**

The temperature dependence of magnetic properties of NiFe have been measured at a fixed state of order. NiFe is a characteristic example of the A.B.-type ferromagnetic alloy undergoing an order–disorder transformation. Particular stress was placed on the change of magnetic properties at the order–disorder transformation temperature 490°C. Magnetization was measured with an astatic magnetometer equipped with an electric vacuum furnace enabling rapid heating of the sample. Magnetostriction was measured by a new apparatus designed to simplify manipulation of the sample at high temperatures. At a fixed state of order, the saturation magnetostriction was seen to decrease monotonically with temperature, whereas at a fixed temperature it was seen to increase with the formation of order. In particular, λ_s increases by 200 per cent from below 2×10^{-6} at the disordered state to $5 \cdot 8 \times 10^{-6}$ at the ordered state, at the order–disorder transformation point. (*PA*, 1955, #2867)

721. THE MAGNETOSTRICTION CONSTANTS OF SILICON STEEL. II

Takaki, H. and Nakamura, Y.

***Journal of the Physical Society of Japan*, v. 9, no. 5, pp. 748–752, September–October 1954**

By use of long cylindrical single-crystal rods of 2.6%, 3.2% and 4.0% silicon steel with various crystallographic orientations, prepared by the Bridgeman method, magnetization and magnetostriction were measured at room temperature. It was found that Kaya's law with regard to the remanent magnetization holds for these specimens and on the basis of the law their magnetostriction constants λ_{100} and λ_{111}, and also their crystal anisotropy constants K_1 were determined. In conjunction with the results of Pt I, λ_{111} and K_1 are found to decrease almost linearly with silicon content. On the other hand, λ_{100} decreases more rapidly at low silicon content, then suddenly increases at about 2% silicon and shows no considable change up to 4% silicon. (*PA*, 1955, #2875)

722. STUDY OF FERRONICKEL SHEET AROUND THE CURIE POINT, WITH THE AID OF WEAK ALTERNATING FIELDS

Marais, A.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, v. 239, no. 15, pp. 873–875, October 11, 1954 (in French)**

Measurements at 1000 cps of the permeability in a field of 2.3×10^2 oersted of two alloys (76.5%Ni, 5% Cu, 4% Mo and 76.5% Ni, 5% Cu, 1.5% Cr). Curves of permeability as a function of temperature for specimens annealed under different conditions show a maximum just below the Curie point and a variation of Curie point with annealing time. (*PA*, 1955, #1987)

723. FERROMAGNETIC RESONANCE IN IRON–NICKEL ALLOYS

Hoskins, R. and Wiener, G.

Letter in *The Physical Review*, v. 97, no. 3, pp. 834–1154, November 15, 1954

Reports results at wavelength 0.6, 1.2, 3.0 cm for disk-shaped bulk samples with Ni concentrations between 36% and 48%. The g values remain practically constant (2.13 at 1.2 cm) over this concentration range. Values of the saturation induction and line widths were also obtained, the latter being unusually low. (*PA*, 1955 #1052)

724. MAGNETOSTRICTION OF IRON

Weil, L. and Reichel, K.

***Journal de physique et le Radium*, v. 15, no. 12, pp. 72S–73S, December 1954 (in French)**

Results are given of room-temperature measurements on a polycrystalline iron specimen in fields up to 8000 oersted using strain gauges. Saturation is practically complete at 5000 oersted with $\lambda_s \doteq -9 \times 10^{-6}$. (*PA*, 1955, #2870)

725. EINE BEZIEHUNG ZWISCHEN HYSTERESE-BEIWERT UND PERMEABILITAET—2

Kornetzki, M.

***Zeitschrift für angewandte Physik*, v. 6, no. 12, pp. 547–550, December 1954**

Relation between hysteresis coefficient and permeability; analysis of alloys having initial permeability between 1.25 and 1.2×10^5, including permalloy, superalloy, Alnico, Fe-Si-Al alloys, ferrites and others; relationship to Jordan hysteresis constant. (*EI*, 1955)

726. MAGNETISCHE ANISOTROPIE

Hesselbach, H.

***Metall*, v. 8, no. 23–24, pp. 929–935, December 1954**

This report discusses magnetic anisotropy, ferromagnetism, magnetic principles, crystal anisotropy, production of anisotropic materials, core types, anisotropic silicon iron and nickel–iron alloys. (*EI*, 1955)

727. MAGNETO-ELASTICITY OF POLY-CRYSTALLINE IRON AND NICKEL

Narasimhan, V.

***Indian Journal of Physics*, v. 29, no. 1, pp. 27–37, January 1955**

Some of the experiments for the determination of changes in the elastic moduli of polycrystalline iron and nickel are described. The results are compared with those derived from Akulov's theory of the ΔE effect in ferromagnetics. (*PA*, 1955, #8077)

728. NEUTRON DIFFRACTION STUDIES OF THE MAGNETIC STRUCTURE OF ALLOYS OF TRANSITION ELEMENTS

Shull, C. G. and Wilkinson, M. K.

***The Physical Review*, v. 97, no. 2, pp. 304–310, January 15, 1955**

Ferromagnetic disorder scattering has been found for alloys in the disordered state and magnetic superstructure scattering is observed for ordered alloys. Such magnetic scattering when combined with magnetization data offers information on the individual atomic magnetic moments present in the alloy. In general the atomic magnetic moments deviate from their pure elemental values as a function of alloy composition. Scattering data and magnetic moment information are given for members of the Fe–Cr, Ni–Fe, Co–Cr and Ni–Mn series of alloys. (*PA*, 1955, #2878)

729. KINETICS OF MAGNETIZATION IN SOME SQUARE LOOP MAGNETIC TAPES

Bean, C. P. and Rodbell, D. S.

Letter in *Journal of Applied Physics*, v. 26, no. 1, pp. 124–125, January 1955

The essential factors controlling speed of reversal of magnetization are stated. Curves of rate of magnetization in a constant field for 65 permalloy are shown. While flux reversals taking place under identical conditions fail to show exact reproducibility, calculated and test results indicate substantial agreement, suggesting simple crystal geometry and action which follows that of a magnetic single crystal. An alloy of 50% Ni–50% Fe, made into a tape, which presented a square hysteresis loop after cold working, behaved differently, suggesting that domains are nucleated at many places within the tape. At high driving fields, all the materials appear to reverse by domain walls moving in from the surface. (*PA*, 1955, #2894)

730. DOMAINS OF REVERSE MAGNETIZATION IN FERROMAGNETIC METALS

Nilan, T. G. and Paxton, W. S.

Letter in *The Physical Review*, v. 97, no. 3, pp. 834–835, February 1, 1955

Powder pattern experiments on laminated 3¼% Si steel show that the observed closure and reverse magnetization domains are charactersitic of the orientations of the crystal grains relative to the plane of the sheet and the rolling direction and are not influenced by the orientation of neighboring grains as suggested by Goodenough. For demagnetized samples the type of pattern depends entirely on the angle between the plane of the sheet and the plane containing the easy axis, the grain boundary energy having little influence on the nucleation of domains of reverse magnetization. (*PA*, 1955, #3882)

731. RELATION BETWEEN THE TEMPERATURE OF A FERROMAGNETIC SUBSTANCE AND THE HEAT DISSIPATED IN ITS INTERIOR BY AN ALTERNATING FIELD

Ribaud, G. and Bordier, D.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, v. 240, no. 7, pp. 703–707, February 14, 1955 (in French)**

Reports measurements of the heat dissipated at temperatures between room temperature and above the Curie point in cylindrical iron and nickel specimens under the

action of an alternating magnetic field of frequency 470 kc. The ratio W/i^2 of the dissipated power to the mean square current increases by factors of about three for iron and five for nickel between room temperature and the Curie point and then drops sharply to low constant values. (*PA*, 1955, #4792)

732. IRREVERSIBLE MAGNETIC AFTER-EFFECT AND ITS INFLUENCE ON THE COURSE OF THE MAGNETIZATION CURVE
Yamada, O.
***Zeitschrift für Physik*, v. 142, no. 2, pp. 225–240, 1955 (in German)**

Results on specimens of Alnico of the change of magnetization with time are reported. The results are discussed in terms of Néel's treatment, the constant Q being found to equal about 10. (*PA*, 1956, #465)

733. INVESTIGATION OF THE MAGNETIC STRUCTURE OF SILICON-IRON CRYSTALS BY THE POWDER METHOD
Shur, Ya. S. and Abel's, V. R.
***Doklady Akademii Nauk SSSR*, v. 104, no. 2, pp. 209–210, 1955 (in Russian)**

Crystal surfaces coinciding with the crystallographic planes (100) or (110) consist entirely of fundamental domains in which the magnetization vector is parallel to the direction of easy magnetization near the specimen surface (type A domains). Re-entrant domains occur at the ends of the fundamental domains. Where the surface consists of re-entrant domains, the fundamental domains are inside the specimen (B-structure). Combinations of both types are possible. (*PA*, 1956, #4495)

734. ON THE MAGNETIC AGING OF (COMMERCIALLY) PURE IRON
Asanuma, M. and Ogawa, S.
Note in *Journal of the Physical Society of Japan*, v. 10, no. 2, p. 161, February 1955

Describes experiments to show that the decrease of the initial susceptibility of iron on tempering near 130°C is mainly due to the precipitation of nitrogen, artificially introduced after annealing the specimen in an atmosphere of hydrogen. The presence of sulphur and carbon impurities was found to have little effect. (*PA*, 1955, #5511)

735. THE $\Delta\alpha$ EFFECT: (ANISOTROPY OF THE THERMAL EXPANSION COEFFICIENT OF COLD-WORKED FERROMAGNETIC MATERIALS)
Schulze, R.
***Zeitschrift für angewandte Physik*, v. 7, no. 2, pp. 57–58, 1955 (in German)**

Investigations on cold-rolled strips of a commercial alloy (Iso-Elastic) containing 36% Ni, 7–8% Cr and 0·5% Mo show that the thermal expansion coefficient is smaller in a direction parallel to the rolling direction than perpendicular to it. The variation of $\Delta\alpha$ with temperature and strain was investigated. A thermodynamical formula for $\Delta\alpha$ is given, relating it to magnetostrictive properties. (*PA*, 1955, #4788)

736. THE (110) MAGNETOSTRICTION OF SOME SINGLE CRYSTALS OF IRON AND SILICON IRON
Lee, E. W.
***Proceedings of the Physical Society*, London, Series A, v. 68, part 2, pp. 65–71, February 1955**

Using the results of a previous paper on the shape of magnetization curves, the magnetostriction of single crystals of iron parallel to the [110] direction have been calculated as functions of intensity of magnetization and field strength, using the Néel model of domain structure. It is found that the magnetostriction is dependent on crystal width in a manner analogous to that found for the magnetization curves. Measurements on three crystals of Si–Fe show good agreement with their calculated behavior. It is shown that in general the domain vectors in the demagnetized state are not uniformly distributed along all the easy axes and the distribution varies from one crystal to another. The actual distribution is evaluated in the two cases where it is found possible. (*PA*, 1955, #2876)

739. UNTERSUCHUNG VON UMWANDLUNGS-VORGAENGEN UND SEIGERUNGSER-SCHEINUNGEN IN NICKELSTACHLEN MIT MAGNETITSUSPENSION
von Klitzing, K. H. and von Elfreide, M.
***Archiv für das Eisenhüttenwesen*, v. 26, no. 3, pp. 141–144, March 1955**

Investigation of transformation processes and segregation in nickel steels with magnetic suspension, carried out on iron alloys with 30% Ni, and steel with 0.32% C, 7% Ni; application of method of N. F. Bitter lines or patterns, i.e., visualization of magnetic inhomogeneities by exposing magnetic suspension on polished metal surface. (*EI*, 1955)

740. ERZEUGUNG VON MAGNETISCHEN VORZUGSRICHTUNGEN

Houdremant, E. and Ruediger, O.

***Archiv für das Eisenhüettenweser*, v. 26, no. 3, pp. 153–157, March 1955**

This article discusses: production of magnetic preferred directions by inhomogeneous stresses in magnetostriction materials; investigation of influence of inhomogeneous stresses due to cold rolling, surface treatment, bending, etc, on formation of preferred directions; tests conducted on iron chromium alloy with 25% Cr, and on pure nickel and iron silicon alloy; detection of preferred locations by means of F. Bitter lines. (*EI*, 1955)

741. LEAKAGE FLUX AND SURFACE POLARITY IN IRON RING STAMPINGS

Hammond, P.

***Proceedings of the Institution of Electrical Engineers*, v. 102, Part c, no. 1, pp. 138–147, March 1955 (Monograph no. 116)**

A discussion is given of: conduction of magnetic flux through iron circuits magnetized by windings which surround only part of iron; complete solution obtained for infinitely long hollow iron cylinder magnetized by single current loop; surface polarity on iron plays dominant part in causing flux to be substantially constant at all sections around circumference of cylinder. (*EI*, 1955)

742. THE FUNDAMENTAL MAGNETIZATION PROCESSES IN ALNICO PERMANENT MAGNET ALLOYS

Fahlenbrach, H.

Note in *Naturwissenschaften*, v. 42, no. 3, pp. 64–65, 1955 (in German)

Brief results are given of electron-microscopical investigations of the precipitation process in magnetically annealed Alnico alloys at various stages of the heat treatment, including that giving optimum permanent magnet properties [energy product $(BH)_{max} = 5 \times 10^6$]. Qualitative estimates are also made of the saturation magnetizations and Curie temperatures of the precipitates and the matrix. (*PA*, 1955, #4801)

743. FERROMAGNETIC RESONANCE ABSORPTION IN COLLOIDAL SUSPENSIONS

Bagguley, D. M. S.

***Proceedings of the Royal Society of London*, Series A, v. 228, pp. 549–567, March 22, 1955**

Suspensions of pure metals and alloys have been investigated at wavelengths of 3.14 and 1.25 cm at 290°K. The g-factor for iron is measured to be 2.06 ± 0.02 and for nickel $2.22 = 0.02$. In the nickel-iron alloys there appears to be a sharp anomaly near 40% Ni, where the g-factor falls to 2.01, and for alloys having between 50 and 85% Ni the g-factor is found to be 2.10 ± 0.02. Apart from nickel there seems to be good agreement between $g - 2$ obtained from the microwave measurements and $2 - g'$ derived from gyromagnetic experiments. The half-width of the absorption line for iron is 700 oersted $\pm$ 10%. For the face-centered alloys the line width varies smoothly with a minimum value of about 300 oersted near 70% Ni, where the magnetic anisotropy is least. It does not seem possible to assign the whole of the line width to spin–spin interactions of the type suggested by Kittel and Abrahams. A brief discussion of the g-factors for iron and nickel is given in terms of a localized electron model. (*PA*, 1955, #3888)

744. ON DISAPPEARANCE OF THE HOPKINSON EFFECT

Tino, Y.

***Journal of the Scientific Research Institute*, Tokyo, v. 49, pp. 97–102, March 1955**

In some Fe–Ni alloys the magnetization-temperature curve obtained either in weak fields or in high fields, takes a peculiar shape that is characterized by a monotonic decrease of magnetization with rising temperature. Such alloys are, more or less, inherent mixtures of two phases ($\alpha + \gamma$), which are, however, in a state of very fine dispersion; in general, they do not show two-phase character, as seen in the magnetization-temperature curve; thus, they might be regarded as in a transition state. These circumstances were studied experimentally, and suggestions made for solving the various anomalies in the Fe–Ni system as well as for analyzing the general mechanism of phase transformation. (*PA*, 1955, #9769)

745. THE DAMPING OF IRON–NICKEL ALLOYS

Ochsenfeld, R.

***Zeitschrift für Physik*, v. 143, no. 3, pp. 357-373, 1955 (in German)**

This article reports results of measurements of the logarithmic decrement of Fe–Ni strips, with Ni contents between 0 and 60%, performing flexural oscillations, as dependent on the frequency (200-1300 cps), the strain amplitude and the applied field strength. The various contributions to the damping mechanism (magnetic and magnetomechanical hysteresis, macroscopic and microscopic eddy currents) are discussed. (*PA*, 1956, #2233)

746. UEBER EINE NEUARTIGE MAGNETOMETERAPPARATUR UND IHRE ANWENDUNG

***Zeitschrift für Metallkunde*, v. 46, no. 4, April 1955**

"New Magnetometer or Dip Needle Apparatus and Its Application: Description of Magnetometer." P. K. Hermann, H. Winterhoff; "Advantages, Measurement of Cylindrical Specimens"; "Examination of Mild Iron Specimens." "Possibilities of Application and Results Obtained." F. Pawlek, K. Reichel; "Measurements of Alnico 400"; "Heusler Alloys"; "Determination of Reduction Degree of Iron Compounds at 400 and 450°C." (*EI*, 1955)

747. EFFECT OF LOW TEMPERATURE ON THE STABILITY OF PERMANENT MAGNETS

Clegg, A. G.

***British Journal of Applied Physics*, v. 6, no. 4, pp. 120–123, April 1955**

Magnetometer measurements have been made of the change in magnetization with temperature between +60 and −60°C for magnets with a range of dimension ratios. The materials tested were Alcomax III, Columax, Alnico, 35 and 15% cobalt steels. With decreasing temperatures the magnetization increases reversibly except for the shorter dimension ratio magnets in Alcomax III and Columax, for which losses occur. The influence of tempering on these losses is discussed. Losses occur in the lower coercivity materials only with increasing temperature. The losses, whether due to increase or decrease of temperature, can be minimized by a partial demagnetization by an alternating field. The results are correlated with the changes in the demagnetization curves of the materials with temperature. (*PA*, 1955, #4786)

748. A NEW METHOD FOR INVESTIGATING THE DOMAIN STRUCTURE OF FERROMAGNETICS

Kaczér, J.

***Czechoslovak Journal of Physics*, v. 5, no. 2, pp. 239–244, April 1955**

The method uses a permalloy probe in the form of a very thin strip which is made to vibrate near the surface of the specimen and is surrounded by a secondary coil. The magnetic field on the surface produces a flux in the probe whose time derivative gives the voltage induced in the coil. Results obtained by the method on an iron–silicon crystal were compared with results obtained by the powder pattern method. (*PA*, 1955, #8892)

749. THE MAGNETO-ELASTIC PROPERTIES OF SOME FERROMAGNETIC IRON–NICKEL ALLOYS

Ochsenfeld, R.

***Zeitschrift für Physik*, v. 143, no. 4, pp. 375–391, 1955 (in German)**

The ΔE effect is shown to be affected by the application of the external forces during the measurement of Young's modulus and, since these cause some demagnetization of the specimen, the total ΔE measured is not the "true" effect which depends only on the state of magnetization in the applied field. Furthermore, the effect also depends on the strain amplitude, so that Hooke's law is not obeyed even for small values of the amplitude. This effect is suggested to be due to magnetomechanical hysteresis. The non-Hookean range can be reduced by application of an external magnetic field, and the transition to normal Hookean behavior is shown to take place spontaneously. (*PA*, 1956, #2234)

750. CHARACTERISTIC BITTER FIGURES ON SILICON–IRON CRYSTALS WITH INTERNAL STRAINS

Stephen, W.

***Annalen der Physik*, Leipzig, v. 15, no. 5–6, pp. 337–344, 1955 (in German)**

Powder patterns on internally strained 4% Si–Fe crystals which have been electrolytically polished reveal the presence of zigzag boundaries. The patterns on quenched specimens have a maze-like character. The effects of field reversals normal to the specimen surface were also investigated. (*PA*, 1955, #6294)

751. DAS PROBLEM DER UNMAGNETISIERUNGSVERSLUSTE IN TRANSFORMATOREN
Lihl, F.
***Radex Rundschau*, no. 3–4, pp. 460–472, May–June 1955**

This report discusses: problems of magnetic reversal losses in electric transformers, requirements to be met by transformer steels from theoretical and economical viewpoint, hot rolled transformer steels, steel sheets with preferred crystal orientation, influence of cooling in magnetic field. (*EI*, 1955)

752. THE ORIGIN OF THE PERMEABILITY CHANGE OF IRON–SILICON SINGLE CRYSTALS BY MEANS OF MAGNETIC ANNEALING
Fahlenbrach, H.
Note in *Naturwissenschaften*, v. 42, no. 7, pp. 174–175, 1955 (in German)

Report is given on powder pattern and initial magnetization measurements on picture frame specimens of 3.5% Si–Fe. The movement of 180° domain boundaries parallel to the [100] direction was found to take place in much lower fields after magnetic cooling than without. It is suggested that rotational processes in the [110] limbs of the frame take place more easily after magnetic cooling. (*PA*, 1955, #6293)

753. ELECTRONIC ENERGY BANDS IN IRON
Callaway, J.
***The Physical Review*, v. 99, no. 2, pp. 500–509, July 15, 1955**

The method of orthogonalized plane waves has been used to calculate the energy band structure of valence electrons in iron. Application of the results is made to the energy band theory of ferromagnetism. The exchange splitting of the energy bands and the tendency to ferromagnetism at absolute zero have been calculated. (*PA*, 1955, #8951)

754. MAGNETIC INVESTIGATIONS OF THE ORIENTATION AND AMPLITUDE DISTRIBUTION OF THE INTERNAL STRAINS IN PLASTICALLY DEFORMED METALS
Reimer, L.
***Zeitschrift für angewandte Physik*, v. 7, no. 7, pp. 332–336, 1955 (in German)**

Measurements of the remanent magnetization of cubic nickel and iron specimens which have been deformed by tension or compression show that the remanence is anisotropic, due to the presence of uniaxial strains in the direction of original deformation. The remanence change due to tension of nickel wires which have been previously deformed may be interpreted by assuming a rectangular amplitude distribution of the internal strains, whose orientations deviate by angles of no more than 10 deg from the direction of original deformation. Measurements were also made on bent specimens for which a different internal strain distribution was observed. (*PA*, 1955 #8076)

755. DE ANFANGSPERMEABILITAET EINIGER EISENWERKSTOFFE BEI MECHANISCHER BEANSPRUCHUNG
Jellinghaus, W. and Janssen, K.
***Archiv für das Eisenhuttenwessen*, v. 26, no. 7, pp. 405–419, July 1955**

Initial permeability of Armco iron, unalloyed steel containing 0.45% C, steel having 3.4% silicon content and iron nickel alloy containing 75.6% Ni under tensile stresses within elastic range has been measured; influence of demagnetization; mechanically irreversible and magnetically irreversible behavior; comparison of results with theory of magnetizing phenomenon. (*EI*, 1955)

756. GYROMAGNETIC RATIO OF IRON AT LOW MAGNETIC INTENSITIES
Scott, G. G.
***The Physical Review*, v. 99, no. 4, pp. 1241–1244, August 15, 1955**

It is shown that the measured value for the gyromagnetic ratio of pure iron as determined by a direct magnetomechanical method, undergoes a change for low values of the induced magnetic intensity. The effective value of this ratio extrapolated to zero intensity, checks the value which is theoretically expected from a consideration of recent ferromagnetic resonance experiments. For higher values of the induced magnetic intensity, the gyromagnetic ratio approaches a constant value which checks the value obtained in previous investigations based upon the Einstein–de Haas effect. (*PA*, 1955, #8922)

757. AGAIN ON THE WORK ON PURE IRON
Špaček, L.
***Czechoslovak Journal of Physics*, v. 5, no. 3, pp. 431–433, August 1955 (in German)**
(*PA*, 1956, #3003)

758. REPLY TO THE COMMENT OF L. ŠPAČEK
Bednár, J., Broz, J., Smirous, K. and Tronsil, Z.
***Czechoslovak Journal of Physics*, v. 5, no. 3, pp. 433–434, August 1955 (in German)**
(*PA*, 1956, #3003)

759. HALL EFFECT IN PERMALLOYS
Foner, S.
***The Physical Review*, v. 99, no. 4, pp. 1079–1081, August 15, 1955**

Measurements of the Hall effect for two permalloys of approximately 25 and 55% Fe in Ni are reported and compared with recent results for some Co–Ni and Fe–Ni alloys. Qualitative aspects concerning the band structure of these Fe–Ni alloys are briefly discussed. (*PA*, 1955, #8923)

760. EFFECT OF HEAT TREATMENT ON THE COERCIVE FORCE OF FERRUGINOUS MANGANESE ORES
Rao, B. S. R. and Bhimasankaram, V. L. S.
***Current Science*, v. 24, no. 8, pp. 261–262, August 1955**

Specimens containing 41% Mn, 18% Fe were annealed at temperatures between 300 and 900°C and the coercivity was found to be largest (180 oersted) for an annealing temperature 600°C. (*PA*, 1956, #4494)

761. THE INFLUENCE OF DEMAGNETIZATION METHOD ON THE PERMEABILITY OF IRON
Brož, J. and Sternberk, J.
***Czechoslovak Journal of Physics*, v. 5, no. 3, pp. 425–428, August 1955 (in Russian)**

It is sometimes thought that all methods of demagnetizing a specimen of iron, say, are equivalent. The authors' experiments, however, on Armco and other types of iron, show that specimens demagnetized by an alternating magnetic field possess thereafter higher permeability than the same specimens demagnetized by heating above the Curie point and slowly cooling to room temperature. Further, the higher the frequency of the alternating demagnetizing field, the higher the subsequent values of $\Delta\mu$ plotted against H for the specimens when remagnetized. An explanation is put forward in terms of magnetic textures quoted in Vonsovskii and Shur's "Ferromagnetism." (*PA*, 1956, #495)

762. ON THE MEASUREMENT OF THE MAGNETIC PERMEABILITY OF METALS BY MEANS OF A CAVITY RESONATOR AND THE PERMEABILITY OF IRON IN THE REGION OF FERROMAGNETIC RESONANCE. I.
Reich, K. H.
***Frequenz*, v. 9, no. 9, pp. 299–305, September 1955 (in German)**

An account of the results of theoretical and experimental investigations of the permeability of iron at frequencies up to 100 Gc/s. The subject is introduced historically, and then there is a review of the theory of magnetic permeability, particularly in the region of ferromagnetic resonance. (*PA*, 1956, #471)

763. EFFECT OF NITRIDES ON THE COERCIVE FORCE OF IRON
Kerr, J. and Wert, C.
***Journal of Applied Physics*, v. 26, no. 9, pp. 1147–1152, September 1955**

The effect of plates of nitrides on the coercive force of iron has been determined. A pronounced particle size effect was observed. The maximum effect on the coercive force was produced by particles whose largest dimension was of the order of the domain wall thickness, δ. For particles much larger than δ, an expression given by Néel for the effect of inclusions is found to be valid. The results of this study are in good agreement with earlier results reported for the effect of carbides on the coercive force of iron. (*PA*, 1955, #8903)

764. ORDERING AND MAGNETIC HEAT TREATMENT OF 50 PCT FE–50 PCT CO ALLOY
Hall, R. C., Conard, G. P., and Libsch, J. F.
***Journal of Metals*, v. 7, no. 9, Section 2, pp. 985-999, September 1955**

Alloy undergoes transformation from disorder to ordered structure of CsCl type reportedly in vicinity of

732°C; during process, coercive force goes through maximum, apparently as result of strains associated with coherent nucleation and growth reaction; alloy also shows marked increase in ratio of residual to saturation induction. (*EI*, 1955)

765. ABHAENGIGKEIT DER UMMAGNETISIERUNGSVERLUSTE WARM GEWALZTER TRANSFORMATORENBLECHE VON DEN GLUEHBEDINGUNGEN

Lihl, F. and Zemsch, P.
***Archiv für das Eisenhuettenwesen*, v. 26, no. 9, pp. 535–540, September 1955**

Effect of annealing conditions on magnetic reversal losses of hot rolled electric transformer steel sheets; studies reported on temperature and time dependence of magnetic reversal losses of 4.3% Si, 0.25% Al steel; magnetic and metallographic examinations of annealing conditions; interpretation of results in accordance with theory by L. Néel. (*EI*, 1955)

766. ON THE ORIGIN OF MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEALING

Chikazumi, S. and Oomura, T.
***Journal of the Physical Society of Japan*, v. 10, no. 10, pp. 842–848, October 1955**

The magnitude of this anisotropy was measured as a function of composition for iron–nickel alloys. It is concluded that it is proportional neither to the magnetostriction nor to the saturation magnetization. The origin of this anisotropy, therefore, can be explained neither by the theory of "strain of directional order" nor by the theory of "elongated order phase." The result can be consistently explained by the dipole–dipole interaction in directionally ordered arrangement of atoms. The result is compared with Néel's formulae. (*PA*, 1956, #474)

767. SHAPE AND CRYSTAL ANISOTROPY OF ALNICO 5

Nesbitt, E. A. and Williams, H. J.
***Journal of Applied Physics*, v. 26, no. 10, pp. 1217–1221, October 1955**

It is concluded from torque measurements on single crystals of Alnico 5 that high coercive force of these crystals depends upon shape anisotropy of fine precipitated plates and that crystal anisotropy of plates is negligible; present physical picture of alloy is that it consists of plates of precipitate of high magnetic saturation separated by matrix of comparatively low magnetic saturation. (*EI*, 1956)

768. THERMAL EFFECTS ASSOCIATED WITH MAGNETIZATION OF HIGH-COERCIVITY MATERIALS

Bates, L. F. and Simpson, A. W.
***Proceedings of the Physical Society*, London, v. 68, no. 431-B, pp. 849–858, November 1, 1955**

Magnetic and thermal properties of Alnico, Alni, Alcomax alloys, Gecalloy and Co-Pt alloy during magnetization process over field range 4000 oersted; analysis of heat generated as materials are taken through hysteresis cycle. (*EI*, 1956)

769. ON THE MAGNETIC AGING OF (COMMERCIALLY) PURE IRON. II.

Asanuma, M. and Ogawa, S.
***Journal of the Physical Society of Japan*, v. 10, no. 11, pp. 1025–1026, November 1955**

The decrease of the initial susceptibility of iron on tempering near 130°C is shown by internal friction measurements to be mainly due to the precipitation of disk-shaped particles of the phase $Fe_{16}N_2$; the phase Fe_4N has similar but less pronounced effects. (*PA*, 1956, #1370)

770. MAGNETIC SECOND-ORDER TRANSITIONS

Tauer, K. J. and Weiss, R. J.
***The Physical Review*, v. 100, no. 4, pp. 1223–1224, November 15, 1955**

The following correlations were derived from published thermal data for α–Fe and several antiferromagnetic substances: (1) $H/RT_c \simeq 1$, (2) $S/R \ln(2s + 1) \simeq 1$, (3) $H/S = T_c/\ln(2s + 1) = AZ$, where H is the magnetic enthalpy, S the magnetic entropy, T_c the Curie temperature, s the number of unpaired electrons, Z the coordination number and A a constant equal to about 113. (*PA*, 1956, #1354)

771. PRODUCTION OF ANISOTROPY IN A PERMANENT MAGNET BY PRESSURE

Gould, J. E. and McCaig, M.
***Nature*, v. 176, p. 977, November 19, 1955**

The demagnetization curve of a 35% Co steel ($H_c = 200$ oersted) was found to be squarer after application of lateral compression to a bar specimen. (*PA*, 1956, #1377)

772. THE DOMAIN STRUCTURE IN POLY-CRYSTALLINE IRON
Špaček, L.
***Czechoslovak Journal of Physics*, v. 5, no. 4, pp. 553–554, December 1955**

Theoretical interpretation of the three types observed. (*PA*, 1956, #7523)

773. MAGNETIC DOMAIN STRUCTURE IN TWINNED CRYSTALS OF SILICON IRON
Street, R. and Hall, E. O.
***Proceedings of the Physical Society*, London, Section B, v. 68, part 12, pp. 1033–1037, December 1955**

The modification of magnetic domain structures on {110} surfaces of single crystals of silicon iron by the presence of twin bands is examined by colloid deposition techniques. It appears that the structure is determined by the presence of free poles alternately of opposite sign on the interface between the twin and the crystal, giving rise to regular domains separated by 180° boundary walls. (*PA*, 1956, #3004)

774. DIE EISENVERLUSTMESSUNG NACH DEM DERZEITIGEN STAND DER TECHNIK
Schindler, M.
***Elin–Zeitschrift*, (Wien), v. 7, no. 4, pp. 171–181, December, 1955**

The problem of measuring iron losses using up-to-date techniques is discussed. 152 refs. (*EI*, 1956)

775. MAGNETIZATION CURVES AND DOMAIN STRUCTURE
Bates, L. F. and Hart, A.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 5, no. 437, pp. 497–505, 1956**

Detailed study of changes in domain patterns on two faces of Néel-cut silicon-iron crystal when crystal dimensions are changed; relation of closure domain systems to bulk magnetization along (110) direction; substantial hysteresis loss is shown for high fields with crystals of finite size. (*EI*, 1956)

776. DIE EIGENSCHAFTEN HANDELSUEBLICHER WARM GEWALZTER DYNAMOBLECHE.
Czerlinsky, E.
***Archiv für das Eisenhuettenwesen*, v. 27, no. 1, pp. 35–40, January 1956**

Properties of conventional hot-rolled electrical sheet iron; determination of effects of stamping and pressure on magnetization curves and hysteresis losses of sheets; change of magnetic properties through heat treatment at 850°C; eddy current losses for various states of insulation of sheets. (*EI*, 1956)

777. STUDY OF DOMAIN STRUCTURES IN ALNICO
Bates, L. F. and Martin, D. H.
British Electrical and Allied Industries Research Association, London, Technical Report N/T71, 1956

Powder deposit examination of ferromagnetic domain structures in four specimens of Alnico in which had been developed coercivities of about 2 (quenched) 10, 40 and 100 oersted respectively. (*EI*, 1956)

778. FERROMAGNETIC DOMAIN NUCLEATION IN SILICON IRON
Bates, L. F. and Martin, D. H.
British Electrical and Allied Industries Research Association, London, Technical Report N/T72, 1956

Powder deposit patterns obtained on single crystals of 3% silicon iron permit description of processes of domain phase creation in terms of nucleation at inclusions in surfaces; domain nucleation is discussed in relation to various magnetic properties. (*EI*, 1956)

779. ON THE MEASUREMENT OF THE MAGNETIC PERMEABILITY OF METALS BY MEANS OF A CAVITY RESONATOR AND THE PERMEABILITY OF IRON IN THE REGION OF FERROMAGNETIC RESONANCE. III.
Reich, K. H.
***Frequenz*, v. 10, no. 1, pp. 11–19, January 1956 (in German)**

Results of measurements of the permeability, as a function of applied field, of pure iron, commercial sheet iron, and silicon-iron sheet, at a wavelength of 1.222 cm and at

20 and 200°C. The measurements were made before and after polishing the specimens. The permeabilities were found to be independent of temperature in the region investigated, and also of the degree of purity of the specimen, but strongly dependent on the roughness of the surface of the specimen, and of the degree of crystal orientation. For an oriented silicon-iron sheet the field strength for resonance was found to vary with the direction of measurement. The results are discussed and compared with theory. (*PA*, 1956, #5219)

780. LAW OF APPROACH TO SATURATION OF A SINGLE CRYSTAL OF Fe–Si IN THE THREE PRINCIPAL CRYSTALLOGRAPHIC DIRECTIONS

Danan, H.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 6, pp. 748–750, February 6, 1956 (in French)**

Reports results on the field dependence of the magnetization of a 4% Fe–Si crystal. For internal fields between 10^3 and 2.7×10^4 oersted the law of approach is $I = I_0(1 - a/H)$, where $I_0 = 1644$ gauss and the a-values parallel to the [100], [110] and [111] axes are respectively 22.4, 26.5 and 28.0. (*PA*, 1956, #3820)

781. FERROMAGNETIC DOMAIN NUCLEATION IN SILICON IRON

Bates, L. F. and Martin, D. H.

***Proceedings of the Physical Society*, London, Section B, v. 69, Part 2, pp. 145–152, February 1956**

Powder deposit patterns obtained by the authors on single crystals of 3% silicon iron are consistent with a description of the processes of domain phase creation in terms of nucleation at inclusions in the surfaces. Domain nucleation is discussed in relation to various magnetic properties. (*PA*, 1956, #3027)

782. THE PHYSICS OF MAGNETIC MATERIALS

Bozorth, R. M.

***Electrical Engineering*, v. 75, no. 2, pp. 134–140, February 1956**

A review is given of the atomic structure of iron and the ferrites to show how magnetic phenomena may be explained. Reference is also made to the domain theory. The properties of iron–silicon and iron–nickel alloys are discussed. It is stressed that basic phenomena should be understood if best engineering results are to be obtained from magnetic materials. (*PA*, 1957, #3436)

783. INVESTIGATION OF THE DEMAGNETIZATION PROCESS IN ALNICO OF HIGH COERCIVE FORCE WITH THE HELP OF POWDER PATTERN TECHNIQUE

Andra, W.

***Annalen der Physik, Leipzig*, v. 19, no. 1–2, pp. 10–18, 1956 (in German)**

An extension of previous work on anisotropic Alnico. A series of powder photographs parallel and perpendicular to the preferred direction show the growth of anti-parallel domains during demagnetization. (*PA*, 1957, #6354)

784. DYNAMIC MAGNETOSTRICTIVE PROPERTIES OF ALFENOL

Davis, C. M. and Ferebee, S. F.

***Journal of the Acoustical Society of America*, v. 28, no. 2, pp. 286–290, March 1956**

The magnetostrictive properties of Alfenol, a cold-rolled Al–Fe alloy, were investigated to determine its suitability for use in electromechanical transducers. The effects of various processing techniques are included. The material, in the form of laminated toroids, was evaluated by the motional impedance method. Measured values of the electromechanical coupling coefficient, the mechanical Q in air, the reversible permeability, the dynamic magnetostrictive constant, and other parameters are given. The measurements indicate that the performance of 12- or 13-alfenal is comparable to that of nickel, at least for low-power applications. The electromechanical coupling coefficient (approximately 0.29) is comparable to that of nickel; the electrical resistivity is at least ten times greater than that of nickel. (*PA*, 1956, #3825)

785. HALL EFFECT AND MAGNETIC PROPERTIES OF ARMCO IRON

Foner S.

***The Physical Review*, v. 101, no. 6, pp. 1648–1652, March 15, 1956**

The Hall effect is examined in detail over a large range of fields. The effect is given by a sum of the ordinary and the extraordinary effect over the range investigated,

including the nonlinear region. It is shown that the extraordinary Hall constant is independent of field within the experimental error. The approach to magnetic saturation in Armco iron is examined at high fields. The Hall effect is shown to be useful for studying detailed behavior of magnetic properties. (*PA*, 1956, #3009)

786. MAGNETIC SCREENING EFFECT OF IRON TUBES
Hammond P.
***Proceedings of the Institution of Electrical Engineers*, v. 103, Part C,no. 3, pp. 112-120, March 1956 (Monograph 144)**

It is shown that magnetic behavior of iron of widely varying permeability can be accurately predicted from theory based on assumption of constant permeability, provided that close study is made of distribution of surface polarity. The theory is applied to screening action of iron tubes. It is shown that screening effect will vary from place to place in screened region. (*EI*, 1956)

787. THE BITTER LINE PATTERNS ON SILICON-IRON CRYSTALS WITH INTERNAL STRESSES
Stephan, W.
***Experimentelle Technik der Physik*, v. 4, no. 4, pp. 153–156, 1956 (in German)**

Stress patterns and zigzag walls occur on the (100) faces of internally stressed silicon–iron crystals. On increasing the internal stress, the volume of unfavorably oriented prisms in the end regions was reduced causing the zigzag walls to split. The maze patterns disappeared on applying a suitable external tension, magnetic measurements indicated that internal stresses could be $> 4\times$ this tension. (*PA*, 1959, #5883)

788. VIBRATING PERMALLOY PROBE FOR MAPPING MAGNETIC FIELDS
Kaczer, J. and Gemperle, R.
***Czechoslovak Journal of Physics*, v. 6, no. 2, pp. 173–184, April 1956**

A detailed description is given of the apparatus for mapping the magnetic field on the surface of ferromagnetic materials. Some of its properties are shown by a calibration equipment used. Examples are given of the application of the probe in mapping the domain structure of silicon iron. (*PA*, 1956, #7514)

789. MAGNETIC DISPERSION AND ABSORPTION OF IRON BETWEEN 0 AND 7 kMc/s
Naschke, E.
***Journal de physique et le Radium*, v. 17, no. 4, pp. 330–337, April 1956 (in French)**

This article reports results of measurements of the complex permeability of iron specimens heat treated at temperatures between 500 and 1220°C, and obtains agreement with the theoretical results of Néel. The domain widths deduced are in good agreement with powder pattern values. (*PA*, 1956, #7524)

790. FORTSCHRITTE AUF DEM GEBIETE DER DAUERMAGNET-WERKSTOFFE
Fahlenbrach, H.
***Technische Mitteillungen Krupp*, v. 14, no. 1, pp. 2–11, April 1956**

Progress in the field of permanent magnet materials; development, production and properties of Alni and Alnico alloys, barium oxide, and iron–cobalt–vanadium alloys; tabular data on materials produced by Krupp WIDIA-Fabrik. (*EI*, 1957)

791. BEITRAEGE ZUR GRUNDIAGENFORSCHUNG DER DAUERMAGNETE
Fahlenbrach, H.
***Technische Mitteilungen Krupp*, v. 14, no. 1, pp. 12–15, April 1956**

This article reviews basic processes in magnetization of Alnico permanent magnet alloys. (*EI*, 1957)

792. DER EINFLUSS EINER INNEREN VORMAGNETISIERUNG AUF DIE WECHSELSTROM-MAGNETISIERUNGSSCHLEIFE VON TEXTURWERKSTOFFEN
Ackermann, W., and Theile, K. J.
***Technische Mitteilungen Krupp*, v. 14, no. 1, pp. 24–28, April 1956**

Influence of internal premagnetization on a-c magnetization curves of textured materials; various Hyperm 50 T (Fe 50% Ni alloys) and Hyperm Co 50 T (Fe 50% Co alloys) studied; hysteresis curves presented and correlated with structure. (*EI*, 1957)

793. SPIN FLUCTUATION SCATTERING OF NEUTRONS AND THE FERROMAGNETIC STATE IN IRON

Lowde, R. D.

***Proceedings of the Royal Society of London,* Series A, v. 235, pp. 305–320, May 8, 1956**

The theory and practice of neutron diffuse reflection is applied to the question: What theoretical model of ferromagnetism is most apposite in the case of iron? Experimental results on the response of diffusely reflected intensity to the magnetization of an iron crystal at room temperature and at 907°K are interpreted as excluding the collective-electron representation, and indicating that the Heisenberg-type, localized-electron model is much closer to the truth. From the fit obtained between the observations and the predictions of the localized-electron model it is suggested that the magnetic electrons in iron vibrate under thermal agitation with measurably less than the nuclear amplitude. (*PA*, 1956, #4489)

794. STUDY OF MAGNETIC ANNEALING ON Ni_3Fe SINGLE CRYSTAL

Chikazumi, S.

***Journal of the Physical Society of Japan*, v. 11, no. 5, pp. 551–558, May 1956**

Magnetic anisotropy induced by magnetic annealing was measured for a Ni_3Fe single crystal by means of a high-temperature-torque magnetometer. It was found that the magnitude of anisotropy depends upon the crystallographic direction of the field which is applied during annealing. It was largest for ⟨111⟩, next for ⟨110⟩ and smallest for ⟨100⟩. It was also found that the minimum of the anisotropy energy lies not in exactly the same direction as that of annealing field, but in the direction nearer to the neighboring ⟨111⟩. These facts could be explained qualitatively by Néel–Taniguchi–Yamamoto's formula. Quantitative discrepancy between them could be attributed to the characteristic of a face-centered cubic lattice that some of the nearest neighbors of one atom are also nearest neighbors of one another. The influence of ordinary order was also investigated. (*PA*, 1956, #5223)

795. MAGNETIZATION CURVES AND DOMAIN STRUCTURE

Bates, L. F. and Hart, A.

***Proceedings of the Physical Society*, London, Section B, v. 69, Part 5, pp. 497–505, May 1956**

For the two main faces of a Néel-cut crystal of silicon iron a detailed study is made of the changes in domain patterns occurring when the crystal dimensions are changed. The contribution of closure domain systems to bulk magnetization along a [110] direction is treated experimentally and theoretically; the results explain differences between the ideal (Akulov) magnetization curve and curves obtained experimentally, and prove that a substantial hysteresis loss occurs in high fields with crystals of finite size. (*PA*, 1956, #6787)

796. DETERMINATION OF THE SPONTANEOUS LATTICE DEFORMATION DURING FERROMAGNETIC TRANSFORMATION

Belov, K. P. and Panina, I. K.

***Doklady Akademii Nauk SSSR*, v. 111, no. 5, pp. 985–987, 1956 (in Russian)**

A specimen is cooled below the Curie point when it magnetizes spontaneously and strains are set up in it. The spontaneous deformation is found from measurements of the temperature dependence of the magnetostriction of the specimen. Alloys studied consisted of 32% Ni, 68% Fe; 31% Ni, 5% Co, 64% Fe (invar.); 33% Ni, 3% Co, 64% Fe; 36% Ni, 64% Fe; 97.6% Ni, 2.49% Si. The magnetostriction and the square of the spontaneous magnetization are found to vary linearly with T. (*PA*, 1957, #5474)

797. ON POWDER PATTERNS AND MAGNETIZATION PROCESSES IN HIGH-COERCIVITY ALNICO MAGNETS

Kussmann, A. and Wollenberger, J. H.

***Zeitschrift für angewandte Physik*, v. 8, no. 5, pp. 213–216, 1956 (in German)**

Bitter patterns have been obtained on Alnico of high coercive force (670 oersted), which had been cooled in a magnetic field, and which was known to have a finely dispersed texture. The patterns consist of lines parallel to the preferred direction. (*PA*, 1956, #6014)

798. DIE ANWENDUNG DER SICHTBARMACHUNG VON ELEMENTARBEREICHSTRUKTUREN MIT BITTERSCHEN STREIFEN

Fahlenbrach, H.

***Metall*, v. 10, no. 9-10, pp. 393–399, May 1956**

The following are discussed: elementary domain structures made visible by Bitter figures; elementary domains are constituents of all ferromagnetic materials, investiga-

tions on magnetic properties of iron nickel and iron silicon alloys; Bitter figures make it possible to reveal quality of crystal orientation. (*EI*, 1956)

799. SATURATION MOMENTS AND d-BAND CONFIGURATIONS IN IRON AND ITS ALLOYS

Coles, B. R. and Bitler, W. R.
***The Philosophical Magazine*, Eighth Series, v. 1, no. 5, pp. 477–486, May 1956**

The saturation magnetic moments of certain iron alloys are difficult to interpret in terms of models found satisfactory for nickel alloys. It has been suggested that in pure iron the total number of empty d-band states is appreciably greater than the number of unpaired spins calculated from the saturation moment. The saturation moments of some iron–cobalt–aluminum alloys have therefore been measured and the effect of aluminum on the moments of iron–cobalt alloys is compared with its effect on the moment of pure iron. It is concluded that in iron the number of empty d-states exceeds the number of unpaired spins; the latter quantity is 2.22 per atom, while the value suggested for the former is greater than 3 per atom. The details of the effects found in the ternary alloys are discussed in terms of the d-band shape. (*PA*, 1956, 6780)

800. ON THE INTERPRETATION OF MAGNETIC TORQUE REVERSAL

Chikazumi, S.
***Journal of the Physical Society of Japan*, v. 11, no. 6, pp. 718–719, June 1956**

Interpretation is given of the change of sign of the torque of Fe_2NiAl at high fields not as due to the preferential growth of acicular precipitates but rather as a direct result of the magnetic annealing treatment, which induces an additional uniaxial anisotropy. (*PA*, 1956, 7525)

801. NEUTRON DIFFRACTION STUDIES ON IRON AT HIGH TEMPERATURES

Wilkinson, M. K. and Shull, C. G.
***The Physical Review*, v. 103, no. 3, pp. 516–524, August 1, 1956**

Measurements have been made at a series of elevated temperatures up to about 1000°C to establish the magnetic scattering effects through the Curie temperature and in the γ-phase region. Diffraction patterns obtained for the face-centered cubic γ phase offer no evidence for an antiferromagnetic structure in γ iron at high temperatures, and the diffuse scattering above T_c suggests that both phases of the metallic lattice are paramagnetic in that temperature region. At temperatures up to the α-γ phase transformation, the paramagnetic scattering suggests the existence of considerable ferromagnetic short range order. Pronounced small-angle scattering was found to develop in the temperature region around the Curie transition, and this type of scattering is explained on the basis of the critical magnetic scattering suggested by Van Hove. Detailed investigations, which included experiments on nickel and magnetite near their Curie transitions, were performed to determine the general characteristics of the critical magnetic scattering. (*PA*, 1956, #7526)

802. GYROMAGNETIC RATIOS OF THE IRON–NICKEL ALLOYS

Scott, G. C.
***The Physical Review*, v. 103, no. 3, pp. 561–563, August 1, 1956**

Measurements by magneto-mechanical experiments show that the gyromagnetic ratios for the alloys of the iron–nickel series undergo changes for low values of the induced magnetic intensity. This leads to a high- and low-intensity value for g' for each metal. Two distinct curves of g' vs. % nickel are thus obtained. Nine different rods were used in which the content of nickel in iron varied from 0% Ni to 100% Ni. (*PA*, 1956, #7538)

803. INFLUENCE OF MAGNETIC FIELD ON THE PRECIPITATION PROCESS OF FERROMAGNETIC PHASE IN Cu–Fe ALLOY. I.

Mitui, T.
***Journal of the Physical Society of Japan*, v. 11, no. 8, pp. 895–896, August 1956**

Reports are given of results of magnetic torque and Vickers hardness measurements on an alloy containing 2% Fe. The dependence of the anisotropy and hardness on the duration of heat treatment was determined, and it is concluded that the precipitates are initially nonferromagnetic and only transform to a ferromagnetic phase after about five hours at 700°C. (*PA*, 1956, #8867)

804. HYSTERESIS–RELAXATION AND PERMEABILITY OF SILICON–IRON CONTAINING CARBON

Schreiber, F.
***Zeitschrift für angewandte Physik*, v. 8, no. 11, pp. 539–551, November 1956**

A detailed treatment, in terms of Preisach diagrams, of hysteresis-relaxation phenomena at low field strengths. The quantities considered are the shape of the hysteresis loop, the harmonic content of the induction, and the permeability, and these are discussed in relation to the movement of carbon atoms and to Barkhausen jumps of Bloch walls. The quantitative relations between the variations in shape of the hysteresis loop and those of the real and imaginary parts of the permeability are treated with the help of a Fourier analysis. As a measure of the hysteresis relaxation a "creep permeability" is introduced. This is the product of two factors – a hysteresis constant and a limiting field strength – which are proportional to the carbon content of the material and which can be determined experimentally. (*PA*, 1958, #658)

805. ON THE FORMATION OF BITTER FIGURES

Bergmann, W. H.
***Zeitschrift für angewandte Physik*, v. 8, no. 11, pp. 559–561, November 1956 (in German)**

The conditions required for the formation of Bitter figures are discussed and it is shown that the size of the suspended particles must lie between certain limits if the figures are to be formed. It is also shown that the intensity of magnetization of the suspended particles must not exceed a certain critical value which depends upon the magnetic properties of the material under examination. The results obtained explain why Bitter figures are not formed on strain-free Ni–Fe alloys containing from 50-80% Ni. (*PA*, 1958, #652)

806. SUPERPOSED MAGNETIC FIELDS IN MATERIALS WITH RECTANGULAR HYSTERESIS LOOPS

Wakeman, C. B. and Beck, F. J.
***American Institute of Electrical Engineers*, v. 75, Part 1, no. 27, pp. 562–569, November 1956**

For certain materials, applying uniform fixed field normal to magnetic intensity to serve as excitation for hysteresis loop, causes apparent saturation flux density to diminish without greatly affecting rectangularity; coercive force of new loop remains small; sharp saturation level is reached below intrinsic saturation flux density; study of 50% nickel iron and 4-79 molybdenum permalloy. (*EI*, 1957)

807. THERMENOL–NEW "SOFT" MAGNETIC ALLOY

Nachman, J. F. and Buehler, W. J.
***Electrical Manufacturing*, v. 58, no. 5, pp. 140–145, 354, November 1956**

Nonstrategic ternary system of iron aluminum molybdenum, developed by authors and currently under heavy investigation as high-temperature structural material, also shows great promise as replacement for critical nickel or cobalt magnetic alloys. (*EI*, 1957)

808. PERFORMANCE OF MAGNETIC MATERIAL UNDER SUPERPOSED ALTERNATING AND DIRECT MAGNETIZATIONS

Patel, S. T.
***Journal of the Institution of Engineers*, India, v. 37, no. 3, Part 2, pp. 253–265, November 1956**

Performance studied under small and larger alternating flux density changes; results obtained from tests on special stalloy strips. (*EI*, 1957)

809. REMARKS ON THE ANOMALOUS BEHAVIOR OF ALLOYS CONTAINING TRACES OF MANGANESE OR SIMILAR ELEMENTS

Gorter, C. J., van den Berg, G. J. and de Nobel, J.
***Canadian Journal of Physics*, v. 34, no. 12A, pp. 1281–1284, December 1956**

The anomalous behavior of alloys containing traces of manganese and similar elements is briefly reviewed as to electric conductivity, magnetoresistance, susceptibility, magnetic resonances, thermoelectricity, specific heat, thermal conductivity, and Hall effect. Special reference is given to recent data obtained in Leyden. It is argued that, while the rapid decrease of the resistance sometimes occurring at very low temperatures apparently must be attributed to some kind of antiferromagnetic alignment, the resistance minimum, as well as the anomalies in thermoelectricity and the Hall effect, might be due to gaps at the crystalline boundaries. (*PA*, 1957, #9198)

810. A COMPARISON OF MAGNETIC VISCOSITY IN ISOTROPIC AND ANISOTROPIC HIGH COERCIVITY ALLOYS

Street, R. and Woolley, J. C.
***Proceedings of the Physical Society*, London, Section B, v. 69, part 12, pp. 1189–1198, December 1956**

Measurements of magnetic viscosity in equiaxed isotropic and anisotropic Alcomax III specimens have been made, the anisotropy was induced by cooling the material, from the single phase region, in a magnetic field of 4000 oersted. The results are discussed in terms of the concept of the thermal activation of irreversible domain boundary wall movements. Comparisons of the results of measurements on anisotropic and isotropic specimens are in reasonable agreement with theoretical predictions. (*PA*, 1957, #2425)

811. AN ANALYSIS OF THE MAGNETIZATION PROCESSES IN IRON SINGLE CRYSTALS BY AN ELECTRICAL METHOD
Parker, R.
***The Philosophical Magazine*, Eighth Series, v. 1, pp. 1136–1146, December 1956**

Doring's theory of the anisotropy of electrical resistivity of ferromagnetics is applied to the published magnetoresistance data of single crystals of iron. The theory is shown to be in good agreement with experiment and the five anisotropy coefficients for iron are evaluated. It is suggested that a study of the magnetoresistance as a function of magnetization may be used to obtain information concerning the magnetization process in ferromagnetic crystals of cubic symmetry. An analysis has been made of the measurements reported by Kuwahara on single crystal strips of iron. In certain favorable cases the actual magnetization process can be inferred from a number of plausible alternatives by a consideration of the electrical data. For other specimens an estimate of the domain vector orientation in the demagnetized state is obtained. The relative advantages of the electrical method are discussed. (*PA*, 1957, #2433)

812. MAGNETS: THERE'S UNTAPPED STRENGTH IN PURE IRON POWDER
Jaumot, F. E., Jr. and Berkowitz, A. E.
***The Iron Age*, v. 178, no. 25, pp. 88–89, December 20, 1956**

Advantages of pure iron permanent magnets; discussion of coercive force and energy product which are considered significant in evaluating magnetic materials; demagnetized sample studied; magnetization factors; methods for producing single-domain particles. (*EI*, 1957)

813. PERMANENT MAGNETS WITH $(BH)_{max}$ VALUES OVER TEN MILLION GAUSS OERSTEDS
Luteijn, A. I. and de Vos, K. J.
***Philips Research Reports*, v. 11, no. 6, pp. 489–490, December 1956**

Reference is made to anisotropic permanent magnetic alloys of "Ticonal" series, and various thermal treatments to increase $(BH)_{max}$ value; $(BH)_{max}$ value of 11.0 million gauss oersteds at remanence of 11,800 gauss and coercivity of 1315 oersteds could be reached with pure alloy of composition 35% Fe 34% Co, 15% Ni, 7% Al, 4% Cu, 5% Ti. (*EI*, 1957)

814. GEFUEGE UND MAGNETISCHE EIGENSCHAFTEN VON DAUERMAGNETIEGIERUNGEN WAEHREND DER ISOTHERMEN AUSSCHEIDUNGSHAERTUNG
Biedermann, E. and Kneller, E.
***Zeitschrift für Metallkunde*, v. 47, no. 12, pp. 760–774, December 1956**

Structure and magnetic properties of permanent magnet alloys during isothermal age hardening; process of segregation of copper nickel iron alloys: interpretation of development of magnetic properties during age hardening: X-ray structure. (*EI*, 1957)

815. SOME MAGNETIC PROPERTIES OF DILUTE ANISOTROPIC FERROMAGNETIC ALLOYS
Sucksmith, W.
British Electrical and Allied Industries Research Association, London, Technical Report, N/T74, 1957

This report is concerned with the magnetic properties of very small particles of iron which are precipitated out of dilute solid solution in copper. An apparatus is described for measuring remanence and coercivity in the very low intensities of magnetization encountered. The work described in Brit. Elect. Res. Assoc. Report N/T64 (1953) has been extended to the development of anisotropic alloys with high coercivities produced by cold drawing of alloys. The results are discussed in the light of existing theories. (*PA*, 1958, #1773)

816. DOMAIN PROCESSES AND MAGNETIC AND THERMOMAGNETIC BEHAVIOUR OF A CRYSTAL OF SILICON IRON
Davis, P. F.
British Electrical and Allied Industries Research Association, London, Technical Report N/T79, 1957

Bitter pattern observations have enabled some of the details of the magnetization curve to be explained, and have been linked with thermomagnetic measurements for a silicon–iron crystal along a direction of easy magnetization. A material with few inclusions should not only have a low coercive force but should also be nearer saturation at the knee of the magnetization curve than a material with many inclusions, because if it contains few inclusions it will contain few tree trunk domains of reverse magnetization and a few Néel spikes attached to inclusions and grain boundaries. However, it is necessary for the material to contain a few large nucleating centers in order that the magnetization may be reversed in a low field. The sizes of Néel spikes and tree-trunk domains depend on the anisotropy of the material; the smaller the anisotropy the smaller are these domains, therefore the lower the anisotropy the more rapidly the material approaches saturation. (*PA*, 1959, #2490)

817. FORGOTTEN MAGNETO-OPTICAL EFFECT
Lamarsh, J. R.
***American Journal of Physics*, v. 25, no. 1, pp. 17–18, January 1957**

An interesting magneto–optical effect discovered at the close of the last century has gone unnoticed. When an annealed soft iron rod is magnetized by a solenoid and then demagnetized it can be remagnetized by light, heat or mechanical shock. The experimental evidence for the phenomenon is reviewed, and a qualitative explanation is presented. New experiments are required to obtain a complete understanding of the effect, and such an undertaking is strongly urged. (*PA*, 1957, #3451)

818. SURFACE STRUCTURES AND FERROMAGNETIC DOMAIN SIZES
Martin, D. H.
***Proceedings of the Physical Society*, London, Section B, v. 70, part 1, pp. 77–84, January 1957**

Studies of the domain structures in the surface layers of crystals of iron and silicon–iron having (111) and (*h*0*l*) type faces, have permitted calculations to be made of the optimum domain sizes in iron crystals as dependent on the crystallographic orientations of their faces and on their sizes. (*PA*, 1957, #4556)

819. UEBER DIE MAGNETISCHE WALZAN-ISOTROPIE KUBISCH FLAECHENZEN-TRIERTER EISEN-NICKEL-LEGIERUNGEN
Bunge, H. J. and Mueller, H. G.
***Zeitschrift für Metallkunde*, v. 48, no. 3, pp. 25–32, January 1957**

Magnetic anisotropy of cubic face centered iron–nickel alloys (30 to 100% Ni); influence of degree and direction of rolling, and of annealing after cold rolling; interpretation of results. (*EI*, 1957)

820. ON THE COMPLEX PERMEABILITY OF IRON–NICKEL ALLOYS AT HIGH FREQUENCIES
Anderson, J. C. and Donovan, B.
***Proceedings of the Physical Society*, London, Section B, v. 70, part 2, pp. 186–191, February 1957**

The real and imaginary parts of the complex permeability have been measured for a series of iron–nickel alloys in the frequency range 300-400 Mc/s. The frequency of the internal resonance observable in this region has been investigated as a function of composition and is found to pass through a minimum in the neighborhood of 70% Ni. The value of the principal anisotropy coefficient is also known to be very small in this region and a qualitative comparison provides additional support for the view that this resonance is attributable to the equivalent magnetic field associated with the anisotropy energy. (*PA*, 1957, #4543)

821. THE EFFECT OF NON-MAGNETIC INCLUSIONS IN SOFT MAGNETIC MATERIALS
Lihl, F.
***Acta Physicia Austriaca*, v. 11, no. 2, pp. 232–240, 1957 (in German)**

The effects of non-magnetic inclusions on the properties of soft magnetic materials are discussed with reference to the theories of Néel and to experimental results on silicon–iron. Particles in the size range 0.05-1 μ are most harmful and the possibilities of removing such particles or preventing their formation by special annealing treatments are considered. (*PA*, 1958, #8116)

822. ANOMALOUS HYSTERESIS CYCLES DUE TO DIFFUSION MAGNETIC AFTER-EFFECT
Brissonneau, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 7, pp. 868–870, February 11, 1957 (in French)**

Reports results of measurements of the hysteresis cycles of an Armco iron specimen containing a small amount of carbon, as dependent on the maximum applied ac field strength and the time interval between application and measurement. In some cases constricted loops were observed. (*PA*, 1957, #7213)

823. FERROMAGNETIC RESONANCE IN CERTAIN Fe–Ni ALLOYS
Frait, Z.
***Czechoslovak Journal of Physics*, v. 7, no. 2, p. 246, 1957 (in Russian)**

Measurements of magnetic resonance parameters were made with specimens in the form of disks, the surfaces of which had been subjected to particularly careful polishing procedure. The apparatus and method have been given earlier. The nickel contents of the alloys were 79, 48 and 37% by weight respectively. It was found that for 3 cm waves the factor g varies little with alloy composition. The results generally were found in good agreement with those of Hoskins and Wiener. (*PA*, 1959, #8326)

824. THERMOMECHANICAL TREATMENT OF VICALLOY
Shur, I. S., Luzhinskaia, M. G., and Shubina, L. A.
***Physics of Metals and Metallography*, (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 1, pp. 45–52, 1957**

Effect of treatment on high coercive alloy containing 52% Co, 12% V, balance Fe: treatment consisting of superimposing unilateral tensile stress on samples at time of annealing, is capable of altering magnetic properties; coercive force may, under certain conditions, be increased by 25%, and maximum magnetic energy by 40 to 50%. (*EI*, 1957)

825. INFLUENCE OF ELASTIC STRESSES ON MAGNETIC PROPERTIES OF ALLOY VICALLOY
Shur, I. S., Luzhenskaia, M. G., and Shubina, L. A.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 1, pp. 40–44, 1957**

Influence of unilateral elastic extension and elastic torsion on Vicalloy (12% V, 52% Co, balance Fe) studied; extension leads to large increase of coercive force and also to growth of remanent induction: reasons for increase of coercive force obtained for both extension and torsion is explained. (*EI*, 1957)

826. ON MAGNETIC PROPERTIES OF THE ORDERABLE Fe_3Al ALLOY
Ivanovskii, V. I.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1, (10), pp. 70–75, 1957 (in Russian)**

Coercive force, susceptibility and magnetic losses of Fe_3Al (25 atom % Al) are reported. These properties are related to the order–disorder transition which occurs at 550°C (the transition temperature is called Kurnakov's point). (*PA*, 1959, #5878)

827. MAGNETIC PROPERTIES OF ORDERED Fe_3Al ALLOY
Ivanovskii, V. I.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 1, pp. 53–57, 1957**

Temperature dependence of coercive force and of initial susceptibility of Fe_3Al alloy; its susceptibility in vicinity of temperature point (about 550°C) established by N. S. Kurnakov; kinetics of magnetic viscosity of Fe_3Al alloy during ordering process. (*EI*, 1958)

828. DEPENDENCE OF THE MAGNETIC PROPERTIES OF SINTERED PERMANENT MAGNETS ON POROSITY
Al tman, A. B.
***Fizika Metallov i Metallovedenie*, v. 4, no. 1 (10), pp. 84–88, 1957 (in Russian)**

The effect of porosity on the magnetic properties of sintered Alni (Al–Fe–Ni), Alnico, Magnico (Al–Co–Fe–Ni) and Cunico (Cu–Ni–Co) magnets is reported. (*PA*, 1959, #5893)

829. DEPENDENCE OF MAGNETIC PROPERTIES OF METALLO-CERAMIC PERMANENT MAGNETS ON POROSITY
Altman, A. B.
Physics of Metals and Metallography (translation of *Fizika Mettalov i Metallovedenie*), v. 4, no. 1, pp. 65–68, 1957

Investigations on influence of permeability of powder metal permanent magnets made from Alni, Alnico, Magnico and Cunico alloys on their magnetic properties; empirical formulas presented expressing dependence of magnitude of maximum magnetic energy and residual induction on concentration of pores in magnets. (*EI*, 1957)

830. STACKING DISORDERS IN NICKEL BASE MAGNETIC ALLOYS
Heidenreich, R. D. and Nesbitt, E. A.
The Physical Review, v. 105, no. 5, p. 1678, March 1, 1957

Electron diffraction patterns produced by a Perminvar sample show streaks and satellite spots associated with the normal Bragg spots. These are attributed to stacking faults on the 111 planes, and it is suggested that stacking faults in single-phase magnetic alloys may be important in the mechanism which causes these alloys to respond to heat treatment in a magnetic field. (*PA*, 1957, #5461)

831. WPLYW WODORU KATODOWEGO NA WLASNOSCI MAGNETYCZNE NIEKTORYCH FERROMAGNETYKOW
Kozlowski, L.
Archiwum Hutnictwa, v. 2, no. 3, pp. 223–241, 1957

Effect of cathodic hydrogen on magnetic properties of some ferromagnetic materials; changes of magnetic properties of low carbon steel specimens and other ferromagnetic materials due to cathodic hydrogen polarization; analysis of formulas of theories concerning coercive force of magnetically soft materials and possibility of their application to interpret results on basis of physical chemistry. English summary. (*EI*, 1957)

832. MAGNETIC AFTER EFFECT AND INTERNAL FRICTION AT HIGH TEMPERATURES IN IRON AND SOME IRON ALLOYS
Ferro, A. and Montalenti, G.
Il Nuovo Cimento, Supplement, v. 6, no. 3. pp. 1214–1215, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #439)

833. THE INFLUENCE OF DISLOCATIONS ON THE COERCIVITY OF IRON
Málek, Z.
Czechoslovak Journal of Physics, v. 7, no. 3, pp. 335–338, 1957 (in German)

A formula due to Vicena, relating coercivity to dislocation density, was tested experimentally on iron wires under different degrees of strain s. The formula gives $H_c \propto s^{1/4}$, in good agreement with the observations. (*PA*, 1959, #8295)

834. DYNAMIC MAGNETOSTRICTIVE PROPERTIES OF Ni–Fe ALLOYS
Davis, Jr., C. M., Helms, H. H., and Ferebee S. F.
Journal of the Acoustical Society of America, v. 29, no. 4, pp. 431–434, April 1957

The dynamic magnetostrictive properties of Ni–Fe alloys containing from 35% to 67.5% nickel were investigated to determine their suitability for use in electromechanical transducers. The material, in the form of toroids made from ring laminations, was evaluated by the motional impedance method. Annealing temperatures were varied from 600°C to 1220°C, and the effect of various annealing techniques was investigated. Measured values of the electromechanical coupling coefficient, the reversible permeability, the dynamic magnetostrictive constant, and other parameters are given. The electromechanical coupling coefficient for alloys containing from 40% to 52.5% nickel was greater than 0.31. A maximum value of 0.37 was found for the 40% nickel alloy. The product of the magnetostrictive constant and the reversible permeability for the above range of alloys was greater than 95×10^4 (dyn oersted^{-1} cm^{-2}) and reached a maximum value of approximately 130×10^4 for the alloy containing approximately 40% nickel. (*PA*, 1957, #8008)

835. ON THE VARIATION OF MAGNETIC AND MECHANICAL PROPERTIES OF IRON DUE TO DISSOLVED HYDROGEN
Ferro, A. and Montalenti, G.
Il Nuovo Cimento (Series 10), v. 5, no. 4, pp. 842–853, April 1957 (in Italian)

The gas contained in the metal in solid solution tends to precipitate as diatomic molecules in elliptical cavities of a length of the order of at least several tens of atomic diameters thus giving rise to a strong pressure in the cavities themselves. This pressure can produce delayed break-

age in the case of harder metals under an applied stress, and in the case of softer materials, the formation of blisters often visible by eye. These blisters are accompanied by rather large plastic slip which, as to magnetic properties, mainly increases the coercive force. The magnetic properties of hydrogen charged iron and cold worked specimens of the same material are compared. In both cases the same behavior of coercive field versus annealing temperature has been found. Therefore the assumptions made receive further evidence. Moreover the average distance among hydrogen precipitation centers in iron is evaluated from the precipitation theory. The values obtained, ranging about 2×10^{-3} cm, are in agreement with the available experimental data. (*PA*, 1957, #8911)

836. NEUENTWICKLUNGEN VON HYPERM-WERKSTOFFEN
Ackermann, F. W., Fahlenbrach, H., Meyer, H. H., and Sommerkorn, G.
***Technische Mitteilungen Krupp*, v. 15, no. 1, April 1957**

Recent developments concerning HYPERM magnetic materials at Krupp, Essen; survey of new or improved materials covers pure iron, and iron silicon, iron aluminum, iron nickel and iron cobalt alloys. (*EI*, 1957)

837. EINFLUSS EINER SCHLUSSGLUEHUNG IM HOCHVAKUUM AUF DIE UMMAGNETISIERUNGSVERLUSTE
Lihl, F.
***Archiv für das Eisenhuettenwesen*, v. 28, no. 4, pp. 223–228, April 1957**

Influence of end anneal in high vacuum on magnetic reversal losses of cold and hot rolled electric transformer sheets; magnetic, metallographic and X-ray investigations of steel sheets containing 4.3% Si and 0.25% Al after annealing in high vacuum; reduction of magnetic reversal losses obtained as compared with annealing in protective atmosphere. (*EI*, 1957)

838. EFFECT OF ELASTIC STRESSES AND MECHANICAL HEAT TREATMENT ON MAGNETIC PROPERTIES OF CERTAIN HARD MAGNETIC MATERIALS
Luzhinskaya, M. G. and Shur, Y. S.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 2, pp. 36–40, 1957**

8% V 52% C balance Fe, 14% V 52% Co balance Fe, and 15% Mn balance Fe alloys investigated; heat treatment consisted of applying unilateral tension loading to specimens during annealing to give state of high coercivity; magnetic properties of alloys are altered on account of change in magnetic anisotropy and texture. (*EI*, 1957)

839. CERTAIN MAGNETIC PROPERTIES OF DISPERSION-HARDENING Fe–Mo AND Cu–Ni–Fe ALLOYS
Ivanovskii, V. I.
***Physics of Metals and Metallography*, (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 2, pp. 41–43, 1957**

Alloys selected for investigation were Fe-Mo (18% Mo) and Cu-Ni-Fe (52 atm% Cu, 36% Ni, 12% Fe); phase diagrams and physical properties of alloys given. (*EI*, 1957)

840. MAGNETIC VISCOSITY IN 4–79 MOLYBDENUM PERMALLOY
Van Sant, O. J.
***Journal of Applied Physics*, v. 28, no. 4, pp. 486–494, April 1957**

The dynamic behavior of 4-79 molybdenum permalloy operating in a reversible region of its hysteresis loop is analyzed theoretically and experimentally. A useful expression is presented which relates B, H, time, and magnetic viscosity. This expression is applied to determine the behavior of the magnetic material when magnetized (1) by sinusoidal currents having frequencies in the kilocycle/second region and (2) by step-function currents producing transient voltages with time constants in the millimicrosecond region. The theoretical results show that there is a correlation between the behaviors under these two extreme cases of current excitation. This correlation is verified by measurements made on thin tapes having nominal thicknesses of ⅛, ¼, ⅓, and ½ mil and the results of these measurements agree with theory. Various effects of magnetic viscosity on the dynamic behavior of the core material are shown and an expression is derived which makes it possible to solve theoretically certain kinds of magnetic engineering problems whose theoretical solutions have not been achieved previously. These problems pertain to devices such as shift registers, high-frequency transformers, and high-frequency magnetic amplifiers which contain cores made of thin ferromagnetic tape. (*PA*, 1957, #7228)

841. SLOW REMAGNETIZATION TIMES IN 4–79 MOLYBDENUM PERMALLOY

Blades, J. D. and Tracy, R. A.

***Journal of Applied Physics*, v. 28, no. 4, p. 516, April 1957**

Measurements of τ are described for a 0.125 x 10^{-3} in. toroidal core, and τ^{-1} was found to increase up to 10^6 sec^{-1} as $(H - H_0)$ increased to about 0.3 oersted, where the critical field $H_0 = 0.138$ oersted. The remagnetization process taking place is discussed. (*PA*, 1957, #8009)

842. DIRECTIONAL ORDERING IN IRON–NICKEL ALLOYS

Ferguson, E. T.

***Comptes rendus hebdomodaires des séances de l'académie des sciences*, Paris, v. 244, no. 19, pp. 2363–2366, May 6, 1957 (in French)**

Reports results of measurements of the uniaxial anisotropy energy $E(T,t)$ for alloys containing up to 50% Fe and heat-treated for a time t at temperature T in a magnetic field. It is found that $E(T, \infty)$ is proportional to $(\theta - T)$, where θ is the Curie temperature. The dependence of E on Fe content was also studied. (*PA*, 1957, #9260)

843. PERFORMANCE OF MAGNETOSTRICTIVE TRANSDUCERS MADE OF ALUMINUM–IRON ALLOY OR NICKEL–COPPER FERRITE

Kikuchi, Y.

***Journal of the Acoustical Society of America*, v. 29, no. 5, pp. 569–573, May 1957**

A brief history of the finding and development of aluminum–iron alloy introduces the description of an industrial specification. The description covers the specification for the melting and rolling processes, both of which are main factors affecting the magnetostriction characteristics. Improvement of transduction efficiency is then discussed in general, and it is concluded that no other material which has larger coupling factor than that of nickel, or "Alfer", (i.e., the 13.5% aluminum–iron alloy), is necessary, in so far as the transducers to be used at their resonance are concerned. Improvement in the efficiency can be attained only by the considerable elimination of the eddy current, and this is accomplished in several magnetostrictive transducers made of Ni–Cu ferrites which are shown to be excellent for generating underwater ultrasound. Electroacoustic efficiency is as high as 90% even at such higher frequencies as 70 and 100 kc/s. Intense generation of ultrasonic waves is successfully carried on up to the rate of 3 W/cm^2 of the radiation surface. (*PA*, 1958, #1569)

844. PRIBOR DLYA ISSLEDOVANIYA MAGNITNOI ANISOTROPII

Timofeev, B. B.

***Elektrichestvo*, v. 77, no. 5, pp. 72–74, May 1957**

Instrument for investigation of magnetic anisotropy; nondestruction method for quick measuring of degree and main directions of magnetic anisotropy of textured and other electrochemical steels. (*EI*, 1958)

845. TIME CHANGE OF PERMEABILITY AND HYSTERESIS LOOP DUE TO DIFFUSION AFTER-EFFECT IN FERROMAGNETICS

Ono, M.

***Memoirs of the Faculty of Engineering*, Nagoya University, v. 9, no. 1, pp. 186–193, May 1957**

The results of observations on 4.16% silicon–iron, both in the completely stabilized state and also immediately after demagnetization, are reported for alternating fields up to 150 milli-oersted. The hysteresis properties were obtained experimentally as loops representing the difference between B and μH where $\mu = B_m/H_m$. Rayleigh's law was confirmed only for measurements made immediately after demagnetization. The results are interpreted on Néel's theory of diffusion after-effect with the aid of a Preisach diagram. (*PA*, 1959, #7167)

846. MAGNETIC SUSCEPTIBILITY OF IRON–NICKEL ALLOYS IN LIQUID AND SOLID STATES

Nakagawa, Y.

***Journal of the Physical Society of Japan*, v. 12, no. 6, pp. 700–707, June 1957**

The magnetic susceptibilities of various Fe–Ni alloys were measured through their melting points up to 1600°C. The susceptibilities of the alloys with less than 60% Ni increase discontinuously on melting, while those of the alloys with more than 60% Ni decrease. The temperature variation of the susceptibilities is approximately expressed by the Curie–Weiss law in the liquid state as well as in the solid state, but the Curie constants and the para-

magnetic Curie temperatures of liquids are in general different from those of solids. These results can be explained by assuming that the atomic magnetic moments remain unaltered and that the magnetic interaction varies with the interatomic distance as indicated by the Berthe–Slater curve. The change of susceptibility at the melting point is solely due to the difference in interatomic distance between the liquid and the solid. It is expected, in some cases, that the especially strong dependence of the magnetic interaction on the interatomic distance results in an appreciable change of interaction with temperature through thermal expansion. It can account for the anomalously large Curie constants of pure γ-Fe and Fe-rich alloys in the solid state. (*PA*, 1958, #8120)

847. MAGNETOSTRICTION OF ALUMINUM–IRON SINGLE CRYSTALS IN THE REGION OF 6 TO 30 ATOMIC PERCENT ALUMINUM
Hall, R. C.
***Journal of Applied Physics*, v. 28, no. 6, pp. 707–713, June 1957**

The spontaneous saturation magnetostriction and the forced magnetostriction were measured on slowly cooled single crystals of the ferromagnetic aluminium-iron alloys in the composition range from 6 to 30 atomic % aluminium. The value of the first constant of spontaneous saturation magnetostriction at 6 atomic % aluminium is similar to that at 6 atomic % silicon in iron. At compositions containing larger amounts of aluminium, the first constant becomes very large; however, near 30% aluminium the constant drops and approaches zero. The second constant of spontaneous saturation magnetostriction is negative below 17% aluminium, reaches a maximum near Fe_3Al, and drops near 30% aluminium. Values of the isotropic forced-magnetostriction constant below 25 atomic % aluminium were found to be slightly higher than that for iron but less than that for silicon iron. Above 25% aluminum the isotropic constant became very large. The anisotropic forced-magnetostriction constants were the largest for the single crystal having 29.6% aluminium; a good fit of the experimental data to be calculated curve was found for this alloy. (*PA*, 1958, #6061)

848. THE ANHYSTERETIC MAGNETIZATION OF PERMANENT MAGNET ALLOYS
Wohlfarth, E. P.
***The Philosophical Magazine* (Eighth Series), v. 2, pp. 719–725, June 1957**

Calculations on the basis of the single domain treatment are reported of the anhysteretic magnetization, the anhysteretic remanent magnetization and the initial magnetization for a simple model of a permanent magnet alloy, and the results are compared with experimental curves for Alcomax III (Gould and McCaig, 1954). (*PA*, 1957, #8722)

849. WIEDEMANN EFFECT OF MAGNETOSTRICTION ALLOY "ALFER"
Shirakawa, Y., Ohara, T., and Abe, T.
***Science Reports of the Research Institutes*, Tohoku University, (Series A), v. 9, no. 3, pp. 176–179, June 1957**

Wiedemann effect of "Alfer" (12.91% Al-Fe alloy) measured at room temperature up to 820 oersted in longitudinal magnetic field was found to increase with increasing longitudinal field and after attaining maximum value decreased gradually at constant current through specimen: effect at high temperatures gradually decreases at constant current through specimen as temperature rises. (*EI*, 1957)

850. MAGNETIC BEHAVIOUR OF IRON–RUTHENIUM–OSMIUM TRIAD
Earnshaw, A., Figgis, B. N., Lewis, J., and Nyholm, R. S.
***Nature*, v. 179, no. 4570, pp. 1121–1124, June 1, 1957**

Importance of ligand field theory in explaining magnetic moments of those six covalent transition metal complexes in which so-called "inner" orbital bonding occurs, as basis for interpreting magnetic behavior of various valency states of iron, ruthenium and osmium. (*EI*, 1957)

851. THE MAGNETO–CALORIC EFFECT AT PHASE CHANGES IN FERROMAGNETIC ALLOYS
Ivanovskii, V. I. and Denisov, P. P.
***Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 550–552, 1957 (in Russian)**

A letter describing briefly the method of accurate determination of the Curie point by measuring the magneto-caloric ΔT as a function of temperature T. Experiments on Fe_3Al showed a very sharp maximum of the $\Delta T/T$ curve at 590°C corresponding to the usual Curie point, and also a broad maximum at about 475°C. This is taken to be the Curie point of another ferromagnetic phase. Similar experiments on Alnico also showed two Curie points, one at about 800°C, the other at about 900°C. (*PA*, 1958, #4155)

852. MAGNETOCALORIC EFFECT DURING PHASE TRANSFORMATIONS IN FERROMAGNETIC ALLOYS
Ivanovskii, V. I. and Denisov, P. P.
Physics of Metals and Metallography (translation of *Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 137–138, 1957

Results of tests at various temperatures in ordered Fe_3Al and in highly coercive Alnico alloy; method based on magnetocaloric effect permits more accurate Curie point determination of individual ferromagnetic phases in alloy than could be obtained from inflexion on I_s (T) curve. (*EI*, 1958)

853. EFFECT OF MAGNETIC NON-LINEARITY OF MATERIAL OF ARTICLES ON FIELD OF CRACK-TYPE DEFECTS
Vlasov, V. V. and Stoinskaia, E. E.
Physics of Metals and Metallography (Translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 3, pp. 139–141, 1957

Specimens prepared from steel 30; defect field is composed of field of magnetic surface charges which arise indirectly on walls of defect, and of field of volumetric charges, formed through magnetic nonlinearity of material. (*EI*, 1957)

854. DESIGN AND PERFORMANCE OF A HIGH-EFFICIENCY LABORATORY ELECTRO-MAGNET
Bowen, L. O.
Journal of Scientific Instruments, v. 34, no. 7, pp. 265–268, July 1957

Major factors required in the performance of laboratory electromagnets, namely field intensity and field homogeneity over accessible working volumes, have been achieved with moderate power consumption in an iron-clad magnet yielding power efficiencies [power efficiency α (air-gap induction $\times$ air-gap)/ampere-turns] approximately 10% in excess of those obtained from similar magnets as previously reported. The magnet and support weighs 2½ tons and operates from an 18-kw dc supply. Pole-face diameters range from 11.5 to 1.5 in. with a range of air gaps from 5 to 0.5 in. Design procedure and data are reproduced. (*PA*, 1957, #8018)

855. EXPERIMENTAL STUDY OF HIGH-PERMEABILITY NICKEL–IRON ALLOYS
Richards, C. E., Walker, E. V., and Lynch, A. C.
Proceedings of the Institution of Electrical Engineers, v. 104, Part B, (Radio and Electronic Engineering) no. 16, pp. 343–358, July 1957

Study of factors which might influence ultimate performance or consistency of metals with particular reference to 77/14/5/4 nickel-iron-copper-molybdenum alloy, using samples made by powder metallurgy. (*EI*, 1957)

856. DOMAIN WALL ORIENTATIONS IN SILICON–IRON CRYSTALS
Graham, C. D., Jr. and Neurath, P. W.
Journal of Applied Physics, v. 28, no. 8, pp. 888–891, August 1957

The stable orientation of a 180° ferromagnetic domain wall in a cubic crystal with ⟨100⟩ easy directions is calculated as a function of crystal orientation for a sheet specimen with a ⟨100⟩ direction parallel to the surface. The effect of the second crystal anisotropy constant K_2 on the domain wall energy is considered and shown to be negligible if $|K_2| < K_1$. If the crystal surface is a {110} plane, there are two equivalent stable domain wall positions, with the wall making an angle of $\pm 32°$ with the normal to the specimen surface. If the crystal surface is a {100} plane, the domain wall lies normal to the surface. These results are changed if a stress is applied to the sample. Experimentally determined domain wall orientations agree with the calculated positions. (*PA*, 1958, #6036)

857. MAGNETIC ANISOTROPY IN CONNECTION WITH ROLLING IN THE COURSE OF PRODUCING SINGLE CRYSTALS OF SILICON STEEL
Yamashita, T. and Tatsumoto, E.
Journal of the Physical Society of Japan, v. 12, no. 8, p. 975, August 1957

A magnetic anisotropy associated with the rolling of single crystal strips is attributed to arrays of nearly spherical pits aligned parallel to the rolling direction. The value of the anisotropy is observed to be 400 erg/cm^3. (*PA*, 1958, #4153)

858. ON THE MAGNETIC AGING OF COMMERCIAL PURE IRON
Asanuma, M. and Ogawa, S.
***Journal of the Physical Society of Japan*, v. 12, no. 8, pp. 955–958, August 1957**

The origin of magnetic aging in commercial pure iron is clarified by means of magnetic initial susceptibility and internal friction. It is due to very small amounts of carbon and nitrogen in the iron, and the effect of nitrogen is greater than that of carbon and it is dominant especially in the period of formation of intermediate nitride. (*PA*, 1959, #8309)

859. MYSTERY OF MAGNETIC ANNEALING
Becker, J. J.
***Metal Progress*, v. 72, no. 2, pp. 84–89, August 1957**

Properties of some magnetic alloys are improved by annealing in magnetic field; in age hardening alloys this may be due to growth of needle-like particles aligned by magnetic field; in solid solutions "ordered" particles may grow in similar shapes, or atom-pairs may be aligned with field; effect of magnetic annealing on precipitation alloys such as Alnico 2 and 5, cobalt ferrite and Cu-Co, and on other alloys including permalloys, perminvars, etc. (*EI*, 1957)

860. PROCESSES OCCURRING DURING THE HEAT TREATMENT OF ALCOMAX
Clegg, A. G. and McCaig, M.
***Proceedings of the Physical Society*, London, Section B, v. 70, part 9, pp. 817–822, September 1957**

The permanent-magnet alloy Alcomax has been investigated after different heat treatments using two techniques. Curves of saturation intensity against temperature have been obtained using a Sucksmith balance, and curves of coercivity against temperature by extraction from a solenoid. It is concluded that maxima in the coercivity curves are associated with subsidiary Curie points. Reversible changes in room temperature coercivity produced between 600°C and 700°C are also associated with the appearance and disappearance of subsidiary Curie points. (*PA*, 1957, #8723)

861. THE UNUSUAL MAGNETIC PROPERTIES OF QUENCHED ALCOMAX III
McCaig, M.
***Proceedings of the Physical Society*, London, Section B, v. 70, part 9, pp. 823–826, September 1957**

If the permanent-magnet alloy Alcomax III is quenched from a high temperature instead of the usual treatment it has the properties of a rather unusual soft magnetic material. The permeability is almost constant up to flux densities over 5000 gauss and the ratio of remanence to saturation intensity is less than 0.1. Details of these properties are given and their theoretical implications considered. (*PA*, 1957, #8724)

862. ON THE EFFECT OF MAGNETIC FIELD COOLING ON MAGNETOSTRICTION OF 45–25 PERMINVAR AND 65 PERMALLOY
Sugihara, M.
***Science Reports of the Tohoku University*, First Series, v. 41, no. 1, pp. 21–34, September 1957**

The magnetostriction of these alloys was measured after they had been cooled in longitudinal magnetic fields, 13.3 and 9.6 oersted respectively, from various temperatures. When the former alloy was cooled from 475°, the obvious discontinuous change of magnetostriction was observed in the vicinity of 465 oersted. When the latter alloy was cooled from 480°, the magnetostriction curve showed several discontinuous changes taking place step by step. It is suggested that this effect intimately relates to the order–disorder transformation. (*PA*, 1959, #5892)

863. ON THE HALL EFFECT IN FERROMAGNETICS
Bazhanova, N. V.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 3 (9), pp. 567–570, 1957 (in Russian)**

The Hall effect in Fe–Ni alloys of the "Invar" group was investigated near the Curie temperature. It is found that in ferromagnetics in which technical saturation has been attained the Hall e.m.f. continues to increase linearly with the true magnetization and confirms the validity of formula proposed by Volkov to describe the Hall effect in ferromagnetics. The dependence of the Hall e.m.f. on magnetic field strength obtained on the basis of Ginzburg's equation for true magnetization of ferromagnetics near the Curie point is satisfactorily confirmed by experiment. (*PA*, 1958, #1774)

864. MAGNETIC INFLUENCE ON THE RECRYSTALLIZED GRAIN TEXTURE OF A FERROMAGNETIC ALLOY
Sawyer, B. and Smoluchowski, R.
***Journal of Applied Physics*, v. 28, no. 9, pp. 1069–1070, September 1957**

Annealing an Fe + 35% Co alloy cold-rolled sheet in a magnetic field at 700°C increases the proportion of those grains having a ⟨100⟩ direction parallel to the field meanwhile decreasing those with a ⟨110⟩ direction similarly oriented. The result cannot be explained by the crystalline anisotropy of the magnetic energy and the effects of thermal variables are believed to be more important. (*PA*, 1958, #1126)

865. SINGLE CRYSTAL "PICTURE FRAMES" OF FERROMAGNETIC ALUMINUM–IRON ALLOYS
Hall, R. C.
***Journal of Applied Physics*, v. 28, no. 10, pp. 1212, October 1957**

The order–disorder transformation for Fe–Al alloys (18% to 33% Al) was investigated magnetically. "Picture frames" were cut in the [100] directions and subjected to two types of heat treatment. Slow cooling in a magnetic field of 4 oersted had no effect. Rapid cooling of a 21.9% Al alloy caused the easy direction of magnetization to change from [111] to [100] direction. For alloys around 30% Al a similar treatment is thought to produce varying amounts of a magnetic phase (Fe_3Al) and a non-magnetic phase (FeAl). (*PA*, 1958, #1127)

866. THERMOMAGNETIC TREATMENT AND PROCESSES OF ORDER-ESTABLISHMENT
Shur, I. S. and Glazer, A. A.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), v. 5, no. 2, pp. 140–145, 1957**

Magnets of 66-permalloy and perminvar were subjected to very strong thermomagnetic treatment; 78-permalloy and Permendur were also studied. The temperature range in which treatment is effective and the temperature dependence of magnetic saturation were determined. Results obtained permit the conclusion that the phenomenon of order establishment does not play a vital role in the mechanism of treatment.

867. TIME DECREASE OF PERMEABILITY IN IRON
Bosman, A. J., Brommer, P. E., van Daal, H. J., and Rathenau, G. W.
***Physica*, v. 23, no. 11, pp. 989–1000, November 1957**

The time decrease of initial permeability was studied for iron containing interstitial nitrogen. The activation energy for nitrogen diffusion is derived from this. A method for resolving the different relaxation times is given. Besides the well known relaxation time for elementary jumps of nitrogen atoms, relaxation is observed at times which are about 1000 times larger. Also satellites of the main relaxation are found and explained. It is shown that the time decrease is influenced by the way of demagnetization preceding the relaxation experiment. An explanation of these effects is offered. (*PA*, 1958)

868. STUDIES ON THE MAGNETIC ANISOTROPY INDUCED BY COLD ROLLING OF FERROMAGNETIC CRYSTAL. I. IRON–NICKEL ALLOYS
Chikazumi, S., Suzuki, K., and Iwata, H.
***Journal of the Physical Society of Japan*, v. 12, no. 11, pp. 1259–1276, November 1957**

Magnetic domain patterns were observed and torque measurements made on single crystals of Ni_3Fe. The easy magnetizing direction was found to be normal to the roll direction for (110) [001] and (001) [100] rolling, while it changes to parallel to roll direction at about 30 percent reduction for (001) [110] rolling. The maximum value of uniaxial anisotropy was (2-3) $\times$ 10^3 erg/cm^3. The results were satisfactorily explained by assuming the appearance of directional order by slip deformation. It was shown theoretically that the anisotropies thus induced are classified into long range order (fine slip) type and short range order (coarse slip) type. Relation to the superlattice formation was also discussed. (*PA*, 1959, #8293)

869. MAGNETIC PROPERTIES OF HIGH-ALUMINUM IRON ALLOYS
Pavlovic, D. and Foster, K.
***Electrical Manufacturing*, v. 60, no. 5, pp. 109–115, November 1957**

Magnetic characteristics of 14 to 17 percent by weight aluminum–iron alloys, as compared to oriented 3 percent silicon iron and 50 percent nickel iron; comparative data on two new high-permeability, low remanence aluminum–iron alloys with residual induction of less than 1 kilogauss without air gap. (*EI*, 1957)

870. THE EFFECT OF TEMPERATURE ON THE MAGNETIC PROPERTIES OF NICKEL IRON ALLOYS
Fritz, J. F. and Clark, J. J.
Westinghouse Electric Corp., Materials Engineering Dept., East Pittsburgh, Pa.
AF 33(616)-309, WADC-TN-434, December 1957
(ASTIA AD-142,267)

The effects of temperature variation on the d-c magnetic properties of six nickel–iron alloys are reported. The alloys are: Hipernik, Deltamax, Supermalloy, Hipernik V, Mo-Permalloy, and Hymu 80. Results are graphed.

871. THE INFLUENCE OF THE TEMPERING PROCEDURE ON THE THERMAL MAGNETIC AGING OF PERMANENT MAGNETS OF AN ALLOY OF THE MAGNIKO TYPE
Morozova, A. M. and Feigina, F. J.
***Fizika Metallov i Metallovedenie*), v. 5, no. 3, pp. 428–433, 1957 (in Russian)**

Heat treatment schedules are derived empirically to give maximum-magnetic stability in permanent bar magnets of various sizes composed of an alloy containing Fe + 15% Ni + 24% Co + 8.5% Al + 3% Cu. (*PA*, 1958, #8118)

872. A CORRELATION OF THE THERMOMAGNETIC AND DOMAIN BEHAVIOR OF A SINGLE CRYSTAL OF SILICON–IRON
Bates, L. F., Christoffel, D. A., Clow H., and Davis, P. F.
***Proceedings of the Royal Society of London*, Series B, v. 243, pp. 160–171, December 24, 1957**

The thermal changes accompanying the magnetization of a single-crystal specimen of silicon–iron along a [001] direction have been measured and a Bitter figure study made of the same specimen. Some success has been obtained in the correlation of the thermal changes in low fields with the appearance of Néel spikes and domains of reverse magnetization. (*PA*, 1958, #237)

873. THE MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF Fe–Al ALLOYS IN THE SUPERLATTICE RANGE Fe_3Al
Gengnagel, H.
***Naturwissenschaften*, v. 44, no. 24, p. 630, 1957 (in German)**

The anisotropy constant K_1 for ordered alloys changes sign at about 12 percent (weight) Al, while for disordered alloys K_1 decreases gradually to vanish at 16 percent. (*PA*, 1958, #8121)

874. UNTERSUCHUNGEN UEBER DIE ANOMALE TEMPERATURABHAENGIGKEIT DER ANFANGSPERMEABILITAET UND MAGNETISCHE NACHWIRKUNG VON EISEN UND EISEN–SILIZIUM–LEGIERUNGEN
Fahlenbrach, H. and Sommerkorn, G.
***Technische Mitteilungen Krupp*, v. 15, no. 7, pp. 161–164, December 1957**

Investigations on relation of abnormal temperature to initial permeability and magnetic after effect of iron and iron silicon alloys at temperatures between 300 and 700°C; results of measurements illustrated graphically. (*EI*, 1958)

875. THE VARIATION OF THE MAGNETIZATION NEAR SATURATION OF PURE POLYCRYSTALLINE IRON AND NICKEL
Danan, H.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 1, pp. 73–76, January 6, 1958 (in French)**

Reports results of precision measurements at 15°C and in fields up to 2.5×10^4 oersted. The saturation magnetization values, obtained by extrapolation, are: Fe, 217.0 ± 0.2 emu gram^{-1}; Ni, 55.05 ± 0.05 emu gram^{-1}. (*PA*, 1958, #3256)

876. THE APPROACH TO SATURATION AS A FUNCTION OF H^{-1} FOR PURE POLYCRYSTALLINE IRON AND NICKEL
Danan, H.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 3, pp. 401–404, January 20, 1958 (in French)**

Experimental results are discussed in terms of the theory of Holstein and Primakoff. The quantum expression is used for iron, while the classical formula is more appropriate to nickel, probably because the condition

$kT \ll$ exchange energy is less well satisfied in this case. Over a limited range the results appear to fit the relation $I = I_s [1 - (a/H]$. The reasons for this are discussed and values of the coefficient of hardness, a, are obtained in terms of the previously discussed theory. (*PA*, 1958, #5112)

877. DIE ENTWICKLUNG DER KUPFER- UND/ODER TITANHALTIGEN ALNICO-MAGNETE ZUM HEUTIGEN GUETESTAND

Zumbusch, W.

***Zeitschrift für Metallkunde*, v. 49, no. 1, pp. 1–8, January 1958**

Developments of copper- and/or titanium-containing Alnico magnets to their present standard of quality; status of magnetically anisotropic Alnico magnets; comparison of important conventional magnetic materials. (*EI*, 1958)

878. METHOD FOR MEASURING MAGNETOSTRICTION CORRECTED FOR INITIAL DOMAIN DISTRIBUTION AND ITS APPLICATION TO NICKEL AND IRON

Stauss, H. E.

***Journal of Applied Physics*, v. 29, no. 2, pp. 182–184, February 1958**

A method was developed for the measurement of magnetostrictive strain that overcomes the effect of initial domain distribution in isotropic materials. A cubic specimen is used, placed between two iron rods of the same cross section. The combination is put along the common axis of two like solenoids connected in series. Strain is measured with a resistance strain-gauge, first parallel to the magnetic field, and then normal to the field after the specimen has been rotated through 90 deg. At saturation the algebraic difference gives $\frac{3}{2}$ of the saturation magnetostriction. Use of the difference eliminates or reduces a number of experimental errors in addition to that arising from nonrandomness of initial domain distribution. The method was applied to grade A nickel and Armco iron. (*PA*, 1958, #8924)

879. THE MAGNETIC PROPERTIES OF Fe–Al ALLOY SINGLE CRYSTALS IN THE SUPERLATTICE RANGE. II. MAGNETOSTRICTION AND RESISTIVITY

Gengnagel, H.

***Naturwissenschaften*, v. 45, no. 4, pp. 81–82, 1958 (in German)**

Reports results of measurements of the principal magnetostriction coefficients for ordered and disordered alloys; the mean value for an isotropic distribution is deduced. The resistivity of the ordered alloys has a minimum at the composition Fe_3Al. (*PA*, 1958, #8122)

880. BEEINFLUSSBARKEIT DER FESTIGKEITSEIGENSCHAFTEN VON FERROMAGNETIKA IM MAGNETFELD

Jahn, H.

***Technik*, v. 13, no. 1, pp. 29–35, January 1958, pp. 94–99, February 1958**

Study of behavior of metals in magnetic fields; tests on carbon steels of different compositions to determine effect of electromagnetic and heat treatment on their mechanical properties (*EI*, 1958)

881. MAGNETORESISTANCE COEFFICIENTS AND THEIR TEMPERATURE DEPENDENCE IN IRON AND SILICON STEEL

Tatsumoto, E.

***The Physical Review*, v. 109, no. 3, pp. 658–662, February 1, 1958**

Measurements of temperature dependence of coefficients below room temperature using single crystal strips of iron and silicon-steel having crystallographic orientations (001) – [100] and (110) – [111]. (*EI*, 1958)

882. MAGNETIC SUSCEPTIBILITY OF THE ALLOY Pt_3Fe BETWEEN 20 AND 900 DEGREES ABSOLUTE

Crangle, J.

***Nature*, v. 181, pp. 644–645, March 1, 1958**

The susceptibility vs. temperature curve of an annealed, ordered specimen exhibits a maximum at 105°K and a minimum at 50°K; cold working destroyed the superlattice and rendered the alloy ferromagnetic. (*PA*, 1958, #4140)

883. TIME DECREASE OF PERMEABILITY IN IRON

Rathenau, G. W.

***Journal of Applied Physics*, v. 29, no. 3, pp. 239–242, March 1958**

Measurements on iron containing interstitial nitrogen are discussed. Relaxation phenomena with different relaxation times can be resolved. Unequal initial stiffness of

the domain walls gives rise to satellites of the main relaxation. The activation energy of the main relaxation and its satellites coincides with that known for bulk diffusion. Short demagnetization of the relaxed material prior to time decrease results in wall movement during the measurement and in apparent longer relaxation times. The method has been applied for the determination of the activation volume for interstitial diffusion. Preliminary results of measurements on single crystals are given. (*PA*, 1958, #2399)

884. ANALOGY BETWEEN DIRECTIONAL ORDERING AND THE MAGNETIC DIFFUSION AFTEREFFECT

Brissonneau, P.
***Journal of Applied Physics*, v. 29, no. 3, pp. 249–251, March 1958**

The preferential distribution of carbon atoms among three different interstitial sites of α iron, depending on the direction of the spontaneous magnetization, has a close formal resemblance to the directional order induced by a field cooling. The measurement of the hysteresis loops of α iron and with carbon content 0.0046% by weight actually revealed such close resemblance to those of the Perminvar type alloys and those of certain ferrites containing cobalt oxide. (*PA*, 1958, #2390)

885. UNIAXIAL MAGNETIC ANISOTROPY INDUCED IN Fe–Ni ALLOYS BY MAGNETIC ANNEAL

Ferguson, E. T.
***Journal of Applied Physics*, v. 29, no. 3, pp. 252–253, March 1958**

The uniaxial magnetic anisotropy induced in iron–nickel alloys by a magnetic anneal was determined as a function of the composition, annealing temperature and duration. It was found that the result is consistent with the Néel–Taniguchi theory. (*PA*, 1958, #8878)

886. RELATION BETWEEN COLLOID PATTERN AND PERMANENT MAGNET PRECIPITATE DURING THE MAGNETIZATION REVERSAL IN ALNICO V

Kronenberg, K. J. and Tenzer, R. K.
***Journal of Applied Physics*, v. 29, no. 3, pp. 299–301, March 1958**

Improved electron microscope observation technique has confirmed some of the basic assumptions on the structure of Alnico V and has added knowledge of details. The permanent magnet precipitate was investigated at various states of its growth starting from nucleation. Pictures with details smaller than 20 Å reveal the completely developed structure of Alnico V which differs somewhat from former descriptions. It can be recognized clearly that the precipitated particles have grown together to a continuous anisotropic network subdividing the matrix.

Colloid patterns on these surfaces have been observed with electron microscope. During the reversal of magnetization, an anisotropic structure in the colloid-covered areas of the pattern can be distinguished. The colloid particles align themselves, preferring one of the two faces of the precipitated structure. This is most pronounced in the steep part of the demagnetization curve. It can be observed as soon as the colloid starts to form patterns.

The necessary surveying of magnet surfaces was possible by preparing very thin oxide replicas with a simple technique that eliminated the former "floating" method. Replicas were stripped from the surface which preserved the orientation without destroying the surface of the magnet. (*PA*, 1958, #8925)

887. PHASE ANALYSIS OF ALNICO V BASED ON TEMPERATURE EFFECTS

Tenzer, R. K. and Kronenberg, K. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 302–303, March 1958**

A magnetic analysis of the composition of the two Alnico V phases was attempted. Structure-independent properties, like saturation magnetization and temperature coefficient, serve to indicate the correctness of alloys supposed to represent these phases. A model of the two-phase structure of Alnico V is derived from electron micrographs. The combined saturation magnetization and the combined temperature coefficients are calculated with this model using the measured properties of the single alloys. The two alloys whose combined properties come closest to those of Alnico V consist mainly of NiAl and Fe_2Co, respectively. (*PA*, 1958, #9139)

888. EFFECTS OF MAGNETIC FIELDS UPON ANISOTROPIC IRON CRYSTALS

Watson, J. H. L., Arrott, A., and Freeman, M. W.
***Journal of Applied Physics*, v. 29, no. 3, pp. 306–308, March 1958**

Problems inherent to magnetic alignment of alpha iron crystals are discussed and explained by electron microscopic observation of the behavior of the single domain crystals under the effect of magnetic fields. With these specimens, which possess a fraction of magnetically unfavorable dendrites, intrinsic coercive forces of over 1700 oersted have been measured without alignment. (*PA*, 1958, #8926)

889. MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEALING AND BY COLD WORKING OF Ni_3Fe CRYSTAL

Chikazumi, S.

***Journal of Applied Physics*, v. 29, no. 3, pp. 346–350, March 1958**

After a brief report on the experiments which have been made on magnetic annealing, recent investigations on the magnetic anisotropy which is induced by cold rolling are described. The local and the average anisotropy induced by rolling was observed by means of domain pattern and torque measurement for (110) [001], (001) [110], (001) [100] rolling of single crystals and rolling of polycrystals. It was shown that anisotropy for individual cases was well explained by assuming the "slip-induced directional order." Two types of the anisotropy, i.e., long-range order (fine slip) type and short-range order (coarse slip) type, were calculated. Dependence on the degree of order and its difference between single and polycrystals are also discussed. (*PA*, 1958, #8892)

890. EFFECT OF SAMPLE THICKNESS ON THE FIELD ANNEALING OF 6.5% Si–Fe

Albert, P. A.

***Journal of Applied Physics*, v. 29, no. 3, pp. 351–352, March 1958**

Iron alloys containing about 6.5 weight percent silicon are known to respond to heat treatment in a magnetic field. Since the degree of response has been observed to vary with sheet thickness, a study was made to better define this variation. Two different alloy compositions were cast in cylindrical moulds. The ingots were drilled to form hollow cylinders which were sliced and polished to rings of final thicknesses of from 0.150 in. to 0.0025 in. D.C. hysteresis loops were measured on samples as annealed 2 hr at 1000°C in dry hydrogen, and as subsequently cooled at 40 deg C/hr from 900°C in a circumferential magnetic field of 10 oersted. The differences in coercive force and maximum permeability between samples field annealed and not field annealed are thickness dependent, and are greater for thicker samples. The effects of thickness on coercive force are lessened by electropolishing, which greatly reduces the slope of the H_c vs. $(1/d)$ curve for both the field-annealed and not field-annealed states. The maximum permeability is not found to be affected by electropolishing. (*PA*, 1958, #1585)

891. EFFECTS OF COMPOSITION AND PROCESSING VARIABLES ON THE MAGNETIC PROPERTIES OF THE 50% NICKEL–IRON ALLOY

Savitski, M. J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 353–355, March 1958**

In a factorial experiment, a study was made of the effects of small amounts of alloying elements and processing variables on the magnetic properties of the 50 percent nickel–iron alloy. The composition variables were: three levels of manganese, two of silicon, two of sulphur, and two of oxygen. The processing variables were: hot rolling at two temperature levels, annealing or not annealing after hot rolling, and final annealing at six temperature levels. The ingots were processed to tape from which torodial cores were made. The results of magnetic tests made with a constant current, flux-reset core tester indicate that certain elements need to be added to the melt to produce a grain-oriented alloy with satisfactory magnetic properties, and that the processing must be compatible with the additions made. The binary manganese–oxygen addition was most beneficial. In general, hot rolling at a high temperature level was beneficial, and annealing after hot rolling was detrimental to the magnetic performance. (*PA*, 1958, #8893)

892. MAGNETIC PROPERTIES OF CUBE TEXTURED SILICON–IRON MAGNETIC SHEET

Walter, J. L., Hibbard, W. R., Fiedler, H. C., Grenoble, H. E., Pry, R. H., and Frischmann, P. G.

***Journal of Applied Physics*, v. 29, no. 3, pp. 363–365, March 1958**

Cube textured magnetic sheet containing approximately 3 percent silicon in iron has been developed in the General Electric Company Research Laboratory.

The magnitude of the cube texture as determined by

torque magnetometer tests is of the order of 90 percent or greater when compared to a single crystal with a (100) [001] orientation. The magnitude of the texture was confirmed by X-ray diffraction pole figures. Static dc magnetic tests and 60 cps ac power loss tests made on single strip samples taken both parallel to the rolling direction and at right angles to the rolling direction indicate nearly equal magnetic properties in both directions of the sheet. These properties are equivalent to the magnetic properties measured in the single good direction of the grain oriented transformer material. Finally, two transformers were made: one using laminations of the cube textured silicon iron, the other of the grain oriented material. It was found that transformer made of the cube textured material produced significantly lower energy losses at all inductions and at 17,000 *g* the losses were approximately 60 percent of the losses produced by the grain oriented transformer. Similarly the current required to produce 17,000 *g* in the cube textured transformer was again about half that required to excite the grain oriented transformer to the same induction. (*PA*, 1958, #8894)

893. EFFECT OF ELASTIC BENDING ON MAGNETIC PROPERTIES OF ORIENTED SILICON IRON

Cole, R. W.

***Journal of Applied Physics*, v. 29, no. 3, pp. 370–371, March 1958**

To determine how the ac and dc magnetic properties are affected by elastic strain, the magnetic properties in the rolling direction of Epstein strips of elastically bent grain-oriented three percent silicon iron were measured in an Epstein frame and in a Carr single-strip permeameter. As the degree of bending becomes more pronounced, the coercive force and the ac core loss increase and the permeability decreases. The domain theory gives a rather simple approximate interpretation of the permeability data for magnetic intensities between one and ten oersted. (*PA*, 1958, #8897)

894. PERFORMANCE OF PERMANENT MAGNETS AT ELEVATED TEMPERATURES

Roberts, W. H.

***Journal of Applied Physics*, v. 29, no. 3, pp. 405–407, March 1958**

The objective of this investigation was to determine the effect of temperature up to 600°C and vibration on the performance of Alnico V and Alnico VI magnets. Data are presented on the effect of cycling stability, coefficient of remanence, extended exposure to elevated temperature and vibration. The results of this investigation show that the use of Alnico V and Alnico VI in most instrument and control applications is feasible up to 500°C. However, a considerable loss in properties should be expected if the temperature exceeds 500°C. (*PA*, 1958, #8119)

895. MICRO UNIFORMITY OF PERMANENT MAGNETS

Mendelsohn, L. I.

***Journal of Applied Physics*, v. 29, no. 3, pp. 407–408, March 1958**

A measurement system was developed to measure variations in the flux density normal to the pole faces of short, axially-magnetized cylindrical permanent magnets. A quartz crystal vibrated a single-turn pick-up coil to scan an area 0.028 × 0.00002 in. at a distance of 0.010 in. from the pole face. Circumferential variation of flux density was used as the uniformity criterion. For magnets compacted from powders variations may be held to be less than 4 percent of the average. Directional materials such as cast Alnico V show variations as high as 17 percent. (*PA*, 1958, #5125)

896. SOME ASPECTS OF TEMPERING 3¼% SILICON STEEL AS FOLLOWED BY TIME DECAY OF PERMEABILITY

Anolick, E. S. and Singer, J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 412–413, March 1958**

The time decay of permeability has been employed in the study of the distribution of interstitials (C,N) in 3¼ percent Si-Steel. In following the 150°C tempering of slowly cooled samples, a reversion phenomenon is noted. A method is discussed for obtaining the solubility of carbon over a limited range of temperature, with some preliminary results included. (*PA*, 1958, #8903)

897. MAGNETIC FLUCTUATIONS IN MOLYBDENUM PERMALLOY

Brophy, J. J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 483–484, March 1958**

Considerations of generalized noise and magnetic viscosity suggest the existence of magnetic fluctuations in

ferromagnets. Magnetic fluctuations in molybdenum permalloy tape ring cores were detected by observing noise voltages at the terminals of a coil wound on the sample. For thin tape cores and at low frequencies, the observed magnetic noise spectrum is in excess of Nyquist noise and is characteristic of a slow relaxation phenomenon with an activation energy of 0.04 eV. For thick tape cores and at high frequencies, core losses yield noise voltages in agreement with Nyquist's law and provide a means of studying ferromagnetic loss with zero magnetic excitation. (*PA*, 1958, #8908)

898. TRANSITIONS FROM FERROMAGNETISM TO ANTIFERROMAGNETISM IN IRON ALUMINUM ALLOYS

Sato, H. and Arrott, A.

***Journal of Applied Physics*, v. 29, no. 1, pp. 515–517, March 1958**

From a study of magnetic isotherms over the range of compositions from pure Fe to 40 atomic percent Al in Fe and over temperatures from 4°K to 300°K, we have produced strong evidence for the existence of superexchange interactions between iron atoms separated by aluminum atoms. The iron rich alloys show ferromagnetism in the usual way, but, for concentrations approaching 40 atomic percent Al, the alloys behave as antiferromagnetic with Néel points near liquid hydrogen temperatures. There is a transition range of composition in which the stable state just below the Curie temperature is ferromagnetic but at low temperatures is antiferromagnetic.

The large changes in magnetic properties occur for the ordered structures and in composition ranges where the number of nearest neighbor iron-iron interactions is changing rapidly with composition, but where the number of next nearest neighbor iron-iron interactions remains practically constant. These considerations lead to a model where only the nearest neighbor direct positive exchange interactions between iron atoms, and indirect negative exchange interactions between iron atoms separated by an aluminum atom are taken into account. The treatment by a Bragg-Williams type calculation leads to a qualitative understanding of the observed magnetic effects in the iron aluminum system, including the differences between the disordered state and the two types of ordered states. The model also leads to a reinterpretation of neutron diffraction data. (*PA*, 1958, #8909)

899. FURTHER MAGNETIC AND X-RAY DIFFRACTION STUDIES ON IRON-RICH IRON-ALUMINUM ALLOYS

Taylor, A. and Jones, R. M.

***Journal of Applied Physics*, v. 29, no. 3, pp. 522–523, March 1958**

Lattice parameter determinations of body-centered cubic iron-rich α-phase iron–aluminum alloys have revealed anomalies in the region of Fe_3Al which can be associated with magnetic properties and order-disorder transformations. In particular, it has been discovered that by severely cold-working nonmagnetic alloys in the region of 35 atomic percent aluminum, an extremely large increase in lattice volume is induced. This is of the order of 3 percent and is of a much larger order than that to be expected from dislocation theory. At the same time the alloys develop a high degree of ferromagnetism. Annealing the alloys for a few minutes at 150° to 200° causes the magnetism to disappear and restores the lattice parameter to its original value. The breadths of the main lattice lines after the anneal and the re-emergence of superlattice reflections seem to indicate that the loss of ferromagnetic properties is associated with lattice ordering and not with the removal of microstresses.

900. CASTING OF ALNICO VII WITH IMPROVED PHYSICAL PROPERTIES

Wenny, D. H. and Olsen, K. M.

***Journal of Applied Physics*, v. 29, no. 3, pp. 504–505, March 1958**

Alnico VII having the highest coercive force $H_c = 1000$ of the Alnico alloys has not come into extensive use because of its brittleness. Studies in the metallurgical laboratories show that highly purified Alnico VII castings melted under a hydrogen atmosphere are just as brittle as castings air melted with standard raw materials. On the other hand, silica shell molds which cut the initial average cooling rate of the castings to about 20°C per min afford a convenient way to cast sound crack-free Alnico VII magnets which can withstand the handling and thermal shock of the subsequent heat treating process. Satisfactory magnetic quality and chemical uniformity are obtained by air melting standard raw materials of commercial purity. The magnets are amenable to cutting and grinding and have an excellent surface. Though the molds are costly, and their fragile nature necessitates careful handling, the use of silica shell molds will produce an Alnico VII with good magnetic and physical properties.

901. IRON–ALUMINUM ALLOY SYSTEMS, PART 7: STUDY OF MAGNETIC PROPERTIES (PERIOD COVERED: MARCH–SEPTEMBER 1957)
Sato, H. and Arrott, A.
Ford Motor Co., Scientific Laboratory Metallurgical Dept., Dearborn, Mich.
AF 33(600)–32448, Item 4, Project 7351, WADC-TR-57-298, Part 7, April 1958 (ASTIA AD–151,105)

902. SINGLE CRYSTAL ANISOTROPY AND MAGNETOSTRICTION CONSTANTS OF SEVERAL FERROMAGNETIC ALLOYS
Hall, R. C.
Westinghouse Electric Corp., Materials Engineering Dept., East Pittsburgh, Pa.
AF 33(616)–5555, AF 33(616)–309, WADC-TN-58-127, April 1958 (ASTIA AD–155,519)

The anisotropy and magnetostriction have been measured prior to irradiation of single crystals of iron and nickel; of binary alloys of nickel iron, silicon iron, cobalt nickel, and aluminum iron; and of magnetite. The effect of the order–disorder reaction on the properties is reported, and the data are compared to previous experiments.

903. FERROMAGNETIC RESONANCE ABSORPTION IN PERMENORM AT 1.64 cm WAVELENGTH
Hedvig, P.
***Acta Physica Academiae Scientiarum Hungaricae*, v. 8, no. 4, pp. 437–439, 1958**

Absorption curves for a disk-shaped, strongly deformed, single crystal of Permenorm are presented for six directions of external magnetic field in the plane of the disk. (*PA*, 1958, #1589)

904. THE HIGH TEMPERATURE STABILITY OF PERMANENT MAGNETS OF THE IRON–NICKEL–ALUMINUM SYSTEM
Clegg, A. G. and McCaig, M.
***British Journal of Applied Physics*, v. 9, no. 5, pp. 194–199, May 1958**

The open circuit magnetization of rectangular bars of various modern permanent magnet alloys was measured at temperatures up to 550°C. A differential ballistic method was used and, after magnetization at room temperature, both reversible and irreversible losses occur on heating. These losses vary with material and dimension ratio, and in an attempt to explain these variations demagnetization curves at 500°C were measured. To avoid the irreversible losses, stabilization at a higher temperature is better than aging in an alternating field. (*PA*, 1958, #4129)

905. CORRELATIONS SUGGESTING THE D–SHELL CONFIGURATION AND A MAGNETIC EXCHANGE MECHANISM IN IRON GROUP METALS
Wollan, E. O.
***The Physical Review*, v. 110, no. 5, pp. 1205–1206, June 1, 1958**

It is suggested that the ground state d-shell configurations of the iron group metals are those appropriate to the 3+ ion, the remaining three electrons per ion being itinerant. Arguments similar to those used by Goodenough in discussing magnetic exchange in the perovskite compounds are then used to account for some of the magnetic properties of iron and chromium. (*PA*, 1958, #7162)

906. ELECTRICAL STEELS
Ruediger, B. A.
***Steel*, v. 142, no. 23, pp. 116–118, 120–121, June 9, 1958**

Making choice between fully or semiprocessed materials; magnetic and mechanical properties of silicon steels; improved electrical steel such as alloys having grain oriented in two directions; stress relief; annealing; oxidation; bluing; stacking of laminations; typical applications of commercial silicon steels. (*EI*, 1958)

907. DIRECT MEASUREMENT OF THE VELOCITY OF PROPAGATION OF A FERROMAGNETIC DOMAIN BOUNDARY IN "PERMINVAR"
Lee, E. W. and Callaby, D. R.
***Nature*, v. 182, pp. 254–255, July 26, 1958**

The radial velocity of a single circular domain wall in an annular specimen of Perminvar was measured using the Kerr effect to detect the passage of the wall across illuminated portions of the specimen. For small driving fields the velocity obeys the relation $V = G(H - H_c)$, where H_c

was found to be 0.108 oersted and G about 23 cm sec^{-1} $oersted^{-2}$ —a value in good agreement with that calculated for a plane domain wall. (*PA*, 1958, #8931)

908. A SEMI-EMPIRICAL EQUATION FOR THE INITIAL SUSCEPTIBILITY OF HOMOGENEOUS FERROMAGNETIC ALLOYS

Lee, E. W. and Jackson, R. C.
***Proceedings of the Physical Society*, London, v. 72, Part 1, pp. 130–134, July 1958**

The equation relates the initial susceptibility to the magnetocrystalline anisotropy and magnetostriction coefficients, and gives reasonable agreement with experimental values for disordered Fe–Ni alloys. (*PA*, 1958, #7172)

909. THE INITIAL MAGNETIZATION OF ALPHA-IRON AT HIGH TEMPERATURES

Alberts, L. and Shepstone, B. J.
***The Philosophical Magazine*, Eighth Series, v. 3, pp. 700–706, July 1958**

As the inherent crystal anisotropy of iron tends to zero above 600°C the initial magnetization above this temperature is considered in terms of purely rotational movements of the domain vectors from preferential directions determined by applied and internal stresses. Experimental results on the influence of applied stress on the initial permeability are described. It is shown that the results are in fair agreement with the theoretical predictions. (*PA*, 1958, #6060)

910. HYSTERESIS LOOPS OF PICTURE-FRAME SINGLE CRYSTALS OF Al-Fe ALLOYS

Gengnagel, H.
***Naturwissenschaften*, v. 45, no. 15, pp. 361, 1958 (in German)**

A picture-frame crystal of 4 percent Al–Fe with [100] sides was found to have a large coercive force and a low permeability, while a similar crystal of 3 percent Al–Fe had a low coercive force and a sharply rectangular hysteresis loop. Examination of the surface of the crystals by Bitter patterns showed the 4 percent crystal to contain a non-magnetic precipitate that hindered domain wall movement. This was shown to be aluminium oxide. (*PA*, 1959, #2513)

911. THE INFLUENCE OF INCLUDED CARBON ON THE MOBILITY OF BLOCH WALLS

Rothenstein, B. and Hrianca, J.
***Naturwissenschaften*, v. 45, no. 15, p. 360, 1958 (in German)**

The mobility of Bloch walls in iron has been studied by measurement of the effect of a magnetic field on the internal friction, and the effect of included carbon has been examined. (*PA*, 1959, #2512)

912. HYSTERESIS LOOPS ASSOCIATED WITH A SIMPLE DOMAIN STRUCTURE

Hart, A.
***Proceedings of the Physical Society*, London, v. 72, part 2, pp. 244–248, August 1958**

The complex domain structures existing in most ferromagnetic specimens prevent precise information about individual domain processes from being obtained from technical magnetization curves. Experiments on ring specimens of a magnetically annealed Perminvar-type alloy show that reversal of magnetization in such specimens involves only one 180 deg domain wall. Rings of varying external to internal diameter ratio were used, and the hysteresis loops of all specimens could be explained using a simple theoretical model. All specimens except those whose hysteresis loops were controlled by nucleation processes had the same coercive field, 0.09 oersted. This field gave a direct measure of the impedance to motion of an isolated 180 deg wall. The experiments also show that the use of a specimen with large external to internal diameter ratio effectively reduces the slope of the sides of the measured (B, H) loop; a close approach to a rectangular loop is possible only in specimens with small radial width. The effects of nucleation are evident in all of the loops, and in the case of the specimens with the smallest radial width, the loop shapes are controlled entirely by nucleation. (*PA*, 1958, #8136)

913. PAPERS ON IRON-TESTING EQUIPMENT

***Proceedings of the Institution of Electrical Engineers*, v. 105, part A, no. 22, pp. 375–405, August 1958**

"Ferrometer for Determination of A.C. Magnetization Curve and Iron Losses of Small Ferromagnetic Sheet Samples," H. Blomberg, P. J. Karttunen; "Direct-Reading Iron-Loss Testing Equipment for Single Sheets, Single Strips and Test Squares," J. McFarlane, P. Milne, J. K. Darby;

"Control of Flux Waveforms in Iron Testing by Application of Feedback Amplifier Techniques," J. McFarlane, M. J. Harris. (*EI*, 1958)

914. THE PRESSURE DEPENDENCE OF THE FERROMAGNETIC ANISOTROPY ENERGY

Gugan, D. and Rowlands, G.
***Proceedings of the Physical Society*, London, v. 72, part 2, pp. 207–213, August 1958**

A formula is derived and used to analyze measurements of the change of technical magnetization caused by the application of hydrostatic pressure. Some of the changes can be described by a dependence of the ferromagnetic anisotropy energy on pressure. Values are obtained for this pressure dependence in certain nickel–iron alloys and they are found to agree moderately well with estimates made from volume magnetostriction measurements. (*PA*, 1958, #8139)

915. SOME MAGNETIC PROPERTIES OF DILUTE FERROMAGNETIC ALLOYS II

Lothian, B. W., Robinson, A. C. and Sucksmith, W.
***The Philosophical Magazine*, Eighth Series, v. 3, pp. 999–1012, September 1958**

Previous experiments were carried out on the magnetic properties of precipitates of dilute ferromagnetic alloys precipitated from solid solution in a nonferromagnetic matrix. This process could be followed from the initial stages of superparamagnetism through single to multidomain size of the aggregates, and the magnetic measurements correlated with particle growth. In the present communication, the work is extended to the production of precipitates with greater departure from spherical shape produced by cold drawing of suitable alloys of the ferromagnetics iron, nickel and cobalt. Magnetic measurements on the anisotropic specimens so produced are shown to give evidence for the distribution of particle shape, size and structure. The reverse magnetic field required to reduce the remanence to zero is shown to be an additional useful parameter in these determinations. (*PA*, 1958, #8123)

916. TEMPERATURE DEPENDENCE OF MAGNETIC PROPERTIES OF SILICON–IRON

Chen, C. W.
***Journal of Applied Physics*, v. 29, no. 9, pp. 1337–1343, September 1958**

Permeability, coercive force, remanence, hysteresis and core losses of a 3 percent singly oriented silicon–iron alloy was measured in the temperature range from 30° to 700°C. Their temperature dependence is interpreted in terms of either the intrinsic properties of a ferromagnetic or domain theory. The magnetization curve is analyzed on the basis of the crystallographic characteristics of the texture in the material. Domain distribution is discussed at each stage of magnetization. Application of the analysis leads to the establishment of the relationship between the temperature coefficient of permeability and the magnetization processes. (*PA*, 1959, #438)

917. ON THE TEMPERATURE STABILITY OF THE DOMAIN STRUCTURE IN SILICON IRON CRYSTALS

Kirenskii, L. V. and Degtyarev, I. F.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 3(9), pp. 584–586, 1958 (in Russian)**

The meridian magneto-optical Kerr effect was employed to investigate the domain structure of 3 percent silicon iron in the temperature range from 20 to 700°C. It is shown that in the indicated range the domain structure is highly stable. (*PA*, 1959, #2515)

918. MAGNETIC PROPERTIES AND MICROSTRUCTURE OF HIGH-C, HIGH-Cr MAGNET STEEL

Tachikawa, K.
***Aeronautical Research Institute*, Tokyo Imperial University, v. 24, no. 7, Report 336, pp. 171–187, September 1958**

Description of changes of magnetic properties and microstructures of steel containing 10% carbon and 18% chromium by various heat treatments: origin of permanent magnetism of this steel. (*EI*, 1958)

920. CONTRIBUTION TO THE QUANTITATIVE STUDY OF DIFFUSION MAGNETIC LAG OF CARBON IN ALPHA IRON

Brissonneau, P.
***Journal of Physics and Chemistry of Solids*, v. 7, no. 1, pp. 22–51, October 1958 (in French)**

A magnetic lag of considerable magnitude has been found and measured in very dilute solid solutions of carbon in iron. The results are interpreted by Néel's theory. Measurements of the time decrease of the induc-

tion allow the determination of the diffusion lag field, which can be separated into the contributions due to the 90-deg and 180-deg Bloch walls and for which theory gives a simple expression. The diffusion mechanism can be accurately represented only by introducing a fairly wide range of time constants. A large number of anomalies has been found and interpreted in a.c. fields, but in this case, the quantitative measurements are greatly hindered by hysteresis and eddy currents. It seems that the measurement of the diffusion lag field could be used as a very sensitive method for the quantitative determination of dissolved impurities. (*PA*, 1959, #8297)

921. CHANGES OF THE SATURATION MAGNETIZATION AND THE ELECTRICAL RESISTANCE OF IRON–NICKEL ALLOYS ON OMNIDIRECTIONAL COMPRESSION AT LOW TEMPERATURES

Kondorskii, E. I. and Sedov, V. L.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 4(10), pp. 845–853, 1958 (in Russian)**

Study was made of the changes in the saturation magnetization and the electrical resistance of the binary iron–nickel alloys, containing 38 and 45% of nickel, under the influence of pressure created by freezing of water in a bomb. The measurements were carried out in the temperature interval from 1.7 to 77°K and in fields up to 7000 oersted. The limiting values of the saturation magnetization and electrical resistance for $T \rightarrow 0$ were found to change under omnidirectional compression, the signs of the changes of these two quantities being opposite. The indicated limiting values also change with the growth or decrease of the field at high magnetic field strengths, and for $T \rightarrow 0$ the differential magnetic susceptibility in the region of magnetic saturation does not vanish. The relationships between the variation of the limiting values of the saturation magnetization and the electrical resistance induced by pressure or by the field are found to be similar. (*PA*, 1959, #2516)

922. SURFACE ENERGY OF A 90° DOMAIN WALL IN IRON

Graham, C. D., Jr.
***Journal of Applied Physics*, v. 29, no. 10, pp. 1451–1453, October 1958**

The relative surface energy of a 90-deg domain wall in a cubic material with $K_1 > 0$ (iron) is evaluated over the range of possible wall orientations. As the plane of the wall passes through a {110} plane, the minimum-energy configuration changes from a right-hand to a left-hand rotation of the atomic moments; this leads to a sharp upward cusp in the energy vs. orientation curve. The calculated orientation dependence of the surface energy can be used to predict a stable wall position in an iron whisker. The prediction is in reasonable agreement with observation. (*PA*, 1959, #2510)

923. REVERSIBLE PERMEABILITY AND LOSSES IN MAGNETICALLY ANNEALED PERMINVAR

Lee, E. W. and Troughton, G. H.
***Proceedings of the Physical Society*, London, v. 72, Part 4, pp. 596–603, October 1958**

Measurements are reported of reversible permeability and associated losses for a specimen of magnetically annealed perminvar possessing a rectangular $B - H$ loop. Measurements were recorded both as the hysteresis cycle was traversed and when a circular domain was nucleated and pushed into the center of the specimen using a small pulsed field. Under these conditions the observed eddy current losses were twelve times those calculated from a uniform permeability model. A tentative explanation of the nature of the restoring force on the circular wall is given. (*PA*, 1959, #1587)

924. EFFECT OF ORDER–DISORDER REACTION ON MAGNETIC ANISOTROPY AND MAGNETOSTRICTION OF SINGLE CRYSTALS OF FERROMAGNETIC ALUMINUM–IRON ALLOYS

Hall, R. C.
***Transactions of the Metallurgical Society of AIME*, v. 212, no. 5, pp. 703–706, October 1958**

Investigation of alloys near Fe_3Al composition; variation in magnetostriction with ordering depended on composition; on disordering, anisotropy changed toward larger positive values for all compositions. (*EI*, 1958)

925. CRYSTAL-ORIENTED FERROXPLANA

Stuijts, A. L. and Wijn, H. P. J.
***Philips Technical Review*, v. 19, no. 7–8, pp. 209–217, 1957–1958**

Magnetically soft "ferroxplana" materials have permeability which remains constant up to frequencies far above 100 Mc; crystals of these materials can be aligned; as

result, permeability is appreciably increased, with only slight drop in limiting frequency; this produces material with anisotropic permeability, for which there are special applications. (*EI*, 1958)

926. MAGNETOCRYSTALLINE ANISOTROPY CONSTANTS OF IRON AT ROOM TEMPERATURE AND BELOW

Graham, C. D., Jr.
***The Physical Review*, v. 112, no. 1117–1120, November 15, 1958**

The anisotropy constants of iron were determined from torque measurements on a (110) single-crystal disk in fields up to 15000 oersted or higher and at temperatures of 77, 195 and 300°K. The values of K_1 at the three temperatures are $(520 \pm 10) \times 10^3$, $(505 \pm 10) \times 10^3$, and $(480 \pm 10) \times 10^3$ ergs/cm^3; the value of K_2 at all three temperatures is $(0 \pm 50) \times 10^3$ ergs/cm^3. The anisotropy decreases as the fourth power of the saturation magnetization over the temperature range studied. (*PA*, 1959, #7158)

927. INFLUENCE OF LIGHT UPON THE MAGNETIZATION OF MASSIVE IRON

Stauss, H. E.
***American Journal of Physics*, v. 26, no. 8, pp. 551–552, November 1958**

Recently Lamarsh called attention to old experiments that indicated an influence of light upon the magnetization of massive iron. One of the experiments was repeated under conditions as free as possible from disturbing conditions that may have influenced the original experiments. No influence of light upon the magnetization of iron was observed. The upper limit of possible change of magnetization in the specimen that may have escaped detection was one cgs unit of intensity of magnetization *I*. (*PA*, 1959, #3644)

928. THE INFLUENCE OF TENSION STRAINS ON THE REMANENCE OF α–IRON AT HIGH TEMPERATURES

Shepstone, B. J. and Alberts, L.
***Zeitschrift für Naturforschung*, v. 13a, no. 12, pp. 1096–1097, December 1958 (in German)**

The observed variation of remanence with tension is, except near the Curie temperature, in agreement with that calculated assuming magnetization to take place by domain rotation. (*PA*, 1959, #8306)

929. MAGNETIC PROPERTIES OF SPHEROIDAL GRAPHITE CAST IRON

Shirakawa, Y. and Miyazaki, T.
***Science Reports of the Research Institutes, Tohoku University*, Series A, v. 10, no. 6, pp. 399–404, December 1958**

The magnetic properties of spheroidal and flake graphite cast irons of similar composition cast in sand molds of various diameters were measured. Under the same degree of graphitization, the maximum induction, the coercive force and the hysteresis loss of spheroidal graphite cast iron were lower than those of flake graphite cast iron, and so the maximum permeability and the residual induction were higher. With increasing degree of graphitization, the maximum permeability increased, whereas the other four quantities decreased. (*PA*, 1959, #5880)

930. TWO HALL EFFECTS OF IRON–COBALT ALLOYS

Beitel, F. P., Jr. and Pugh, E. M.
***The Physical Review*, v. 112, no. 5, pp. 1516–1520, December 1, 1958**

The Hall coefficients and the resistivity of Fe − Co alloys were measured at 77°K, 169°K and room temperature using fields up to 3.3 webers/m^2. For up to 0.2% Co in Fe the ordinary Hall coefficient R_0 is positive at room temperature but becomes negative at low temperatures; for all other composition R_0 is negative. Analysis with a simple model in which the (4*s*) conduction band consists of a parallel and an antiparallel sub-band shows that, for up to 20% Fe in Co, the parallel 3d sub-band is filled. It then empties as the Fe content increases, having about 0.2 holes per atom at 50% Fe, but at 65% Fe the bands apparently shift so that again the parallel 3*d* sub-band is filled. These conclusions remain unchanged if the analysis is based instead upon a model proposed recently in which the 3d electrons may be in nonconducting states as well as in the usual conducting-type states. The extraordinary Hall coefficient R_1 is positive for less than 25% Co in Fe, but for all other compositions it changes from positive to negative as the temperature decreases from 300°K to 169°K. R_1 and the resistivity ρ satisfy the relation $R_1 = a + b\rho^2$.

931. LONG TERM MAGNETIC STABILITY OF ALNICO V AND OTHER PERMANENT MAGNET MATERIALS

Kronenberg, K.and Bohlmann, M. A.
Indiana Steel Products Co., Magnetic Research Lab., Valparaiso
AF 33(616)-3385, WADC-TR-58-535, December 1958
(ASTIA AD-203-387)

The long term stability of permanent magnets lying quietly at room temperature was investigated. Magnets of Alnico III, V, and VII and of Indox I and V (barium ferrites) were tested over a period of time up to 2½ years. Samples of each material and of various shapes were studied. After magnetization, the remanents were carefully measured at regular intervals with precision equipment based on an impulse compensation principle.

932. MAGNETIC MOMENTS OF ALLOYS AND COMPOUNDS OF IRON AND COBALT WITH RARE EARTH METAL ADDITIONS

Nesbitt, E. A., Wernick, J. H., and Corenzwit, E.
***Journal of Applied Physics*, v. 30, no. 3, pp. 365–367, March 1959**

In order to determine whether ferromagnetic or antiferromagnetic exchange coupling would result from alloying the rare earth metals with cobalt or iron, a number of melts were made containing these elements. The data on saturation magnetization with composition and on saturation magnetization with temperature obtained on the cobalt-gadolinium system indicates strongly that antiferromagnetic exchange coupling exists in this system. (*PA*, 1959, #7171)

933. DOMAIN BOUNDARY CONFIGURATIONS DURING MAGNETIZATION REVERSALS

Becker, J. J.
***Journal of Applied Physics*, v. 30, no. 3, pp. 387–390, March 1959**

The signal resulting from the application of an alternating field while a magnetization reversal is taking place yields information about the total domain boundary area contributing to the reversal at each moment. This technique is used to show that the variation in rate during a reversal in a 65 permalloy tape core corresponds to changes in the area of moving domain boundary, whereas in a 3¼% silicon-iron single crystal picture frame specimen the area of moving domain boundary remains approximately constant, and variations in reversal rate therefore correspond to variations in velocity.

934. MAGNETOCRYSTALLINE ANISOTROPY CONSTANT OF 3.1% Si–Fe AT ROOM TEMPERATURE AND BELOW

Graham, C. D., Jr.
***Journal of Applied Physics*, v. 30, no. 3, pp. 391–392, March 1959**

The first crystal anisotropy constant of a 3.1% Si-Fe alloy has been determined from torque measurements on a {100} single-crystal disk, in fields up to 20,000 oersted and at temperatures of 77, 195, and 300°K. The values of K_1 at these three temperatures are $425 \pm 10 \times 10^3$, $405 \pm 10 \times 10^3$, and $365 \pm 10 \times 10^3$ ergs/cm^2.

935. DISTRIBUTION OF MAGNETIC DOMAINS BETWEEN THE TWO PHASES IN A SINGLE-CRYSTAL FLAT DISK OF IRON

Neissen, K. F.
***Philips Research Reports*, v. 14, no. 2, pp. 101–110, April 1959**

A single-crystal oblate spheroid of iron is considered, whose plane is a (001) plane of the crystal. It is subjected to a magnetic field H lying in the first quadrant of this plane, making an angle θ with the second of the two preferential axes [100], [010] which lie also in the plane. The total number of magnetic domains is called N, all being of the same moment m, whereas Nm is supposed to be known. The ratio in which these domains are distributed between the preferential directions of the crystal depends on the strength H of the external field. The graphical determination of this ratio is the aim of the present paper. It is compared with the analytical determination given by Néel and by Lawton and Stewart. (*PA*, 1959, #8300)

936. MAGNETIC AND CRYSTALLOGRAPHIC ANALYSIS BY ELECTRON DIFFRACTION

Yamaguchi, S.
***Il Nuovo Cimento*, v. 12, no. 3, pp. 286–289, May 1, 1959**

The Lorentz effect observable in electron diffraction is utilized for measurement of the magnetization of ferro-

magnetic substances. In the present study, the martensitic transformed layer of austenitic stainless steel was studied magnetically and crystallographically by electron diffraction. (*PA*, 1959, #8288)

937. SINGLE CRYSTAL ANISOTROPY AND MAGNETOSTRICTION CONSTANTS OF SEVERAL FERROMAGNETIC MATERIALS INCLUDING ALLOYS OF NiFe, SiFe, AlFe, CoNi, AND CoFe

Hall, R. C.

***Journal of Applied Physics*, v. 30, no. 6, pp. 816–819, June 1959**

The anisotropy and magnetostriction of single crystals of several ferromagnetic materials have been determined experimentally. The materials include the metals iron and nickel, binary alloys of nickel iron, silicon iron, aluminum iron, cobalt nickel, and cobalt iron, ternary alloys of moblybdenum nickel iron, nickel cobalt iron, and molybdenum aluminum iron, and magnetite. The effect of the order-disorder reaction on these properties was measured for several of the alloys.

The present data for the nickel iron and silicon iron systems agree well with recently published values. Ordering generally raises the magnetostriction and lowers the anisotropy of the aluminum iron alloys near the Fe_3Al composition. The first anisotropy constant, K_1, for the cobalt nickel system as derived from torque curves is similar to old data derived from magnetization curves. However, K_1 for cobalt iron (30, 35, and 45% cobalt) appears to be considerably larger than previously reported. In general, the addition of cobalt to nickel and to iron changes the magnetostriction constants (λ_{100} and λ_{111}) toward large positive values. Thus, λ_{100} increases to 100×10^6 for 50% cobalt nickel and to 130×10^6 for 45% cobalt iron; λ_{111} increases to 30×10^6 for 45% cobalt iron but remains approximately constant for the cobalt nickel alloys.

938. MAGNETIC ANNEALING IN PERMINVAR. I. STRUCTURAL ORIGIN

Heidenreich, R. D., Nesbitt, E. A., and Burbank, R. D.

***Journal of Applied Physics*, v. 30, no. 7, pp. 995–1000, July 1959**

Deals with the results of an electron diffraction investigation of the structure of soft magnetic materials which exhibit magnetic annealing. The property of heat treatment in a magnetic field has been found to depend upon the oxygen content present as an impurity and is associated with distinct diffraction phenomena. A structural model based on an interpretation of diffraction results, magnetic properties, and oxygen content is presented. The pertinent conclusions from this study are as follows. (1) The ability of soft magnetic alloys containing Fe, Co, and Ni to exhibit magnetic annealing properties is due to oxygen present as an impurity. (2) An oxygen content of about 0.001% is sufficient to produce magnetic annealing with the proper heat treatment. An alloy containing only 0.0001% oxygen fails to respond to field heat treatment or is "dead." (3) The oxygen impurity produces magnetic activity in the alloy crystal (with proper heat treatment) by condensing into the (111) planes of the crystal, thus giving rise to a stacking disorder of fault. The term "impurity fault" has been introduced to describe this structural irregularity. (4) The oxygen impurity faults are presently thought to be aligned by magnetic annealing and are intimately connected with field heat treatment properties. If sufficient oxygen is available in the crystal, the faults thicken and organize to yield metal oxides. (*PA*, 1959, #8310)

939. MAGNETIC ANNEALING IN PERMINVAR. II. MAGNETIC PROPERTIES

Nesbitt, E. A. and Heidenreich, R. D.

***Journal of Applied Physics*, v. 30, no. 7, pp. 1000–1003, July 1959**

Previous work on Alnico single crystals (permanent magnet alloy) showed that magnetic torque reversals are associated with an inhomogeneous structure. More recently, it has been found that alloys of iron, nickel, and cobalt in the perminvar region also exhibit these torque reversals although the alloys are considered to be solid solutions. An inhomogeneous structure occurs simultaneously with the torque reversals in some of these alloys. The inhomogeneous structure has been observed by means of electron diffraction, and the observations have been interpreted to mean that there are faults in the lattice normal to [111] directions. The faults form in the temperature region where the magnetic field heat treatment is effective and their density is roughly proportional to the response of the magnetic field treatment. When the crystals are not heat treated in a field, the faults are arranged to have cubic symmetry and their magnetic anisotropy has cubic symmetry. When the crystals are heat treated in a magnetic field, electron diffraction indi-

cates that the faults are usually affected also. Evidence has been obtained that small amounts of oxygen as an impurity in perminvar cause both the faulting and the heat treatment in a magnetic field. An extremely small amount of oxygen (0.0014%) is sufficient to cause such effects. In a more detailed sense, it is felt that the magnetic anisotropy introduced by heat treatment in a magnetic field probably arises either from short range order within the faults or from the arrangements of the faults each of which is parallel to a (111) into regions whose shape anisotropy is along the direction of the magnetic field. (*PA*, 1959, #8311)

V. MAGNETIC PROPERTIES OF FERROUS METAL COMPOUNDS

A. *Films, Thin Layers, Particles, Whiskers and Wires*

940. MEASUREMENT OF THE COMPLEX TENSOR PERMEABILITY OF FERRITES

Rowen, J. H. and von Aulock, W.
Letter in *The Physical Review*, v. 96, no. 4, pp. 1151–1153, November 15, 1954

Modifies the method of Artman and Tannenwald by using very thin, disk-shaped, rather than small spherical specimens. The advantages of this choice are discussed, and values of the tensor components are given as a function of field strength (up to 4000 oersted). (*PA*, 1955, #1053)

941. THE EFFECT OF PARTICLE SHAPE VARIATIONS ON THE COERCIVITY OF IRON OXIDE POWDERS

Osmond, W. P.
***Proceedings of the Physical Society*, London, Section B, v. 67, Part 12, pp. 875–882, December 1954**

A Gaussian distribution function for the variation of the axial ratio m of powder particles is suggested as the explanation for the measured values of the coercivity of γ-ferric oxide powders being less than the theoretical values for particles of the observed mean shape factor $\overline{m}$. Superposition of the theoretical hysteresis loops for 20 packets of equal volume, each assumed to consist of particles with one value only of m, approximating to such a distribution gives values of bulk coercivity in very close agreement with measured values for two particular examples of widely different mean shape factors. In the light of these results explanations are offered of some other observed values for this oxide, and it is suggested that this mechanism may account in part for results obtained by Weil for precipitated ferronickels. (*PA*, 1955, #1989)

942. FERROMAGNETIC RESONANCE IN NICKEL FERRITE BETWEEN ONE OR TWO KILOMEGACYCLES

Suhl, H.
Letter in *The Physical Review*, v. 97, no. 2, pp. 555–557, January 15, 1955

Describes the theory of a method of measurement producing low resonance frequencies in ferrite specimens in the form of single crystal, single domain spheres or disks. For fields above a certain critical field H_c applied parallel to an axis of difficult magnetization, the magnetization vector also lies parallel to this axis and the resonance frequency is given by $\gamma(H - H_c)$ which can be made low. Results are derived for general orientations of the magnetization vector, and the effects of misalignment and residual domain structure are investigated. Results of measurements of the resonance frequency and line width are given for $Ni_{0.75}Fe_{2.25}O_4$. (*PA*, 1955, #2872)

943. NATURE OF "GAMMA-FeO"

Franklin, A. D., Muldawer, L., and Flanders, J.
***Journal of Physical Chemistry*, v. 59, no. 4, pp. 340–343, April 1955**

Study of black ferromagnetic powder, composition of which is approximately FeO, produced by thermal

decomposition of ferrous formate near 250°C; it has been reported that material possesses spinel structure; magnetic, X-ray and chemical study of this material; evidence suggests it consists of Fe_3O_4 finely divided Fe or Fe_3C (or both) and perhaps some alpha FeO. (*EI*, 1955)

944. DEPENDENCE OF THE COERCIVE FORCE ON THE DENSITY OF SOME IRON OXIDE POWDERS

Morrish, A. H. and Yu, S. P.
***Journal of Applied Physics*, v. 26, no. 8, pp. 1049–1056, August 1955**

An experimental investigation has been made of the dependence of the coercive force on the density of some magnetite and γ-ferric oxide powders consisting of different sized and shaped particles. Various aspects of the data are discussed. In particular, an interpretation based on a calculation of the critical single domain size of iron oxide particles with a prolate spheroidal shape is consistent with the experimental results. (*PA*, 1955, #8900)

945. EFFECT OF NITRIDES ON COERCIVE FORCE OF IRON

Kerr, J. and Wert, C.
***Journal of Applied Physics*, v. 26, no. 9, pp. 1147–1151, September 1955**

Coercive force of ferromagnetic materials; in particular, effect of plates of nitrides on coercive force of iron has been determined; pronounced particle-size effect was observed; maximum effect on coercive force was produced by particles whose largest dimension was of order of domain wall thickness; for particles much larger, expression given by L. Néel for effect of inclusions is found to be valid. (*EI*, 1955)

946. THE REMANENT MAGNETIZATION OF HAEMATITE POWDERS

Wohlfarth, E. P.
***The Philosophical Magazine*, v. 46, pp. 1155–1164, November 1955**

Calculations are described of the remanent magnetization and the remanence after demagnetization as a function of field strength for powders of haematite, α-Fe_2O_3. The calculations are based on the assumptions that the powder particles are single domains and that their hysteretic properties are due to magnetocrystalline anisotropy with threefold symmetry in the basal crystal plane. The calculations are intended for eventual comparison with experiments now in progress. (*PA*, 1956, #3029)

947. MAGNETIC FIELDS IN SMALL FERRITE BODIES WITH APPLICATIONS TO MICROWAVE CAVITIES CONTAINING SUCH BODIES

Berk, A. D. and Lengyel, B. A.
***Proceedings of the IRE*, v. 43, no. 11, pp. 1587–1591, November 1955**

Microwave magnetic field in small ferrite sphere and thin circular cylinder is found in first approximation; expressions are derived which are applied to calculation of detuning and change of Q of microwave resonators containing ferrite spheres, cylinders and disks; use of these expressions for other calculations relating to cavity characteristics. (EI, 1956)

948. DIRECT-READING *B-H* METER

Kramer, A.
***Audio Engineering Society Journal*, v. 4, no. 1, pp. 41–46, January 1956**

Reference made to equipment requirements in manufacture of magnetic iron oxide for recording tape, where frequent tests must be made to maintain uniformity of product; simplest and quickest method has hitherto been use of *B-H* loop tracer but this has its limitations; improved method of testing materials, particularly magnetic iron oxide, where most important properties, i.e., B_m, B_r, H_m and H_e are indicated directly on calibrated meter. (*EI*, 1956)

949. THE FREQUENCY DEPENDENCE OF THE PERMEABILITY OF MAGNETITE BETWEEN 1 AND 3 kMc/s

Nagy, I., Pallagi, D., and Pal, L.
***Acta Physica Hungarica*, v. 6, no. 2, pp. 341–444, 1956**

Reports results of waveguide measurements on magnetite powders of size less than 10μ dispersed in paraffin wax. The permeability and loss angle are linear functions

of volume concentration, and the real and imaginary components of the permeability vary with frequency in the usual way. (*PA*, 1957, #7212)

950. MAGNETIC MEASUREMENTS ON INDIVIDUAL MICROSCOPIC FERRITE PARTICLES NEAR THE SINGLE-DOMAIN SIZE

Morish, A. H. and Yu, S. P.
***The Physical Review*, v. 102, no. 3, pp. 670–673, May 1, 1956**

A novel quartz-fiber torsion balance is employed to make magnetic measurements on individual microscopic ferrite particles. A very direct experimental test provides strong evidence for the existence of single-domain magnetic particles. Further, the results confirm theoretical calculations of the critical single-domain size within a small factor. (*PA*, 1956, #6009)

951. EFFECT OF Al^{3+} IONS SUBSTITUTED FOR Fe^{3+} IONS ON THE MAGNETIC PROPERTIES OF THE COMPOUNDS 6 $Fe_2O_3 \cdot BaO$, 6 $Fe_2O_3 \cdot SrO$ and 6 $Fe_2O_3 \cdot PbO$

Guillaud, C. and Villers, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 24, pp. 2817–2820, June 11, 1956 (in French)**

For the Al free compounds the coervice force H_c varies roughly hyperbolically with the grain size, reaching 3200 oersted at 1 μ. Replacing Fe_2O_3 by 15% Al_2O_3 decreases the grain size and increases H_c, 10,000 oersted at about 0.3 μ, in agreement with the calculated value for crystalline anisotropy controlled single domains. The saturation magnetization was found to decrease linearly on increasing the Al_2O_3 content. The magnetization, coercive force and remanance were also measured as function of field, and an anomalous inflection was observed and believed to be due to a partial antiferromagnetic contribution to the total magnetization at fields below about 4500 oersted. (*PA*, 1956, #7522)

952. THE MAGNIFICATION OF THE MAGNETO-OPTIC KERR ROTATION BY MEANS OF EVAPORATED LAYERS.

Kranz, J.
***Naturwissenschaften*, v. 43, no. 16, pp. 370–317, 1956 (in German)**

If the surface of a polycrystalline Fe–Si specimen is covered with an evaporated layer of SiO or ZnS the Kerr rotation is multiplied by factors 2.8 and 5.1 respectively, and the contrast is also improved. (*PA*, 1957, #3440)

953. INVESTIGATIONS ON BARIUM FERRITE MAGNETS

Sixtus, K. J., Kronenberg, K. J., and Tenzer, R. K.
***Journal of Applied Physics*, v. 27, no. 9, pp. 1051–1057, September 1956**

Barium ferrite ($BaO{:}6Fe_2O_3$) has been investigated magnetically to test the predictions of fine-particle theory in the region of grain sizes larger than the critical one for which no satisfactory theory exists as yet. Grain size and coercive force of polycrystalline magnets (nonoriented and crystal oriented) were closely related to sintering temperatures. A comparison of theoretical and observed temperature dependence of coercive force is made and shows a close fit when certain reasonable assumptions are made. Susceptibilities showed values attributed to rotation of the magnetization vector for samples of high coercive force only (4000 oersted), while wall movements contribute more or less to the susceptibility of all other samples. Domain patterns show wall movements in applied fields on samples with particle thickness down to 10×10^{-4} cm. Patterns on grains below 5×10^{-4} cm thickness ($_iH_c$ more than 2000 oersted) indicate reversals of magnetization by the rotation process. On magnets of the transition particle size both processes can be observed side by side, the walls being less movable for higher coercive forces. (*PA*, 1956, #8865)

954. EFFECT OF THE INTERACTION BETWEEN MAGNETIC PARTICLES ON THE CRITICAL SINGLE-DOMAIN SIZE

Morish, A. H. and Watt, L. A. K.
***The Physical Review*, v. 105, no. 5, pp. 1476–1478, March 1, 1957**

On theoretical grounds, the critical single-domain size of a ferromagnetic particle is expected to be influenced

by the interaction of other neighboring particles. Measurements of the coercive force of some γ-Fe_2O_3 powders containing particles of different sizes and shapes at various concentrations provide experimental evidence for the existence of such an effect. (*PA*, 1957, #4554)

955. MEASUREMENT OF DIELECTRIC AND MAGNETIC PROPERTIES OF FERROMAGNETIC MATERIALS AT MICROWAVE FREQUENCIES

von Aulock, W. and Rowen, J. H.
***Bell System Technical Journal*, v. 36, no. 2**
pp. 427–428, March 1957

Techniques for measurement of properties of ferrite materials in microwave region by observing perturbation in cylindrical cavity due to insertion of small ferrite sample; comparison of properties of thin disk samples with those of small spheres shows that disks yield more accurate results in region below ferromagnetic resonance; instruments for measurements at 9200 Mc. (*EI*, 1957)

956. THE EFFECT OF GRAIN SIZE ON THE MAGNETOTHERMAL PROPERTIES OF FERRITES

Christoffel, D. A.
***Proceedings of the Physical Society*, London,**
Section B, v. 70, Part 6, pp. 623–625, June 1957

A continuation of previous work, giving further data on specimens of Ni_xCo_{1-x} Fe_2O_4 ($x = 1.00$ and 0.98) having particle sizes in the ranges 1-5μ and 5-10μ. For the pure ferrite a critical size effect was observed. (*PA*, 1957, #8014)

957. THE ANHYSTERETIC REMANENT MAGNETIZATION OF FERRIMAGNETICS

Rimbert, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 4,**
pp. 406–408, July 22, 1957 (in French)

Measurements are reported for powders of magnetite dispersed (1%) in clay and for haematite powders, for a range of direct fields up to 500 oersted, and 50 cps alternating fields up to 800 oersted. The process of demagnetization by the same ac methods is also described, and a correspondence between the two processes is established. (*PA*, 1957, #9263)

958. POSSIBILITY OF POLARIZATION MICROSCOPY WITH ELECTRON BEAMS

Yamaguchi, S.
***Naturwissenschaften*, v. 44, no. 21, p. 555, 1957**
(in German)

Electron beams passing through a magnetic material, such as Fe_3O_4, are deflected or polarized on account of the spin interaction. When this occurs in a specimen in the electron microscope, the deflected electrons may be thrown out of the objective aperture, thus giving rise to extra contrast. The effect is illustrated by an electron micrograph of a film of Fe_3O_4 about 200 Å thick. (*PA*, 1959, #7082)

959. ÜBER DIE URSACHE DER PRESSANISOTROPIE BEI MAGNETISCH HARTEN FERRITEN

Staeblein, H.
***Technische Mitteilungen Krupp*, v. 15, no. 7,**
pp. 165–168, December 1957

Cause of pressure anisotropy studied on barium ferrite powder; magnetic values of sintered compact which are parallel with pressing direction are higher than in vertical directions; previous suppositions confirmed that cause for this phenomenon lies in lamella shape of powder particles. (*EI*, 1958)

960. ON MEASUREMENT OF PERMITTIVITY AND TENSOR PERMEABILITY OF THIN FERRITE RODS

Ogasawara, N.
***Electrotechnical Journal of Japan*, v. 3, no. 4,**
pp. 126–130, December 1957

Methods for determination of all constants of magnetized ferrites, using rod sample process; arrangement of device employed in measurements in 3 cm band. (*EI*, 1958)

961. NEW METHOD FOR MAKING MAGNETIC FIELDS VISIBLE
Suchow, L.
***Journal of Applied Physics*, v. 29, no. 2, pp. 223–224, February 1958**

Thin, plate-like crystals of α-Fe_2O_3 align themselves in a magnetic field so that an axis in the plane of the broad face of the crystal is parallel to the field. If a liquid suspension of such crystals is subjected to a magnetic field, orientation of the assemblage occurs in such a manner that the field becomes visible by reason of the transparency of the suspension when the plates are parallel to the line of sight, the brightness when incident light is reflected, and the darkness in other orientations. (*PA*, 1958, #2394)

962. ZUSAMMENHANG ZWISCHEN TEILCHENGROESSE, TIEFE DER MAGNETISCHINHOMOGENEN OBERFLAECHENSCHICHT, ETC
Torkar, K., Scheikl, O., and Egghart, H.
***Archiv für das Eisenhuettenwesen*, v. 29, no. 2, pp. 139–146, February 1958**

Relation between particle size, depth of magnetic inhomogeneous surface layer, coercive force and magnetic saturation of carbonyl iron and magnetite powders; results show that highest values for coercive force are essentially affected by crystal anisotropy only; magnetic saturation decreases in both powders with decreasing grain size. (*EI*, 1958)

963. EXCHANGE ANISOTROPY IN THE IRON–IRON OXIDE SYSTEM
Meiklejohn, W. H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 454–455, March 1958**

Exchange anisotropy is the result of a magnetic interaction between a ferromagnetic and an antiferromagnetic system. This interaction was discovered in the Co–CoO system, wherein cobalt is the ferromagnetic and cobaltous oxide is the antiferromagnetic system. The material consisted of fine particles ($\sim$ 200 Å) of cobalt which had a coherent cobaltous oxide film. Above the Néel temperature where the CoO is the paramagnetic state the material had the expected behavior of a ferromagnetic. Below the Néel temperature the interaction between the ferromagnetic cobalt and the antiferromagnetic cobaltous oxide resulted in a displaced hysteresis loop and a nonvanishing value of the rotational hysteresis for applied magnetic fields greater than $2K/I_s$. Further investigation of the temperature dependence of this system has shown that the high field ($H > 2K/I_s$) rotational hysteresis vanishes precisely at the Néel temperature of cobaltous oxide. Work on the Fe–FeO system shows a nonvanishing value of rotational hysteresis for temperatures below the Néel temperature of FeO and for magnetic fields greater than $2K/I_s$ for iron. The temperature dependence of this high field rotational hysteresis shows that it vanishes at precisely the Néel temperature of FeO. (*PA*, 1959, #402)

964. DISPERSION OF THE COMPLEX TRANSVERSE SUSCEPTIBILITY OF LITHIUM FERRITE IN THE FREQUENCY RANGE 10–10000 Mc/s
Voigt, F.
***Annalen der Physik*, Leipzig, Folge 7, v. 1, no. 1–3, pp. 86–101, 1958 (in German)**

Measurements of the real and imaginary parts of the complex magnetic susceptibility in transverse static fields up to 8000 oersted were made on thin annular discs of lithium ferrite. From supplementary measurements of the initial magnetization curve and the demagnetizing factors of the specimens the internal transverse field was calculated as a function of the applied field. The magnetic spectra for 11 values of internal field up to 1490 oersted show two dispersion regions at about 50 Mc and 2500 Mc. From the variation of the shape of the curves it is deducted that the dispersion region near 50 Mc arises from rotational processes. (*PA*, 1958, #8127)

965. TEMPERATURE DEPENDENCE OF MICROWAVE PERMEABILITIES FOR POLYCRYSTALLINE FERRITE AND GARNET MATERIALS
Nemarich, J. and Cacheris, J. C.
***Journal of Applied Physics*, v. 29, no. 3, pp. 474–476, March 1958**

Measurements of the microwave permeabilities μ_{11} and $\mu_1 = (\mu^2 - K^3)/\mu$ were made at a frequency of about 9200 Mc using a cavity perturbation technique. Samples in the form of thin slabs were used. Both the static magnetic field and the temperature were varied. The temperature ranged from 25 to 150°C and the internal magnetic

fields were varied from zero to 1500 oersted. A general qualitative agreement between theory and experiment is obtained for one of the ferrite materials. Both μ_1 and μ_{11} were found to increase with increasing temperature for the range measured. (*PA*, 1959, #433)

966. RELATIONS BETWEEN DIFFERENT MODES OF ACQUISITION OF THE REMANENT MAGNETIZATION OF FERROMAGNETIC PARTICLES

Wohlfarth, E. P.

***Journal of Applied Physics*, v. 29, no. 3, pp. 595–596, March 1958**

Particles of γ-Fe_2O_3 are considered in particular, although the note is applicable to various materials.

967. MAGNETIC DETERMINATION OF SHAPE DISTRIBUTION OF SINGLE-DOMAIN POWDERS

Johnson, C. E. and Brown, W. F., Jr.

***Journal of Applied Physics*, v. 29, no. 3, pp. 313–314, March 1958**

By demagnetizing a magnetic powder specimen with diminishing alternating fields of various initial amplitudes and by interpreting the results with the Stoner–Wohlfarth model, one can obtain information about the shape distribution of the particles. This was done with powders of acicular γ-ferric oxide at various temperatures; the temperature variation of the results gave information about the size distribution. The sample was first magnetized to saturation, the diminishing ac field then applied and the remanence measured. Since the particles are not aligned along the applied field, it is necessary to get the equivalent magnetization curve for an aligned sample by operating on the data mathematically. The results indicate that only a small volume fraction of the γ-ferric oxide particles are small enough to be a paramagnetic. There is a relatively large volume fraction of particles with nearly zero critical field. It is thought that this is caused by particles which change their magnetization by a mechanism different from the Stoner–Wohlfarth uniform rotation. On a volume basis, the shape distribution curves peak at a length-to-diameter ratio of about 1.6:1, which gives a coercive force of 300 oersted. The coercive force agrees very well with measured values. The length-to-diameter ratio does not agree with electron microscopic observations, which give a mean of about 5:1. (*PA*, 1958, #8888)

968. OPTICAL PROPERTIES OF SEVERAL FERRIMAGNETIC GARNETS

Dillon, J. F., Jr.

***Journal of Applied Physics*, v. 29, no. 3, pp. 539–541, March 1958**

All of the ferrimagnetic garnets studied to date were found to be transparent to visible light down to wavelengths of about 5200 Å. Thin sections (e.g., 0.005 cm) of yttrium, erbium, and gadolinium iron garnets were examined to determine the absorption and the specific Faraday rotation through that part of the visible spectrum where they transmit light. These measurements were made at temperatures down to 4.2°K. They are interpreted as giving information on electronic energy levels. A magnetic birefringence and a circular dichroism have been observed. The Faraday rotation permits observation of the domain structure in these crystals at any temperature below the Curie point. Possible microwave-optical experiments are discussed briefly. (*PA*, 1958, #8695)

969. FERROMAGNETIC RESONANCE LINE WIDTH IN YTTRIUM IRON GARNET SINGLE CRYSTALS

LeCraw, R. C., Spencer, E. G., and Porter, C. S.

***The Physical Review*, v. 110, no. 6, pp. 1311–1313, June 15, 1958**

A study of ferromagnetic resonance line width in polished, single-crystal spheres of yttrium iron garnet is described. Waveguide cavity perturbation techniques are used with samples 0.013 in. to 0.020 in. in diameter. An extremely narrow line width of 520 millioersted (the full width) is observed at 9300 Mc along the hard axis [100]. It is believed this is the narrowest resonance line yet reported on ferromagnetic materials. The line width is shown to be strongly influenced by the sample surface, with the line narrowing by over a factor of twenty as the polishing proceeds. The line width at 3000 Mc on the same sample is 530 millioersted. The approximate invariance of the line width for more than three-to-one change in frequency is compared with the predictions of some recent theories of ferromagnetic resonance line width. The invariance of line width with frequency is also used to conclude that $\lambda\omega$ and T_2 in the Landau–Lifshits and

Bloch–Bloembergen equations of motion, respectively, are approximately constant over this frequency range. (*PA*, 1958, #8915)

970. COERCIVE FORCE OF IRON OXIDE MICROPOWDERS AT LOW TEMPERATURES

Morrish, A. H. and Watt, L. A. K.
***Journal of Applied Physics*, v. 29, no. 7, pp. 1029–1033, July 1958**

The coercive force of some magnetite and gamma-ferric oxide micropowders was measured in the temperature range from 77 to 300°K. Some of the powders contained essentially only single-domain non-circular particles, others contained only multi-domain particles. For the former, the results are consistent with an interpretation based on the usual relationship between coercive force and the anisotropies; for the latter with an interpretation based on the variation of the crystalline anisotropy constant with temperature. In addition, a new memory effect was observed for the multi-domain magnetite powders. If a sample was placed in some state of magnetization below the transition temperature, warmed to room temperature and then recooled, the measured value of the coercive force depended on this original state. (*PA*, 1959, #437)

971. FERRIMAGNETIC RESONANCE IN YTTRIUM IRON GARNET AT LIQUID HELIUM TEMPERATURES

Dillon, J. F., Jr.
***The Physical Review*, v. 111, no. 6, pp. 1476–1478, September 15, 1958**

Ferrimagnetic resonance experiments were performed on single crystal spheres of yttrium iron garnet [$Y_3Fe_2(FeO_4)_3$] at 24kMc. At 4.2° the line width measured with the steady field along [100] is 15 oersted as compared with 30 oersted at 295°, 400 oersted at 65°K. At liquid helium temperatures the crystal is apparently cubic. There is a strong anisotropy in line width. Except for the case of the field along [100], the line width varies strongly with temperature in this temperature region. A large magnetocrystalline anisotropy is indicated by the variation in field for resonance with direction. This ranges over 3000 oersted.

The results quoted in this paper were obtained on two polished spheres 0.0107 in. and 0.0080 in. in diameter.

972. DIRECT OBSERVATION OF WEISS DOMAINS BY MEANS OF THE FARADAY EFFECT

Kooy, C.
***Philips Technical Review*, v. 19, no. 10, pp. 286–289, 1957–1958**

During the preparation of single crystals of $BaFe_{12}O_{19}$, the main constituent of ferroxdure, single crystal platelets less than 1 μ thick are obtained under certain conditions. The hexagonal axis lies perpendicular to the surface of the platelets, which, moreover, are transparent to red light. Since the magnetization of the Weiss domains is parallel to the hexagonal axis (and alternately in opposite directions in adjacent domains), a Faraday effect is observed with transmitted light. This effect makes the Weiss domains immediately visible when such a crystal is viewed through a polarizing microscope with nicols not quite exactly crossed. A number of photos are reproduced showing the patterns so obtained in both virgin and magnetized platelets. Conclusions can be drawn from the photos regarding the distribution and size of the Weiss domains. (*PA*, 1958, #4126)

973. THE MAGNETIC FIELDS OF A FERRITE ELLIPSOID

Hurd, R. A.
***Canadian Journal of Physics*, v. 36, no. 8, pp. 1072–1083, August 1958**

Approximate expressions are found for the internal and the adjacent external magnetic fields of a small ferrite ellipsoid under plane-wave excitation. Consideration is given to the variation of apparent susceptibility with the size of the ferrite. (*PA*, 1959, #413)

974. OBSERVATION OF DOMAINS IN THE FERRIMAGNETIC GARNETS BY TRANSMITTED LIGHT

Dillon, J. F., Jr.
***Journal of Applied Physics*, v. 29, no. 9, pp. 1286–1291, September 1958**

It was found that single crystals of the ferrimagnetic YFe, GdFe and other garnets are transparent to visible light. Thin sections (e.g., 0.005 cm thick) transmit sufficient light for microscopic examination. The transmitted light undergoes a nonreciprocal rotation similar to the Faraday effect. By virtue of this rotation many features of the domain structure are readily visible. A magnetic bire-

fringence was also observed which can be used to differentiate domains whose magnetization lies perpendicular to the line of sight. It is possible to study domain structure at any temperature below the Curie point. The effects of strains set up by the polishing procedure are discussed. Finally, mention is made of possible combined microwave-optical experiments, as well as experiments aimed at understanding the switching process. (*PA*, 1959, #3650)

975. SHAPE DISTRIBUTION OF MAGNETIC POWDERS

Johnson, C. E., Jr. and Brown, W. F., Jr.
***Journal of Applied Physics*, v. 29, no. 12, pp. 1699–1701, December 1958**

In work reported earlier, the average length-to-diameter ratios determined magnetically did not agree with those observed under the electron microscope; this was thought due to magnetic interactions. This paper describes further shape determination measurements on γ-Fe_2O_3 samples of increasing dilution by the original method and by two analogous methods described by Wohlfarth. The results show a slight increase of mean length-to-diameter ratio with dilution and a considerable broadening of the distribution toward large length-to-diameter ratios. The different methods of measurement described do not yield the expected congruent curves at very low concentration. This indicates a deviation from Stoner-Wohlfarth rotation in these particles. The details of the mathematical methods are also described. (*PA*, 1959, #4788)

976. PROPERTIES OF THIN MAGNETIC FILMS FOR MICROWAVE APPLICATIONS

Tannenwald, P. E.
Lincoln Laboratory, M.I.T., Lexington, Mass.
***IRE WESCON Convention Record*, (Part I) 1959**

The microwave properties of thin magnetic films are described and are compared with ferromagnetic insulators. Consequences of two processes which give rise to some special properties are examined, namely the initial permeability and the gyromagnetic permeability. The specific topics include a comparison of the frequency response of ferrites and films; electromagnetic wave transmission through thin magnetic films, with particular regard to controlling the power flow by changes in permeability; discussion of the limitation imposed by the skin depth to obtain an adequate number of effective spins; potential applications of the initial permeability at microwave frequencies; and, finally, a description of a scheme which, in principle, represents a spin parametric amplifier.

977. DOMAIN BEHAVIOR IN SOME TRANSPARENT MAGNETIC OXIDES

Sherwood, R. C., Remeika, J. P., and Williams, H. J.
***Journal of Applied Physics*, v. 30, no. 2, pp. 217–225, February 1959**

Magnetic domains were observed by means of the Faraday effect, and by the Bitter technique in a number of compounds having the spinel, magnetoplumbite, and perovskite-like structures. The latter compounds are orthorhombic and have the general formula $MFeO_3$ where M is Y, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, or Lu. Domain boundaries in these compounds move for fields less than one oersted, and after saturation, crystals as large as ($\sim 0.2 \times 0.2 \times 0.1$ in.) remain single domains. Fields of 2500 oersted are required to reverse the magnetization in the single domain crystals. Reversal occurs by nucleation and growth of a reverse domain. This is evident from the unusual torque curves. The fact that domain walls occur and move in such weak fields in these compounds indicate that the slight or parasitic magnetization is a uniform body property of the crystals. The parasitic magnetization of these compounds was determined from torque measurements. These crystals are well suited for light modulators because a uniaxial anisotropy holds the magnetization vectors normal to the large surfaces of thin flat crystals and weak fields produce changes in magnetization. Absorption coefficients were measured for some compounds for a radiation having wavelengths from 0.6μ to 13μ. Thin sections were found to be transparent to light at the red end of the visible spectrum. The Farady rotation was measured for $Li_{0.5}Fe_{2.5}O_4$, $MgFe_2O_4$, $YFeO_3$, and $PbFe_{11}Al_1O_{19}$.

(See also references: 984, 988, 1017, 1022, 1028, 1029, 1040, 1118, 1142, 1217, and 1256)

B. General

978. MOTION OF A FERROMAGNETIC DOMAIN WALL IN Fe_3O_4

Galt, J. K.
***The Physical Review*, v. 85, no. 4, pp. 664–669, February 15, 1952**

979. MOTION OF DOMAIN WALLS IN FERRITE CRYSTALS
Galt, J. K., Andrus, J., and Hopper, H. G.
***Reviews of Modern Physics*, v. 25, no. 1, pp. 93–97, January 1953**

980. TEMPERATURE DEPENDENCE OF THE MAGNETIC SPECTRA OF NiZn FERRITES IN THE RADIO-FREQUENCY RANGE
Fomenko, L. A.
***Zhurnal Ekspermentalnoi i Teoreticheskoi Fiziki*, v. 25, no. 1, pp. 107–114, 1953 (in Russian)**

The effect of temperature on the dispersion and absorption bands in the magnetic spectrum was studied for a solid solution of NiZn ferrites (initial permeability 2140 G/oersted at 20°C) in the radio-frequency range 0.05–60 Mc and at temperatures from −180 to +99°C. It was shown that the NiZn ferrite investigated had a continuous magnetic spectrum whose frequency band of magnetic relaxation remained in the radio-frequency range and was shifted toward lower frequencies at the temperature increased (up to the Curie point). This regularity was also observed at temperatures above that of the thermal maximum of permeability. (*PA*, 1955, #381)

981. TOWARDS THE THEORY OF THE MEASUREMENT OF μ AND ε OF SEMICONDUCTING FERROMAGNETICS
Polivanov, K. M.
***Doklady Akademii Nauk* SSSR, v. 95, no. 1, pp. 61–64, 1954 (in Russian)**

A method of measuring the permeability μ and dielectric constant ε of ferrites is described. Specimens are fashioned into particular shapes and their open- and short-circuit impedances when used as terminations for a coaxial line are measured. Simple formulae are given for the calculation of μ and ε. Several advantages over the method of Brockman, Dowling and Steneck are claimed. (*PA*, 1957, #7221)

982. K TEORII OPREDELENIYA PRONITSAEMOSTI METALLICHESKIKH FERROMAGNETIKOV I MAGNETODIELEKTRIKOV PO DANNIM OPITOV
Polivanov, K. M.
***Elektrichestvo*, no. 3, pp. 19–29, March 1954**

Theory for determination of permeability of ferromagnetic metals and magnetodielectric substances from experimental data; experiments carried out on oxide type of ferromagnetics, nickel zinc and manganese ferrites. (*EI*, 1956)

983. INVESTIGATION OF THE PARAMAGNETISM OF CERTAIN FERRITES
Galperin, F., Dmitrakova, G., and Molodtsova, L.
***Doklady Akademii Nauk SSSR*, v. 95, no. 5, pp. 833–834, 1954 (in Russian)**

Curves were obtained for the variation of $1/\chi_\mu$ and α with temperature for ferroxdure, vectolite, and ferrites based on Mn, Co, Mg, Co–Mn, Co–Ni. For the cobalt ferrite and for vectolites containing Co, anomalous behavior was found in that the susceptibility increased with temperature. A similar result had been found earlier for cobalt telluride. At higher temperatures the $1/\chi_\mu - T$ curve is found to be very close to a hyperbola and it is suggested that the Néel law has no valid foundation. (*PA*, 1957, #2428)

984. QUELQUES PROPRIETES PHYSIQUES DES FERRITES
Wijn, H. P.
***Onde eléctrique* v. 34, no. 326, pp. 418–424, May 1954**

Some physical properties of ferrites; discussion on influence of porosity of ferrites on their ferromagnetic properties; reason for low magnetic saturation; initial permeability for high quality coils and high-frequency transformers; properties of finely divided ferrite powders, particularly for frequencies above 100 Mc; how to obtain rectangular hysteresis loop with toroids of glass-covered ferrites. (*EI*, 1955)

985. FERROMAGNETISM OF SUBSTANCES OF FERRITE TYPE AND ANTIFERROMAGNETISM
Vlasov, K. B. and Ishmukhametov, B. K.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 27, no. 1, pp. 75–86, 1954 (in Russian)**

Above the antiferromagnetic Curie point the permeability follows the Curie-Weiss law, the paramagnetic Curie point differing from the antiferromagnetic one. Theoretically this indicates exchange interaction not only

between sublattices but also inside the sublattices themselves. Below the antiferromagnetic Curie point the permeability is anisotropic, the perpendicular permeability being independent of temperature, and the parallel permeability dependent; the latter tends towards zero at 0°K and toward the value of the perpendicular permeability at the antiferromagnetic Curie point. The form of the temperature curve of the parallel (or resultant) permeability is determined by the ratio of the values of paramagnetic and antiferromagnetic Curie points; the smaller this ratio, the greater the slope of the curve referred to the temperature axis near the Curie point. These results agree with Néel's and van Vleck's conclusions based on the method of molecular fields. Certain differences exist for such materials as $MnFe_2$ and FeF_2, but they are partly due to disagreements between experimental conditions which render correct comparisons difficult and the theory has so far been evolved only for a somewhat limited temperature range. (*PA*, 1955, #1041)

986. TRANSIENT PHENOMENA IN A FERRITE
Matz, S.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 239, no. 6, pp. 487–488, August 9, 1954 (in French)**

Results are given of measurements of the complex permeability of a Ni–Zn ferrite as a function of time (several seconds to several hours) at temperatures between −196 and 20°C, at frequencies 0.1 to 1.0 Mc and in various field strengths. The results are interpreted on the basis of Néel's theory of magnetic viscosity by diffusion, here of electrons between the lattice sites occupied by ferric and ferrous ions. (*PA*, 1955, #383)

987. VARIATION WITH TEMPERATURE OF MAGNETIC PROPERTIES OF NICKEL–ZINC AND COPPER–ZINC FERRITES
Suchkov, A. I.
***Zhurnal Tekhnicheskoi Fiziki*, v. 24, no. 9, pp. 1579–1583, 1954 (in Russian)**

Results of experimental investigations of variation with temperature (from −180 to 180°C) of a range of nickel-zinc ferrites and copper-zinc ferrites are presented graphically. Magnetic properties of some semiconducting ferrites vary very sharply between −50 and +50°C. It is shown that the temperature variations of magnetic properties of ferrites and metallic ferromagnetic materials are governed by the same laws. This result is of importance for high-frequency applications of ferrites. (*PA*, 1956, #2231)

988. MOTION OF INDIVIDUAL DOMAIN WALLS IN A NICKEL–IRON FERRITE
Galt, J. K.
***Bell System Technical Journal*, v. 33, no. 5, pp. 1023–1054, September 1954**

Samples have been cut from single crystals of the nickel-iron ferrite $(NiO)_{0.75}(FeO)_{0.25}Fe_2O_3$ in such a way that they contain one and only one movable ferromagnetic domain wall. The viscous damping coefficient for this wall, which is a measure of the losses associated with domain wall motion in this material, has been measured as a function of temperature. This damping shows a very large increase as the temperature goes down to the region of 77°K. The value of this damping is correlated with the theoretical analysis. In addition, it is suggested that the sharp increase in damping at low temperatures is due to a relaxation associated with a rearrangement of the valence electrons on the divalent and trivalent iron ions in the ferrite. A tentative phenomenological theory of the losses based on this mechanism is presented. (*PA*, 1955, #1049)

989. ON THE Λ-SHAPED FERRIMAGNETISM OF $FeS_{1.10}$
Hirone, T., Maeda, S., and Tsuya, N.
***Journal of the Physical Society of Japan*, v. 9, no. 5, pp. 736–739, September–October, 1954**

A Λ-shaped change in the thermomagnetic curve in iron sulphide $FeS_{1.10}$ (γ-transformation) was investigated experimentally. It was found that the peak height was increased by decreasing the heating speed of the specimen. Temperature hysteresis in the thermomagnetic curves was also found at the low-temperature side of the peak. Excess specific heat corresponding to the thermomagnetic anomaly was observed; the amount of anomalous heat absorption during the transformation was of the order of 100 cal/mol. It was concluded that the change of magnetism at the transformation is due to the ferrimagnetic distribution of ferrous and ferric ions and the change of vacant site distribution at the transformation. (*PA*, 1955, #2869)

990. SATURATION MAGNETIZATION AND CRYSTAL CHEMISTRY OF FERRIMAGNETIC OXIDES

Gorter, E. W.

***Philips Research Reports*, v. 9, no. 4, pp. 295–320, August 1954, pp. 321–365, October 1954**

The following subjects are covered: Spinel structure, geometry, crystal chemistry, etc. (in August). Theory of ferrimagnetism; experimental procedures applicable; evidence for correctness of Néel's hypothesis; experiments on angle dependence of superexchange interaction; saturation moment and crystal chemistry of ferrimagnetic (in October). (*EI*, 1955)

991. MAGNETIC ANISOTROPY CONSTANTS OF FERROMAGNETIC SPINELS

Weisz, R. S.

***The Physical Review*, v. 96, no. 3, pp. 800–801, November 1, 1954**

Calculates values of K_1 for the ferrites $MO \cdot Fe_2O_3$ (M = Mn, Co, Ni, Cu, Mg) from the formula $\mu_0 - 1 = kI_0^2/K_1$ appropriate to a rotational process of magnetization, μ_0 being the initial permeability and k a constant (taken equal to 21 from direct measurements on magnetite). Comparison is made with directly measured values; the calculated values are correlated with the multiplicities of the M^{++} ions in the ground state and with observed values of the magnetostriction constants. (*PA*, 1955, #1051)

992. REVERSIBLE SUSCEPTIBILITY OF FERROMAGNETICS

Grimes, D. M. and Martin, D. W.

***The Physical Review*, v. 96, no. 4, pp. 889–896, November 15, 1954**

Derivation of expression relating magnetization dependence of reversible susceptibility normal to field direction to that of parallel reversible susceptibility; measurements on three ferrite specimens. (*EI*, 1955)

993. MAGNETIC AND CRYSTALLINE BEHAVIOR OF CERTAIN OXIDE SYSTEMS WITH SPINEL AND PEROVSKITE STRUCTURES

Maxwell, L. R. and Pickart, S. J.

***The Physical Review*, v. 96, no. 6, pp. 1501–1505, December 15, 1954**

A series of substitutions have been performed on nickel ferrite where the Fe^{3+} is replaced by varying amounts, with In^{3+}, Sc^{3+}, Y^{3+}, Gd^{3+} and La^{3+}. In^{3+} went into solid solution with the nicked ferrite to form a spinel structure whose lattice constant a_0 increased linearly with increasing amounts of In^{3+} to a maximum value of 8.708 Å for 1.5 In^{3+} ions per molecule. At greater concentration of In^{3+}, the starting materials appeared as a mixed phase with $NiO \cdot Fe_{0.5}In_{1.5}O_3$. The saturation magnetization (μ_0), obtained by extrapolation to absolute zero, increased with increasing amounts of In^{3+}, in a manner indicating that the In^{3+} ions preferred the A sites. In the case of Sc^{3+}, an increased cell size was found which "leveled off" at $a_0 = 8.41$ Å for 0.75 Sc^{3+} ions per molecule. μ_0 decreased with increasing Sc^{3+} content and approached a compensation point similar to that found previously for the Al^{3+} substitution. It is concluded that trivalent metal ions having a rare-gas electronic structure, by showing a preference for the B sites, give rise to compensation points and the Néel *P*-type curves. The Curie temperatures for the substitution of In^{3+} and Sc^{3+} show a nearly linear decrease with concentration but with slopes greater and less, respectively, than the slope of the single curve found previously to represent both the Al^{3+} and Ga^{3+} substitutions. The Y^{3+}, Gd^{3+} and La^{3+} substitutions resulted in a mixed solution of nickel ferrite and corresponding perovskite structures formed with Fe^{3+}. (*PA*, 1955, #2015)

994. SATURATION MAGNETIZATION AND CRYSTAL CHEMISTRY OF FERRIMAGNETIC OXIDES. II, III

Gorter, E. W.

***Philips Research Reports*, v. 9, no. 5, pp. 321–365, October 1954, no. 6, pp. 403–443, December 1954**

In a number of mixed-crystal series anomalous σ-T curves have been looked for: these are not found in the systems $Ni_{1+a}Fe^{III}_{2-2a}Ti_aO_4$ and $Ni_{1.5-a}Zn_aFe^{III}Ti_{0.5}O_4$ because of the unexpected presence of Ti^{4+} ions in tetrahedral sites, proved for $Ni_{1.5}Fe^{III}Ti_{0.5}O_4$ by measurements of the effective g-factor. In the system $Li_{0.5}Fe^{III}_{2.5-a}Cr_aO_4$ ($0 < a < 2.0$) the distribution of the Li^+ and Fe^{3+}

ions is anomalous as a result of short-range order. The resultant moment remains positive, and only one type of anomalous σ-T curve, viz: that for which the spontaneous magnetization changes sign with temperature, occurs in a wide range of compositions. For $a < 1.25$ the materials belong to group (*a*). A change of sign of the resultant moment does occur in the system $NiFe^{III}_{2-a}Al_aO_4$ Anomalous σ-T curves are here found in a narrow range of compositions, but not all types predicted by Néel; the reasons are discussed. The presence of Mn^{2+} ions apparently promotes the formation of angles between the ionic moments in B sites: the complete system $MnFe^{III}_{2-a}Cr_aO_4$ belongs to group (*b*), as well as $MnFe_2O_4$ prepared by other authors and part of the system $Ni_{1.5-a}Mn_aFe^{III}Ti_{0.5}O_4$. In the first-named system *m* probably changes sign only as a result of these angles. (*PA*, 1955, #1061)

995. FERROXDURE II AND III. ANISOTROPIC PERMANENT MAGNET MATERIALS

Stulits, A. L., Rathenau, G. W., and Weber, G. H.
***Philips Technical Review*, v. 16, no. 5–6, pp. 142–147, November–December 1954**

This article discusses a new group of ceramic permanent magnet materials based on compound $BaFe_{12}O_{19}$; development of anisotropic type of Ferroxdure, product comparable to that of modern magnet steels; properties and preparation. (*EI*, 1955)

996. MAGNETIC ROTATION PHENOMENA IN A POLYCRYSTALLINE FERRITE

Park, D.
***The Physical Review*, v. 96, no. 1, pp. 60–66, January 1, 1955**

In order to calculate the initial susceptibility at high frequencies of a polycrystalline sample of ferrite, one must take account of the interaction between neighboring crystallites, and of the fact that the crystallites differ from each other in their orientation (assumed random) and in their characteristic resonant frequencies. Each crystallite is acted upon by an oblique alternating field, and its magnetization precesses in an elliptical cone. A simple solution of this problem is given by the use of complex variables involving two different imaginaries. It is found that the interaction between crystallites has little effect on the magnetic spectrum other than to raise the effective value of the resonant frequencies, and that the spectrum obtained is not very sensitive to the exact form chosen for the distribution of resonant frequencies among the crystallites. The resulting expressions for the real and imaginary parts of the susceptibility are compared with the results of some measurements by F. Brown and C. L. Gravel on a lightly-sintered sample of nickel ferrite, assuming that the major part of the suspectibility is due to rotation processes. The agreement is satisfactory and shows among other things that the damping constant need be no larger in these materials than it is found to be in a single crystal. (*PA*, 1955, #1991)

997. DOMAIN ROTATION IN NICKEL FERRITE

Brown, F. and Gravel, C. L.
***The Physical Review*, v. 97, no. 1, pp. 55–59, January 1, 1955**

Initial permeability and r.f. dispersion in sintered nickel ferrite found to be principally due to rotation of crystallite magnetic moments in equivalent anisotropy field; experiments showing importance of polycrystalline structure in determining mechanism of initial polarization. (*EI*, 1955)

998. OBSERVATION OF EXCHANGE RESONANCE NEAR A FERRIMAGNETIC COMPENSATION POINT

McGuire, T. R.
Letter in *The Physical Review*, v. 97, no. 3, pp. 831–832, February 1, 1955

Exchange resonance was observed on a small spherical specimen of $Li_{0.5}Cr_{1.25}Fe_{1.25}O_4$ and the general features of the predictions of the preceding abstract were verified. The compensation point was found to lie at about 57°C. (*PA*, 1955, #3879)

999. ON MICROWAVE COTTON-MOUTON EFFECT IN FERROXCUBE

DuPre, F. K.
***Philips Research Reports*, v. 10, no. 1, pp. 1–10, February 1955**

The effect in which microwave beam traversing ferrite will be split up into two beams with different velocities when transverse magnetic field H is applied; ordinary beam has its magnetic field parallel to H, extraordinary beam perpendicular to H; beams will emerge with phase difference; this difference is determined for Ferroxcube 4B as function of field; frequency used is 9350 Mc. (*EI*, 1955)

1000. CIRCULARLY POLARIZED CAVITIES FOR MEASUREMENT OF TENSOR PERMEABILITIES

Spencer, E. G., Le Craw, R. C., and Reggia, F.
Letter in *Journal of Applied Physics*, v. 26, no. 3, pp. 354–355, March 1955

Since a ferrite resonance splits the degeneracy of a TE cavity, its exact measurement is difficult with linearly polarized exciting radiation, but with right and with left circularly polarized radiation, two distinct curves are obtained and can be analyzed separately. (*PA*, 1955, #4784)

1001. MOTION OF INDIVIDUAL DOMAIN WALLS IN A NICKEL–IRON FERRITE. ERRATUM

Galt, J. K.
***Bell System Technical Journal*, v. 34, no. 2, pp. 439–441, March 1955**

This article gives an alternative derivation of the relation for the velocity of a 180 deg domain wall on the basis of Néel's theory of magnetic viscosity. (*PA*, 1955, #7182)

1002. FERROMAGNETIC RESONANCE ABSORPTION IN $BaFe_{12}O_{19}$, A HIGHLY ANISOTROPIC CRYSTAL

Smit, J. and Beljers, H. G.
***Philips Research Reports*, v. 10, no. 2, pp. 113–130, April 1955**

The ferromagnetic resonance absorption was measured at 24,000 Mc for a single crystal of hexagonal $BaFe_{12}O_{19}$. The resonance conditions are severely influenced by the crystalline anisotropy and, for fields too small for saturation, also by the Weiss-domain structure. The theory predicts, for a varying magnetic field perpendicular to the hexagonal axis, at most three absorption peaks, which have been observed at elevated temperatures. The gyroscopic splitting factor g and the anisotropy field are evaluated. The g-factor has the spin-only value. The crystalline anisotropy is suggested to be caused by dipole-dipole interaction. (*PA*, 1956, #1361)

1003. DIRECT OBSERVATION OF DOMAIN ROTATION IN FERRITES

Brown, F. and Gravel, C. L.
***The Physical Review*, v. 98, no. 2, pp. 442–448, April 15, 1955**

A direct experimental observation of domain rotation in the initial permeability region of sintered nickel ferrite has been made using a technique similar to that originated by F. Bloch to observe nuclear precession. A 5 mm diameter sphere of ferrite is surrounded by crossed transmitter and receiver loops adjusted for minimum r.f. signal when the sample is demagnetized. Application of an external steady field (as low as 5 oersted, perpendicular to both loops) then causes a measurable receiver loop output which cannot be eliminated by readjusting the planes of the loops. The motion of the net magnetic moment is thus rotational. In the present case, the external field is needed only to polarize the sphere, the field for Larmor precession being supplied by the equivalent anisotropy fields seen by each individual domain. Since the applied field is much smaller than these anisotropy fields, a plot of the detector loop output (per unit applied field) vs. frequency delineates the rotational resonance spectrum of the polycrystalline sample. Measurements have been made from 20 Mc to 800 Mc and can be described qualitatively using the theory of domain rotation. In order to understand the relatively low dispersion frequency indicated by the measurements, it is hypothesized that intermediate conditions exist in some polycrystalline ferrites between the situation in which the initial permeability is purely a result of domain rotation and that in which motion of domain walls is the dominant mechanism. The distinction between the models is thus probably not very sharp. (*PA*, 1955, #5513)

1004. MAGNETIC ROTATION PHENOMENA IN A POLYCRYSTALLINE FERRITE. II

Park, D.
***The Physical Review*, v. 98, no. 2, pp. 438–441, April 15, 1955**

The calculations of Part I are extended to the determination of the entire permeability tensor of a polycrystalline sample of a ferrimagnetic material in which there is a slight over-all magnetization. The calculation takes account of the largely random orientation of the magnetic axes of the crystallites and of the fact that their characteristic resonant frequencies are statistically dis-

tributed. It is shown that the magnetic interaction between crystallites can be included, but it does not greatly affect the form of the final results. (*PA*, 1955, #5512)

1005. THE HEAT CHANGES ACCOMPANYING MAGNETIZATION PROCESSES IN FERRITES
Bates, L. F. and Sherry, N. P. R.
***Proceedings of the Physical Society*, London, Section B, v. 68, Part 5, pp. 304–309, May 1959**

Measurements have been made, for the first time, of the thermal changes accompanying the step-by-step magnetization of a number of ferrites. The method was that used with metals by Bates and his co-workers, with the added improvement that the thermal deflections were recorded via a split photocell amplifier. Measurements were made on certain mixed ferrites of the nickel–zinc series. The results showed that the major part of the heat changes can be explained satisfactorily in terms of the changes of intrinsic magnetization with field. In some of the specimens a slight irreversible heating was observed; it therefore appears that domain rotational effects make a very small contribution to the thermal changes. An anomalous, low-field effect previously found in certain metals occurred in some of the ferrites. This effect is not yet fully understood, although some qualitative suggestions are made to account for it; it is concluded that the observed thermal effects in ferrites can be explained on the same lines as those for metals. (*PA*, 1955, #5520)

1006. MAGNETIC PROPERTIES OF FeTe
Uchida, E. and Kondoh, H.
***Journal of the Physical Society of Japan*, v. 16, no. 5, pp. 357–362, May 1955**

The susceptibility-temperature relation for the compound FeTe was measured over a range of temperatures between liquid air and 1150°C. Evidence was found of an antiferromagnetic character in the region of temperatures below 500°C, the molal magnetic susceptibility having been expressed by $\chi = 0.92/(T + 220)$. The effective number of Bohr magnetons was estimated to be 2.72. The susceptibility dependence on temperature in the region beyond 600°C showed evidences of the feeble constant paramagnetism and an anomaly at 815°C, which is the melting point of this compound. A tentative interpretation of these magnetic properties is given in terms of an electronic configuration of Fe. (*PA*, 1955, #6295)

1007. FERROMAGNETIC RESONANCE IN FERROXDURE
Weiss, M. T. and Anderson, P. W.
***The Physical Review*, v. 98, no. 4, pp. 925–926, May 15, 1955**

Ferromagnetic resonance experiments have been performed on Ferroxdure at various microwave frequencies from 9,000 Mc to 50,000 Mc. With no externally applied field a natural resonance occurs near 50,000 Mc. With magnetic field applied perpendicular to the hexagonal axis, a double resonance occurs for frequencies below 50,000 Mc, while with a field applied along the hexagonal axis a single resonance occurs above 50,000 Mc. A theory is developed to explain the above results. (*PA*, 1955, #6296)

1008. PARAMAGNETIC STUDY OF RARE EARTH FERRITES
Benoit, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 240, no. 25, pp. 2389–2390, June 20, 1955 (in French)**

Results are given of susceptibility measurements for the following substances above their Curie points: $Fe_2O_3 \cdot M_2O_3$, where M = La, Gd, Dy, Er. (*PA*, 1955, #8898)

1009. FERROMAGNETIC TITANOMAGNETITES AND ILMENITES. I. OPTICAL, RADIOCRYSTALLOGRAPHIC AND CHEMICAL STUDY. II. STUDY OF MAGNETIC PROPERTIES
Chevallier, R., Bolfa, J. and Mathieu, S.
***Bulletin de la societé française de mineralogie et de cristallographie*, v. 78, no. 4–6, pp. 306–346, April–June, 1955, no. 7–9, pp. 365–399, July–September, 1955 (in French)**

1010. RELAXATION PHENOMENA IN FERRITES
Clogston, A. M.
***Bell System Technical Journal*, v. 34, no. 4, pp. 739–760, July 1955**

Galt suggested a mechanism for the losses observed in ferromagnetic resonance and domain wall motion in single crystals of nickel ferrite containing small amounts of divalent iron substituted for divalent nickel. Each such

substitution provides one electron able to move between the various octahedral sites in the crystal. Galt's suggestion is that the losses arise from a relaxation associated with the motion of these electrons. This paper develops a theory of this mechanism based on a thermodynamic model. Expressions are found for the velocity of domain wall motion for the line width in ferromagnetic resonance and for the displacement of the field for resonance. (*PA*, 1956, #466)

1011. FIGURE OF MERIT FOR MICROWAVE FERRITES AT LOW AND HIGH FREQUENCIES
Lax, B.
Letter in *Journal of Applied Physics*, v. 26, no. 7, p. 919, July 1955

The figure of merit F is defined as the ratio of the Faraday rotation to the attenuation and is shown to equal ωT, where ω is the frequency and T the Bloch-Bloembergen relaxation time constant. Typical values of F are estimated. (*PA*, 1955, #8899)

1012. REVIEW OF STRUCTURE AND SOME MAGNETIC PROPERTIES OF FERRITES
Blackman, L. C. F.
***Journal of Electronics*, v. 1, no. 1, pp. 64–77, July 1955**

This article discusses the combination of high electrical resistivity and useful magnetic properties which has caused ferrites to become increasingly important as h.f. core materials; description of general structural and saturation magnetization properties of more simple ferrites, and their preparation; theories of magnetic interaction associated with ferromagnetism. (*EI*, 1955)

1013. FERRITES—FUNDAMENTALS
Aden, A. L., Ayres, W. P., and Melchor, J. L.
***Sylvania Technologist*, v. 8, no. 3, pp. 76–83, July 1955**

The application of general theory of magnetism to magnetic ferrites; properties, with emphasis on composition, structure, and loss mechanisms are reviewed. (*EI*, 1955)

1014. MULTIPOLARIZATION IN THE HEXAGONAL BARIUM IRON OXIDE MAGNETS
Kubota, B. and Okazaki, C.
Note in *Journal of the Physical Society of Japan*, v. 10, no. 8, p. 723, August 1955

After appropriate magnetic annealing a rod-shaped specimen was found to be divided into regions of magnetization alternately parallel and antiparallel to the axis of the rod. (*PA*, 1955, #9765)

1015. FERROMAGNETIC RESONANCE OF GADOLINIUM FERRITE AS DEPENDENT ON TEMPERATURE, AT 9000 Mc/s
Pauleve, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 6, pp. 548–550, August 8, 1955 (in French)**

The resonance field was measured between −200 and +270°C and found to reach low values in the neighborhood of the compensation temperature 33°C. (*PA*, 1956, #470)

1016. THERMAL EXPANSION STUDY OF SAMARIUM FERRITE AND THE MAGNETIC TRANSITIONS OF THE RARE-EARTH FERRITES
Guiot-Guillain, G. and Wache, X.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 6, pp. 550–552, August 8, 1955 (in French)**

The expansion coefficient/temperature curve exhibits a change of slope at about 400°C, one of the two magnetic transition temperatures, but not at the other, 300°C. (*PA*, 1956, #475)

1017. ON THE THEORY OF THE COERCIVE FORCE OF THE BARIUM FERRITE PERMANENT MAGNET MATERIAL MANIPERM
Müller, H. G.
***Deutsche Electrotechnik*, v. 9, no. 8, pp. 286–290, August 1955 (in German)**

The factors contributing to the coercive force of magnetic materials and of Maniperm particularly, are discussed and it is concluded that the coercive force of this material is due primarily to the magnetocrystalline anisotropy of its particles. (*PA*, 1956, #467)

1018. FREQUENCY DEPENDENCE OF MAGNETIC RESONANCE IN α-Fe_2O_3
Kumagai, H., Abe, H., Ono, K., Hayashi, I., Shimada, J., and Iwanaga, K.
***The Physical Review*, v. 99, no. 4, pp. 1116–1118, August 15, 1955**

Magnetic resonance absorption in single crystals of natural α-Fe_2O_3 was examined in the wavelength range from 5.4 mm to 6.2 cm. Resonance fields H_r observed in the basal plane do not give a quadratic relation with the normal resonance field H_0 as predicted by the usual Kittel formula, but rather the following linear relationship: $h\nu/g\beta = H_0 = H_r + H_A$, where H_A is 4.2_5 K oersted and g is 2.5_4. (*PA*, 1955, #8901)

1019. FERROMAGNETIC RESONANCE IN TWO NICKEL–IRON FERRITES
Yager, W. A., Galt, J. K., and Merritt, F. R.
***The Physical Review*, v. 99, no. 4, pp. 1203–1210, August 15, 1955**

Measurements of ferromagnetic resonance in range 4.2 to 380°K in $(NiO)_{0.95}(FeO)_{0.05}Fe_2O_3$ and in $(NiO)_{0.75}(FeO)_{0.25}Fe_2O_3$ at 24,000 Mc; thermodynamic analysis of loss mechanism. (*EI*, 1955)

1020. MAGNETOSTRICTION AND PERMEABILITY OF MAGNETITE AND COBALT-SUBSTITUTED MAGNETITE
Bickford, L. R., Jr., Pappis, J., and Stull, J. L.
***The Physical Review*, v. 99, no. 4, pp. 1210–1214, August 15, 1955**

The principal magnetostriction constants of magnetite were determined over the temperature range from 120 to 300°K by the strain-gage technique. Since λ_{111} and λ_{100} are different in sign and practically constant over this entire range ($\lambda_{111} \simeq +80 \times 10^{-6}$; $\lambda_{100} \simeq -20 \times 10^{-6}$) the change in direction of easy magnetization which occurs at 130°K is manifested by a change in structure of λ vs. H curves in a polycrystalline sample. The substitution of small amounts of cobalt for divalent iron in polycrystalline magnetite causes a marked shift upwards in the temperature of the maximum in initial permeability, which in the case of magnetite occurs at 130°K. The temperature shift is practically linear with respect to cobalt ferrite content, the rate being $\sim$ 140 deg C/mole percent. Magnetostriction vs. magnetic field curves for these specimens indicate that the shifted permeability peak is still associated with a change in direction of easy magnetization. The predicted anisotropy of cobalt ferrite, obtained by extrapolation of these results, is in reasonable agreement with the values measured directly by other investigators. (*PA*, 1955, #8906)

1021. LOSSES IN MAGNETIC FERRITES
Hipskind, G. S.
***Electrical Manufacturing*, v. 56, no. 2, pp. 108–112, August 1955**

Measurement of losses in manganese zinc and nickel zinc ferrites permits development of empirical and analytic methods for calculating total core losses; Steinmetz equation found applicable for calculating hysteresis losses at flux densities up to 2000 gauss. (*EI*, 1955)

1022. FERROMAGNETIC RESONANCE IN MAGNESIUM-MANGANESE ALUMINUM FERRITE BETWEEN 160 AND 1900 Mc
Suhl, H., Van Uitert, L. G. and Davis, J. L.
***Journal of Applied Physics*, v. 26, no. 9, pp. 1180–1182, September 1955**

Results are reported of measurements on a disk-shaped ferrite specimen with composition Mg : Mn : Al : Fe = 1.00 : 0.11 : 0.65 : 1.27, which has a relatively low resonance frequency. This is found to be a linear function of the applied field strength (100–900 oersted) but with an anomalously low intercept, which is interpreted in terms of the incomplete saturation of the individual crystal grains. Line profiles were found to be asymmetrical, being wider on the low-field side of resonance. (*PA*, 1956, #1362)

1023. FIRST-ORDER MAGNETIC ANISOTROPY CONSTANTS OF FERRITES
Birks, J. B.
***The Physical Review*, v. 99, no. 6, p. 1821, September 15, 1955**

Certain sources of error in attempting to derive the first-order anisotropy constants of ferrites from magnetostatic data are pointed out. High-frequency observations, particularly of the natural spin resonance frequency, are preferable. (*PA*, 1956, #473)

1024. FREQUENCY DEPENDENCE OF MAGNETOCRYSTALLINE ANISOTROPY
Bozorth, R. M., Cetlin, B. B., Galt, J. K., Merritt, F. R., and Yager, W. A.
***The Physical Review*, v. 99, no. 6, p. 1898, September 15, 1955**

For $(NiO)_{0.7}Fe_2O_3$, static and microwave determinations of K_1 give practically identical results at room temperature but markedly different results at −196°C. The frequency dependence is ascribed to a rearrangement of electrons between Fe ions. For a Mn ferrite, K_1 was found to be practically independent of frequency. (*PA*, 1956, #1366)

1025. MAGNETIC FERRITES WITH HYSTERESIS LOOPS CHARACTERISTIC OF PERMINVARS
Kornetzki, M., Brackmann, J., and Frey, J.
***Naturwissenschaften*, v. 42, no. 17, p. 482, 1955 (in German)**

"Wasp-waisted" loops were observed in Ni- and Ni-Zn ferrites containing small additions of MnO and CoO. The character of the loops is altered by cooling in a magnetic field, the loops becoming anisotropic. (*PA*, 1956, #464)

1026. MEASUREMENT OF SUSCEPTIBILITY TENSOR IN FERRITES
Artman, J. O. and Tannenwald, P. E.
***Journal of Applied Physics*, v. 26, no. 9, pp. 1124–1132, September 1955**

Experimental techniques for measuring magnetic susceptibility tensor components in microwave cavities; general expressions for perturbation of microwave cavities by magnetic properties of ferrites developed; experimental results given for Ferramic 1331 measured at 9165 Mc; comparison of results with Bloch-Bloembergen magnetic resonance theory as applied to circularly polarized excitation, are reviewed. (*EI*, 1955)

1027. ANISOTROPY AND MAGNETOSTRICTION OF SOME FERRITES
Bozorth, R. M., Tilden, E. F., and Williams, A. J.
***The Physical Review*, v. 99, no. 6, pp. 1788–1798, September 15, 1955**

Measurements on single crystal and polycrystalline ferrites of composition MFe_2O_4 where "M" is Mn, Fe, Co, Ni, and Zn in various proportions; studies of heat treatment in magnetic field; anisotropy constants are given. (*EI*, 1955)

1028. MAGNETIC CERAMICS
Economos, G.
***Journal of the American Ceramic Society*, v. 38, no. 7, 8, 9, pp. 241–244, July 1955, pp. 292–297, August 1955, pp. 335–340, September 1955**

General methods of magnetic ferrite preparation; ferrospinels; use of controlled partial pressures of oxygen for preparation of magnetite and manganese ferrites; feasibility of methods on commercial scale; properties of magnetite and manganese ferrite fired in various atmospheres; effects of fabrication techniques on magnetic properties of magnesium ferrite; changes were related to change in void volume and particle size of specimens. (*EI*, 1955)

1029. FERRIMAGNETIC RESONANCE IN SINGLE CRYSTALS OF MANGANESE FERRITE
Dillon, J. F., Jr., Geschwind, S., and Jaccarino, V.
***The Physical Review*, v. 100, no. 2, pp. 750–752, October 15, 1955**

Measurements are reported on small spherical monocrystalline specimens of $Mn_{0.98}Fe_{1.86}O_4$ between 4° and 300°K at frequencies 5.9, 9.3 and 23.8 k Mc. Very small line widths were obtained, 50–60 oersted at room temperature depending on orientation. The first and second anisotropy constants were measured over the whole temperature range; K_1/I_0 was found to decrease smoothly with increasing temperature and K_2/I_0 to be small except at the lowest temperatures (K_2/K_1 = about ½ at 4°K). The g value was found to be independent of frequency but dependent on temperature; the room temperature value is 2.004 ± 0.002, indicating spin-only ferrimagnetism corresponding to a $^6S_{5/2}$ groundstate of Mn^{++}. The work described represents the first exhaustive study of a ferrite single crystal. (*PA*, 1956, #1364)

1030. ON CONSTITUTION OF COPPER-FERRITE
Kushima, I. and Amanuma, T.
***Memoirs of the Faculty of Engineering, Kyoto University*, v. 17, no. 4, pp. 290–310, October 1955**

This article discusses the constitution of Cu-ferrite studied by X-ray examination, magnetic and chemical

analyses, and microscopic investigation; cupric-ferrite dissolves excess Fe_2O_3 at high temperature; over 1100°C, it forms cuprous-ferrite in part of itself and so changes magnetic properties and structure; other data; X-ray pictures. (*EI*, 1956)

1031. MICROWAVE APPLICATIONS

Melchor, J. L., Vartanian, P. H., and Aden, A. L.
***Sylvania Technologist*, v. 8, no. 4, pp. 108–117, October 1955**

Review of macroscopic properties which make ferrites useful at microwave frequencies; discussion of susceptibility tensor; theory of wave propagation when applied magnetic field is in direction of propagation; theory and applications for transverse applied field; circumferentially magnetized ferrites. (*EI*, 1955)

1032. TRANSIENT PHENOMENA IN A FERRITE

Matz, S.
***Revue générale de l'électricité*, v. 64, no. 10, pp. 491–509, October 1955 (in French)**

An apparatus is described for the simultaneous measurement of rapid variations in the two components of the complex permeability in a high-frequency (850 kc/s) magnetic field. This apparatus has been used to study transient phenomena in a NiZn ferrite as a function of temperature, field strength and time elapsed between the last demagnetization and the establishment of the field. In very weak fields there is disaccommodation of the complex permeability after demagnetization, the time constant varying from several days at liquid N temperature to about one minute at room temperature, suggesting an activation energy of about 10^4 calories per mole. In larger fields there is, in general, an initial increase in the two components of permeability followed by the decrease. The results are in agreement with the theory of "trainage" discussed by Néel. (*PA*, 1956, #5227)

1033. ORIGIN OF THE UNIAXIAL ANISOTROPY IN IRON-COBALT FERRITES

Iida, S., Sekizawa, H., and Aiyama, Y.
***Journal of the Physical Society of Japan*, v. 10, no. 10, p. 907, October 1955**

Describes experiments on solid solutions of magnetite and cobalt ferrite with Fe/Co between 7.5 and 12. The uniaxial anisotropy induced by magnetic annealing was found to be very sensitive to the degree of oxidation. The anisotropy is suggested to be a result of directional order between Co^{++} ions and cation vacancies, the degree of order being determined by the diffusion rate of cations during the cooling process. (*PA*, 1956, #1367)

1034. LOW MAGNETIC SATURATION FERRITES FOR MICROWAVE APPLICATIONS

Van Uitert, L. G.
***Journal of Applied Physics*, v. 26, no. 11, pp. 1289–1290, November 1955**

How ferrites suitable for microwave applications can be prepared in magnesium aluminum ferrite system; such ferrites can be prepared to possess also relatively high permeabilities at carrier frequencies; Curie temperatures, coercive forces, magnetic saturations at 25°C and initial permeabilities at 0.1 Mc for such materials are given. (*EI*, 1956)

1035. MAGNETIC CERAMICS—4, 5

Economos, G.
***Journal of the American Ceramic Society*, v. 38, no. 10, 11, pp. 353–357, October 1955, pp. 408–411, November 1955**

The following subjects are covered: Development of complex ferrite with rectangular hysteresis loop characteristic; effect of body preparation, forming pressure, firing temperature, and time at peak temperature, on magnetic properties of final product. (October): Magnetic properties of square loop ferrites within system MgO-MnO-Fe_2O_3. (*EI*, 1956)

1036. FERROMAGNETIC RESONANCE IN MANGANESE FERRITE SINGLE CRYSTALS

Tannenwald, P. E.
***The Physical Review*, v. 100, no. 6, pp. 1713–1719, December 15, 1955**

The microwave properties of two types of manganese ferrite single crystals have been investigated by means of the ferromagnetic resonance phenomenon from 300 to 4.2°K and at 24,000, 9,100, 5,600 and 2,800 Mc. The low resistivity of one of the crystals, believed to be related to the presence of divalent iron, led to significantly different microwave behavior. Resonance lines as narrow as 47 oersted have been obtained; however the width depends markedly on crystal direction, temperature and microwave frequency. The g-values are close to

2.00 under all conditions. The anisotropy, although frequency insensitive, increases rapidly at low temperatures. The Kramers–Krönig relations between absorption and dispersion are satisfied, and the line shape is roughly Lorentzian. Double resonances have been observed, and it is speculated that this may be a general phenomenon in single-crystal ferrites under suitable conditions. (*PA*, 1956, #2238)

1037. INITIAL PERMEABILITIES OF SINTERED FERRITES

Rathenau, G. W. and Fast, J. F.
***Physica*, v. 21, no. 12, pp. 964–970, December 1955**

A magnetization process which may contribute to the initial permeability μ_0 of sintered NiZn ferrites is ascribed to the displacement of mobile walls. Wall displacements are also responsible for the dependence of μ_0 on the angle between the directions of magnetization and of ac field demagnetization. The reversible influence of stress on μ_0 can be accounted for by considering only simultaneous spin rotations. The influence of an anisotropic spin distribution on μ_0 in the absence of external stress is a strong argument for the assumption that rotation is the preponderant initial magnetization process for these porous ferrites. (*PA*, 1956, #3006)

1038. FERRITES—PT 3: LIMITATIONS AND MEASUREMENTS

Ayres, W. P., Aden, A. L., and Vartanian, P. H.
***Sylvania Technologist*, v. 9, no. 1, pp. 14–21, January 1956**

Limitations on use of ferrites at low microwave frequencies, at high powers and over wide bandwidths; special types of measurements for determining ferrite properties. (*EI*, 1956)

1039. NOTE ON AN INVESTIGATION OF THE ANOMALOUS TIME-CONSTANT OF CERTAIN IRON DEFICIENT MAGNESIUM MANGANESE FERRITES

Blackman, L. C. F. and Sherry, N. P. R.
***Journal of Electronics*, v. 1, no. 4, pp. 385–388, January 1956**

An investigation of the effect of fabrication conditions on the properties of certain iron-deficient magnesium manganese ferrites revealed that the time constant ($t = RC$) of the materials was remarkably dependent on the firing temperature. A startling anomalous peak of time-constant occurred when the samples were fired within the very narrow temperature range from 1330 to 1380°C. It was found that although both the resistive and dielectric components of the time-constant exhibited a peak at the critical region, the latter was by far the more pronounced. (*PA*, 1956, #6779)

1040. MECHANISM BY WHICH COBALT FERRITE HEAT TREATS IN A MAGNETIC FIELD

Williams, H. J., Heidenreich, R. D., and Nesbitt, E. A.
***Journal of Applied Physics*, v. 27, no. 1, pp. 85–89, January 1956**

Magnetic torque measurements and electron diffraction patterns on several cobalt ferrite and cobalt–zinc ferrite crystals show that those compositions which respond to heat treatment in a magnetic field contain precipitated particles of a second phase. Response of these crystals to heat treatment in a magnetic field is apparently due to the tendency of the precipitated particles to grow preferentially along the field direction in a manner similar to that previously reported by Heidenreich and Nesbitt for Alnico 5. When the crystals are heat treated without a magnetic field the precipitated particles are oriented along the crystal axes, and the shape anisotropy of the particles arrayed in this manner causes a reversal in sign of the torque as the measuring field is increased from zero. This anomalous variation of the torque with field was previously observed with Fe_2NiAl and explained on the same basis. Thus a single mechanism explains the aforementioned magnetic phenomena observed in Fe_2NiAl, Alnico 5, and the cobalt ferrites. (*PA*, 1956, #6774)

1041. INVESTIGATION OF THE MAGNETIC SPECTRA OF SOLID SOLUTIONS OF SOME NiZn FERRITES IN THE RADIOFREQUENCY RANGE

Fomenko, L. A.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 30, no. 1, pp. 18–29, 1956 (in Russian)**

Results of investigation of magnetic spectra of NiZn ferrites with initial permeability values $\mu a = 200$, 400 and 2000 in the frequency range $0.2 - 60$ Mc are presented. The method of measurement of the spectrum and

of avoiding possible errors is discussed. The samples were investigated in the absolute zero state, in the residual magnetization state and at various field strengths of the constant magnetizing field. It is shown that the ferrite spectra are of a resonance or relaxation nature and are practically independent of the core dimensions; they can be explained by dispersion of the ferromagnetic substance; this dispersion for ferrites with $\mu_a \cong 2000$ is probably due to the inertia of the effective boundary mass, and for ferrites with $\mu_a \cong 200$ to precession of the magnetization vector in the effective anisotropy field of the ferrite substance. (*PA*, 1956, #5228)

1042. MAGNETIC ROTATORY POLARIZATION IN COPPER FERRITE AT 10 kMc/s
Mayer, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 1, pp. 81–83, January 4, 1956 (in French)**

Reports results of measurements of the Faraday angle θ in a longitudinal static field H for both cubic spinel and quadratic structures. The θ, H curves resemble hysteresis loops, the former structure having a long and narrow loop and the latter a short and wide one with a "coercivity" value about 70 oersted. (*PA*, 1956, #3031)

1043. PARAMAGNETISM OF SOME RARE EARTH FERRITES
Barbier, J. C. and Aléonard, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 1, pp. 83–85, January 4, 1955 (in French)**

Reports results of susceptibility measurements between 950 and 1450°K on the ferrites $Fe_2O_3 \cdot M_2O_3$ where M = La, Sm, Pr, Nd, Gd. The inverse susceptibility, temperature curves may be approximated by hyperbolae with slight curvature; the Curie constants deduced from the slopes of the asymptotes are larger than those calculated from the ionic moments except for the Gd ferrite. (*PA*, 1956, #3013)

1044. STRUCTURE OF FERRIMAGNETIC FERRITES OF RARE EARTHS
Bertaut, F. and Forrat, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 3, pp. 382–384, January 16, 1956 (in French)**

The authors do not accept Néel's theory of the spontaneous magnetization of perovskite-type compounds. They put forward a new structure with a cubic unit cell of side 12.44 Å containing eight units of $5\ Fe_2O_3 \cdot 3\ Gd_2O_3$. (*PA*, 1956, #4111)

1045. THE DEMAGNETIZATION BY ALTERNATING MAGNETIC FIELDS OF MAGNETITE AND α-IRON SESQUIOXIDE
Rimbert, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 7, pp. 890–893, February 13, 1956 (in French)**

Shows how the isothermal remanence and the thermoremanence are reduced by an alternating field in the presence of an applied steady field. (*PA*, 1956, #4516)

1046. INTRADOMAIN MAGNETIC SATURATION AND MAGNETIC STRUCTURE OF γ-Fe_2O_3
Henry, W. E. and Boehm, M. J.
***The Physical Review*, v. 101, no. 4, pp. 1253–1254, February 15, 1956**

The average moment was found to be 1.18 Bohr magnetons per iron atom, which supports a preferential distribution of iron vacancies on octahedral sites in a spinel structure. A sample motion ballistic method was used for direct measurement of magnetic moments. (*PA*, 1956, #5224)

1047. MAGNETIC PROPERTIES OF SOME ANHYDROUS CHLORIDES OF THE IRON GROUP. II. INTERPRETATION OF THE CRYOMAGNETIC ANOMALIES IN $CoCl_2$, $FeCl_2$, $NiCl_2$ AND $CrCl_3$
Leech, J. W. and Manuel, A. J.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 2, pp. 220–230, February 1956**

It is shown that experimental evidence of magnetic properties and crystalline structure of $CoCl_2$, $FeCl_2$, $NiCl_2$ and $CrCl_2$ conflict with the assumption that these salts are antiferromagnetic. A two-dimensional ferromagnetic structure is indicated and the observed magnetization curves can be explained as due to the influence of high shape anisotropy associated with single layer domains. (*PA*, 1956, #3002)

1048. FREQUENCY DOUBLING IN FERRITES

Ayres, W. P., Vartanian, P. H., and Melchor, J. L.
***Journal of Applied Physics*, v. 27, no. 2, pp. 188–189, February 1956**

The torque equation for the motion of the magnetization in a magnetized ferrite yields a component along the direction of the applied dc magnetic field. The time dependent part of this component is of second order in r.f. quantities and has previously been neglected. With high incident powers an observable double frequency output is predicted. A high intensity microwave magnetic field and an orthogonal dc magnetic field were applied to a ferrite body. Double frequency magnetic fields were generated in the same direction as the dc magnetizing field. A primary frequency of 3175 Mc was used with peak powers up to 200 w. The peak output power at 6350 Mc was found to increase linearly with the square of the peak input power over a range of 42 db. Reasonable agreement was found between theory and experiment. (*PA*, 1956, #3821)

1049. MAGNETOSTRICTIVE EFFECTS IN AN ANTIFERROMAGNETIC HEMATITE CRYSTAL

Urquhart, H. M. A. and Goldman, J. E.
***The Physical Review*, v. 101, no. 5, pp. 1443–1450, March 1, 1956**

Magnetostrictive distortions in an antiferromagnetic natural single crystal of hematite were studied in the region of the transition near −25°C, where the antiferromagnetic axis spontaneously shifts its crystallographic direction by 90°. The magnetostriction is shown to be closely related to the parasitic magnetization and is interpreted in terms of the existence of domain walls separating antiferromagnetic domains. (*PA*, 1956, #3826)

1050. DOMAIN WALLS IN ANTIFERROMAGNETS AND THE WEAK FERROMAGNETISM OF α-Fe_2O_3

Li, Y. Y.
***The Physical Review*, v. 101, no. 5, pp. 1450–1454, March 1, 1956**

At the Néel temperature local nucleations of the antiferromagnetic order and their subsequent growth lead to the formation of domain walls. The domains in an antiferromagnet are thermodynamically stable only when the anisotropy force opposing the gradual switch of spins in the Bloch zone is small such that the wall energy is offset by the gain in entropy. However, in most cases the domain wall would owe its stability to the presence of lattice imperfections, such as interstitial atoms or dislocations. A typical magnetization curve of an antiferromagnet with ferromagnetic domain walls is depicted. The weak ferromagnetism observed in the (111) plane of α-Fe_2O_3 (hematite) is identified with the magnetization in domain walls pinned down by lattice imperfections. An assumption that the linear dimension of domains is, on the average, 10^4 atomic spaces gives the observed strength of the weak ferromagnetism. The disappearance of this ferromagnetism at about −20°C when the magnetic axis switches from a [112] direction to the [111] direction is due to the extreme difference in the anisotropy force in the (111) plane and that in a plane containing the [111] axis. The following experimental findings on α-Fe_2O_3 are interpreted: (a) The variation of the ferromagnetism as the temperature increases shows the general feature of the decrease of long-range order in cooperative phenomena, being very gradual at lower temperatures and growing sharper and sharper as the temperature approaches the Néel point. (b) In the transition region of the two antiferromagnetic states of α-Fe_2O_3 an applied field in the (111) plane causes a decrease of the temperature at which the ferromagnetic effect and the large magnetostriction effect disappear but produces no change in the neutron diffraction intensity of the (111) line. (*PA*, 1956, #2997)

1051. RESONANCE OF FERRITES AT THE COMPENSATION POINT, USING CIRCULARLY POLARIZED FIELDS (FERRIMAGNETIC RESONANCE)

Paulevé, J. and Dreyfus, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 10, pp. 1273–1275, March 5, 1956 (in French)**

This report gives results of measurements at 9.4 kMc on the substances $Li_{0.5}\ Fe_{2.5-a}\ Cr_aO_4$ ($a = 1.25, 1.5$) over a temperature range including the compensation and Curie points. Ferromagnetic and exchange resonances were observed in different parts of the range. (*PA*, 1956, #4493)

1052. FERRITES IN RESONANT CAVITIES
Waldron, R. A.
***British Journal of Applied Physics*, v. 7, no. 3, p. 114, March 1956**

The usual formula for the frequency shift on introducing a sphere of ferrite into a resonant cavity leads to an incorrect value of the applied field for ferromagnetic resonance. The discrepancy is due to assuming that the field in the ferrite is approximately equal to the unperturbed field. Using the calculated value of the field in the ferrite leads to a formula which agrees with observations. (*PA*, 1956, #5218)

1053. FERROMAGNETIC RESONANCE ABSORPTION IN A PYRRHOTITE SINGLE CRYSTAL
Fujimura, T. and Torizuka, Y.
***Journal of the Physical Society of Japan*, v. 11, no. 3, p. 327, March 1956**

This report gives room temperature measurements at 47 kMc parallel to the easy axis of magnetization and in fields up to 2×10^4 oersted. A very broad resonance line (half-width about 10^4 oersted) was observed. The anisotropy field deduced from the measurements has a value of 6.6×10^4 oersted. (*PA*, 1956, #5220)

1054. TEMPERATURE BEHAVIOR OF FERRIMAGNETIC RESONANCE IN FERRITES LOCATED IN WAVE GUIDE
Duncan, B. J. and Swern, L.
***Journal of Applied Physics*, v. 27, no. 3, pp. 209–215, March 1956**

Ferrimagnetic resonance has been investigated in several polycrystalline ferrites located in wave guide over a temperature range from 25°C to the Curie point of each ferrite. The ferrimagnetic resonance line width and the apparent gyromagnetic ratio of two types of ferrites were found to change with increasing temperature. The theories of Wangsness and Kittel have been utilized in interpreting the observed effects. The foregoing effects were shown to influence the temperature behavior of the microwave properties of ferrites away from resonance. (*PA*, 1956, #6775)

1055. MAGNETIC PROPERTIES OF GADOLINIUM FERRITES
Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 15, pp. 1859–1862, April 9, 1956 (in French)**

Reports results of magnetization measurements between 2 and 750°K on $Fe_2O_3 \cdot Gd_2O_3$ and $5Fe_2O_3 \cdot 3Gd_2O_3$. The magnetization is given by $\sigma(H) = \sigma(0) + \chi H$, and the temperature variation of $\sigma(0)$ and $1/\chi$ was obtained. For $Fe_2O_3 \cdot Gd_2O_3$, $\sigma(0)$ is small and vanishes at 670°K; for $5Fe_2O_3 \cdot 3Gd_2O_3$ there is a compensation point at 290°K and a Curie point at 564°K. (*PA*, 1956, #6004)

1056. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF A NATURAL CRYSTAL OF ILMENITE ($TiFeO_3$)
Bizette, H. and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 17, pp. 2124–2127, April 23, 1956 (in French)**

Reports results of measurements between 4°K and room temperature. Susceptibility maxima occur at 68°K both parallel and perpendicular to the ternary axis. At room temperature the mass susceptibility is almost isotropic and equal to 92×10^{-6}. The results are discussed in relation to the crystal structure. (*PA*, 1956, #6002)

1057. RESONANCE WIDTHS IN POLYCRYSTALLINE NICKEL–COBALT FERRITES
Sirvetz, M. H. and Saunders, J. H.
***The Physical Review*, v. 102, no. 2, pp. 366–367, April 15, 1956**

The width of the ferromagnetic resonance has been measured at 10,000 Mc in polycrystalline mixed ferrites of the composition $Co_\alpha Ni_{1-\alpha} Fe_2O_4$, with α between 0 and 0.04. The minimum line width is found for $\alpha = 0.025$ at 20°C. This, as well as the variation of line width with temperature, can be understood on the basis of known single crystal properties and the following assumptions: (a) line width is a linear function of $|K|$; (b) crystal anisotropy is an additive atomic property. (*PA*, 1956, #3823)

1058. EFFECT OF ALKALINE AND ALKALINE EARTH IONS ON THE INITIAL PERMEABILITY OF MANGANESE–ZINC FERRITES
Guillaud, C., Zega, B. and Villers, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 19, pp. 2312–2315, May 7, 1956 (in French)**

The initial permeability is found to increase initially with increasing impurity content and then to reach a steady value. The slope of the initial rise depends markedly on the ionic radius and the polarity of the impurity ions, both factors affecting the internal strains in the material. (*PA*, 1956, #6005)

1059. MAGNETIZATION OF A MAGNETITE SINGLE CRYSTAL NEAR THE CURIE POINT
Smith, D. O.
***The Physical Review*, v. 102, no. 4, pp. 959–963, May 15, 1956**

The isothermal *M-H* curves of magnetite in the principal crystallographic directions have been measured from room temperature to the Curie point. These curves give the anisotropy energy and spontaneous magnetization as a function of temperature. Near the Curie point the magnetizing field required to create a single domain is found to be < 100 Å/*m*, giving an unambiguous experimental determination of the spontaneous magnetization in this critical region. Temperature increments of 0.1°C define the Curie point with an uncertainty of < 0.05°C. In the neighborhood of the Curie point the *M-H* curves are very nonlinear; replotting the data in the form of *H-T* curves at constant magnetization shows that in this region the magnetic energy can be expressed as $U_M = -\mu_0 W M^2/2$, where W is a constant. (*PA*, 1956, #5253)

1060. INITIAL PERMEABILITY AND GRAIN SIZE OF MANGANESE–ZINC FERRITES
Guillaud, C. and Paulus, M.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 21, pp. 2525–2528, May 23, 1956 (in French)**

The initial permeability was found to increase from about 500 to about 3700 as the average grain size increases from about 2μ to 20μ. The results are discussed by considering the combined effects of rotational and translational magnetization processes. (*PA*, 1956, #6773)

1061. MAGNETIC PROPERTIES OF YTTRIUM FERRITE 5 $Fe_2O_3 \cdot 3\ Y_2O_3$ (GARNET)
Aléonard, R., Barbier, J. C. and Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 21, pp. 2531–2533, May 23, 1956 (in French)**

Reports results of measurements of the spontaneous magnetization and susceptibility between 4 and 1500°K. The Curie temperature is 560°K, the saturation magnetization 9.44 μ_B and the inverse susceptibility-temperature curve hyperbolic, appropriate to a ferrimagnetic substance. (*PA*, 1956, #7520)

1062. THE STUDY ON SUBSTANCES HAVING THE ILMENITE STRUCTURE. I. PHYSICAL PROPERTIES OF SYNTHESIZED $FeTiO_3$ AND $NiTiO_3$ CERAMICS
Ishikawa, Y. and Sawada, S.
***Journal of the Physical Society of Japan*, v. 11, no. 5, pp. 496–501, May 1956**

$FeTiO_3$ and $NiTiO_3$ ceramics were synthesized, their thermal, electrical and magnetic properties were investigated and the results obtained were discussed in connection with the crystal structure. Although $NiTiO_3$ is stable up to high temperatures even in air, $FeTiO_3$ is partially oxidized even when it is cooled, being kept in vacuum (10^{-5} mm Hg), to room temperature from the maturing temperature (1350°C). Electrical and magnetic properties of annealed $FeTiO_3$, therefore, differ greatly from those of $NiTiO_3$, but properties of quenched $FeTiO_3$ tend to those of $NiTiO_3$. From these facts, it is concluded that the properties of $NiTiO_3$ are characteristics of the ilmenite structure. In discussion attention was paid especially to the relation between the ilmenite structure and its magnetic properties and to the mechanism of electrical conduction, and it was speculated, from these considerations, what roles Ti^{4+} ions would play in this structure. (*PA*, 1956, #5072)

1063. ON THE UNIAXIAL ANISOTROPY INDUCED BY MAGNETIC ANNEALING IN FERRITES
Taniguchi, S. and Yamamoto, M.
***Journal of the Physical Society of Japan*, v. 11, no. 5, p. 604, May 1956**

Interprets the magnitude and orientation dependence of the energy of anisotropy produced by the magnetic annealing of CoZn ferrite by considering the distribution of the magnetic and non-magnetic ions or ion vacancies among the available lattice sites and the dipole interaction which is anisotropic, between them. (*PA*, 1956, #6008)

1064. PREPARATION AND PROPERTIES OF CERAMIC PERMANENT MAGNET

Gordon, I.

***Bulletin of the American Ceramic Society*, v. 35, no. 5, pp. 173–175, May 1956**

Progress of magnetization of ferromagnetic material; differentiation between magnetically hard and soft metallics and oxides; preparation of permanent magnet having composition $BaFe_{12}O_{13}$ from inexpensive, non-critical compounds by standard ceramic techniques; various magnetic properties can be obtained by varying processing technique. (*EI*, 1956)

1065. NEUTRON DIFFRACTION INVESTIGATION OF THE 119°K TRANSITION IN MAGNETITE

Hamilton, W. C.

***The Physical Review*, v. 110, no. 5, pp. 1050–1057, June 1, 1956**

Neutron diffraction measurements on synthetic single crystals of magnetite confirm the orthorhombic ordering scheme proposed by Verwey and co-workers to explain the changes in physical properties which magnetite undergoes when cooled below 119°K. A magnetic field suitably applied during cooling prevents the multiple twinning which occurs in the absence of a field and allows one to make the following deductions: The spins of all magnetic ions align themselves parallel to the cubic [001] direction nearest the direction of the external field. The face diagonals of the cube orthogonal to this *c* axis become the orthorhombic *a* and *b* axes. If these are labeled such that *a* is magnetically harder than *b*, the ferric ions in octahedral sites lie in rows parallel to *a* and the ferrous ions in rows parallel to *b*. Although the average oxygen position is unchanged, there are presumably shifts in the four oxygen parameters which compensate for the effect of the ordering on the ionic sizes at the various sites. In attempting to reproduce the results on natural crystals, which had a transition temperature some five to ten degrees lower, it was found impossible to remove the [*a*, *b*] twinning by use of a magnetic field; furthermore, failure to observe an (002) reflection would seem to indicate that the twinning persists on a micro basis, that is, that there is only short-range order. A least-squares fit was made to the intensities of the cubic phase at 296°K; a value of $u = 0.2548 \pm 0.0002$ was obtained for the oxygen parameter in the spinel structure. The severe primary and secondary extinction encountered was satisfactorily accounted for by methods previously described. (*PA*, 1958, #8914)

1066. EFFECT OF MAGNETOSTRICTION ON THE INITIAL PERMEABILITY OF MANGANESE–ZINC FERRITES

Vautier, R.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 24, pp. 2814–2817, June 11, 1956 (in French)**

Reports results of measurements of the initial permeabilities μ and magnetostriction coefficients λ of a number of polycrystalline mixed Mn–Zn ferrite specimens which have been heat treated by different amounts. It is found that μ has a minimum value about 1500 when $\lambda = 0$, contrary to expectation. Measurements were also made for samples with different MnO contents; no simple correlation between μ and λ was established. (*PA*, 1956, #7521)

1067. AN ANTIFERROMAGNETIC TRANSITION IN ZINC FERRITE

Hastings, J. M. and Corliss, L. M.

***The Physical Review*, v. 102, no. 6, pp. 1460–1463, June 15, 1956**

Neutron powder diffraction patterns have been obtained for zinc ferrite over the temperature range 2.7-300°K. The data strongly suggest that the compound undergoes a transition from a paramagnetic state to an antiferromagnetic state in the neighborhood of 9°K. Superlattice lines observed below this temperature can be indexed on a cubic unit cell whose edge is twice that of the chemical cell. A model consisting of an antiferromagnetic alternation of ferromagnetic "bands" is tentatively proposed and discussed in relation to the observed line intensities. (*PA*, 1956, #6012)

1068. NEW LOW-TEMPERATURE FERROMAGNETS
Holden, A. N., Matthias, B. T., Anderson, P. W., and Lewis, H. W.
***The Physical Review*, v. 102, no. 6, p. 1463, June 15, 1956**

Complex cyanides of iron transition group metals are observed to be ferromagnetic at liquid helium temperatures; data on absolute temperature of maximum susceptibility of cyanides. (*EI*, 1956)

1069. THE MAGNETIC PROPERTIES OF $FeSe_x$ WITH THE NiAs STRUCTURE
Hirone, T. and Chiba, S.
***Journal of the Physical Society of Japan*, v. 11, no. 6, pp. 666–670, June 1956**

The thermal and X-ray analyses were carried out for iron-selenium system from 48.8 to 57.4 atomic percent of selenium, such range being previously reported to be ferrimagnetic. It was concluded from the experimental results that at room temperature the concentration range from 48.8 to 53.1% selenium is the two phase region $\alpha + \beta$; α has the PbO type structure and β the NiAs type. These two phases transform through a eutectoid reaction into a γ phase with the NiAs structure of slightly different lattice parameters in comparison with those of the β phase, the eutectic temperature being 350°C. The solubility limit in iron side of the phase lies at 53.1% selenium. It is remarkable that the substance with stoichiometric concentration (50% Se) does not lie in the single phase region of NiAs type. It was also found that the ferrimagnetism of this binary system originates from the phase of NiAs type (β phase) and the α phase is weakly paramagnetic or antiferromagnetic. The Curie point of the compound containing 53.1% selenium is 174°C and the spontaneous magnetization at absolute zero of temperature is 0.20 Bohr magneton. This magnitude of magnetization is explained by assuming a kind of the ordered arrangement of ferric ion in the crystal lattice. (*PA*, 1956, #6772)

1070. MAGNETIC PROPERTIES OF A GADOLINIUM ORTHOFERRITE, $GdFeO_3$ CRYSTAL
Gilleo, M. A.
***Journal of Chemical Physics*, v. 24, no. 6, pp. 1239–1243, June 1956**

$GdFeO_3$ in single crystal form exhibits magnetization between temperatures of 78 and 295°K which consists of a field independent part σ_0 and a field dependent part χH for fields above 6,000 oersteds. The parasitic ferromagnetization α_0 amounts to about 1% of the σ(Fe) available and may be attributed to imperfectly compensated antiferromagnetism of the Fe^{3+} ion sublattice. The susceptibility χ appears to be made up of a paramagnetic contribution from the Gd^{3+} ion sublattice and a contribution from the antiferromagnetic Fe^{3+} ion sublattice influenced by interaction between the two sublattices. The anisotropy of σ_0 and χ changes with temperature. The maximum σ_0 and minimum χ do not coincide as they would if both took the direction of the antiferromagnetic axis of the Fe^{3+} ion sublattice. (*PA*, 1956, #6007)

1071. INTRODUCTION TO THE STUDY OF MAGNETO-OPTICAL PHENOMENA IN FERRITES IN THE HYPERFREQUENCY REGION
Benoit, J.
***Onde électrique*, v. 36, pp. 499–507, June 1956 (in French)**

An account of ferromagnetic resonance and of the Faraday effect and magnetic birefringence. The effects observed when a magnetic material is placed in a waveguide are considered, and some typical results are given. Some of the applications to waveguide transmission systems are discussed. (*PA*, 1957, #1470)

1072. MEASUREMENT OF MICROWAVE DIELECTRIC CONSTANTS AND TENSOR PERMEABILITIES OF FERRITE SPHERES
Spencer, E. G., Le Craw, R. C., and Reggia, F.
***Proceedings of the IRE*, v. 44, no. 6, Part 1, pp. 790–800, June 1956**

Bethe-Schwinger cavity perturbation theory is applied to measurements of microwave dielectric constants, etc; cavity opened at position of minimum transverse wall currents is used; frequency-shift method is used for measuring real part of dielectric constant and cavity-transmission method for measurement of loss tangent. (*EI*, 1956)

1073. NICKEL COPPER FERRITES FOR MICROWAVE APPLICATIONS

Van Uitert, L. G.

***Journal of Applied Physics*, v. 27, no. 7, pp. 723–727, July 1956**

Ferrites having both high relative density (~ 98%) and high dc resistivity (>10^9 ohm cm) can be prepared by properly sintering nickel copper ferrites which have both an iron deficiency and a small amount of manganese or cobalt present. Magnetic saturation at room temperature shows a linear dependence upon copper content in this system varying from 3150 gauss for $NiFe_{1.9}Mn_{0.02}O_{4\pm}$ to 2400 gauss for furnace cooled $CuFe_{1.9}Mn_{0.02}O_{4\pm}$. Direct current resistivity remains high for mixtures of these two ferrites if 2Cu < Ni. An anomalous break in the curve relating dc resistivity with copper content occurs when the copper to nickel ratio exceeds this 1:2 value. (*PA*, 1956, #6776)

1074. POLARIMETRIC STUDY OF A FERRITE IN THE 2000 Mc/s BAND

Loudette, P. and Charru, A.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 3, pp. 251–254, July 16, 1956 (in French)**

The rotation of the plane of polarization and the ellipticity of a TE_{11} wave in a circular waveguide, produced by a nickel-zinc ferrite rod, are measured as a function of wavelength and applied longitudinal magnetic field. A correspondence is observed between the effects produced by the variation of these two parameters. (*PA*, 1957, #531)

1075. MAGNETIC PROPERTIES OF SOME ORTHOFERRITES AND CYANIDES AT LOW TEMPERATURES

Bozorth, R. M., Williams, H. J., and Walsh, D. E.

***The Physical Review*, v. 103, no. 3, pp. 572–578, August 1, 1956**

The magnetization of some rare-earth orthoferrites and related compounds, and of some iron-group cyanides, has been investigated at temperatures between room temperature and 1.3°K. Some are ferromagnetic, some antiferromagnetic, and some paramagnetic following the Curie–Weiss law. The compounds $GdVO_3$, $GdFeO_3$ and $ErFeO_3$ are apparently antiferromagnetic with Néel points of 7.5, 2.5 and 4.5°K, respectively. Ordering of the Gd and Er ions at low temperatures is indicated. The compounds $NdFeO_3$, $SmFeO_3$, $YFeO_3$, $NdVO_3$, $PrVO_3$ and $SmVO_3$ show a rapid rise in ferromagnetic moment as the temperature is lowered below about 15°K. $GdTiO_3$ is ferromagnetic with 0.54 Bohr magneton per molecule. Many of the cyanides of type $A(BC_6N_6)$ are ferromagnetic with magnetic moments of 1 to 4 Bohr magnetons per molecule and Curie points of 3 to 50°K. A null method of measurement is used. Movement of a pendulum in a field gradient is detected with strain gauges and balanced with a coil. In the space containing the specimen and the balancing coil the gradient varies linearly with distance. (*PA*, 1956, #7518)

1076. CATION DISTRIBUTIONS IN FERRO-SPINELS. MAGNESIUM–MANGANESE FERRITES

Kriessman, C. J. and Harrison, S. E.

***The Physical Review*, v. 103, no. 4, pp. 857–860, August 15, 1956**

The saturation magnetization as a function of quench temperature is measured for the ferrite system $Mg_yMn_{1-y}Fe_2O_4$. From these data the ionic distribution of Mg ions is evaluated and compared to the theoretical thermodynamic analysis. The interesting quantity $\partial u_1/\partial\eta$, where u_1 is the nonthermal energy and η is the fraction of Mg ions on A sites, can be evaluated from the data only if the variation of the Debye temperature with η can be neglected. If this assumption is made, then it is found that $\partial u_1/\partial\eta$ is linearly dependent on η. The lattice constant has also been determined as a function of quench temperature. (*PA*, 1956, #7529)

1077. ON FERRIMAGNETISM OF SOME SULPHIDES AND OXIDES

Lotgering, F. K.

***Philips Research Reports*, v. 11, no. 3, 4, pp. 190–249, June 1956, pp. 337–350, August 1956**

Results of investigation to determine whether non-oxidic ferrimagnetics exist and, if so, to study their properties; sulphidic compounds were chosen because it was expected that these substances would have ionic character, which would simplify interpretation of magnetic properties; study covers iron sulphur system, and oxygen and sulphur spinels containing either chromium or cobalt. Bibliography. (*EI*, 1956)

1078. LATTICE MAGNETOSTRICTION IN SPINEL-TYPE IRON CHROMITES
Francombe, M. H. and Rooksby, H. P.
***Nature*, v. 178, pp. 586–587, September 15, 1956**

Measurements of the lattice distortion as iron chromites of composition $FeFe_{(2-x)}$ Cr_xO_4 are cooled through their paramagnetic–antiferromagnetic transition temperatures show that the dilation effect is greater for $x = 1.2$ than for $x = 1.0$, and that for $x = 2.0$ it is greater still but in the opposite sense. (*PA*, 1957, #2816)

1079. INVESTIGATIONS ON BARIUM FERRITE MAGNETS
Sixtus, K. J., Kronenberg, K. J., and Tenzer, R. K.
***Journal of Applied Physics*, v. 27, no. 9, pp. 1051–1057, September 1956**

Barium ferrite ($BaO:6Fe_2O_3$); investigated magnetically to test predictions of fine particle theory in region of grain sizes larger than critical one for which no satisfactory theory exists; grain size and coercive force of polycrystalline magnets were closely related to sintering temperatures; comparison of theoretical and observed temperature dependence of coercive force; data on susceptibilities and other properties. (*EI*, 1956)

1080. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF FERROUS CHLORIDE
Bizette, H., Terrier, C., and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 13, pp. 895–898, September 24, 1956 (in French)**

Reports results of measurements of $\chi_\perp$ and $\chi_{||}$ in fields up to 2.5×10^4 oersted and at temperatures between 4° and 200°K; $\chi_\perp$ is independent to field strength and also of temperature below the Néel temperature (75°K), but $\chi_{||}$ varies with field strength below this temperature. Its maximum, lying at the Néel point in low fields, moves to lower temperatures as the field strength increases and tends to disappear above about 1.9×10^4 oersted. The results are discussed in relation to the atomic structure. (*PA*, 1957, #2405)

1081. NEUTRON-DIFFRACTION STUDY OF FERRIMAGNETIC GARNET $Yt_3Fe_5O_{12}$
Bertaut, F., Forrat, F., Herpin, A., and Meriel, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 13, pp. 898–901, September 24, 1956 (in French)**

From neutron-diffraction measurements with and without a magnetic field of 5600 oersted, the contribution to the scattering due to magnetization was determined, and was shown to agree well with theory. (*PA*, 1957, #2414)

1082. FERRITES ISSUE
***Proceedings of the IRE*, v. 44, no. 13, pp. 1233–1468, October 1956**

"Introduction to Ferrites Issue," C. L. Hogan; "Survey of Properties and Applications of Ferrites Below Microwave Frequencies," C. D. Owens; "Fundamental Theory of Ferro- and Ferri-Magnetism," J. H. Van Vleck; "Magnetic Resonance in Ferrites," N. Bloembergen; "Nonlinear Behavior of Ferrites at High Microwave Signal Levels," H. Suhl; "Microwave Resonance Relations in Anisotropic Single Crystal Ferrites," J. O. Artman; "Dielectric Properties of and Conductivity in Ferrites," L. G. van Uitert; "Methods of Preparation and Crystal Chemistry of Ferrites," D. L. Fresh; "Intrinsic Tensor Permeabilities on Ferrite Rods, Spheres, and Disks," E. G. Spencer, L. A. Ault, R. C. LeCraw; "Permeability Tensor Values From Waveguide Measurements," E. B. Mullen, E. R. Carlson; "Resonance Loss Properties of Ferrites in 9 KMC Region," S. Sensiper; "Anisotropy of Cobalt-Substituted Mn Ferrite Single Crystals," P. E. Tannenwald, M. H. Seavey; "Elements of Nonreciprocal Microwave Devices," C. L. Hogan; "Frequency and Loss Characteristics of Microwave Ferrite Devices," B. Lax; "Ferrites as Microwave Circuit Elements," G. S. Heller; "Network Properties of Circulators Based on Scattering Concept," M. A. Treuhaft; "Topics in Guided-Wave Propagation in Magnetized Ferrites," M. L. Kales; "Anomalous Propagation in Ferrite-Loaded Waveguide," H. Seidel; "Birefringence of Ferrites in Circular Waveguide," N. Karayianis, J. C. Cacheris; "New Ferrite Isolator," B. N. Enander; "Magnetic Tuning of Resonant Cavities and Wideband Frequency Modulation of Klystrons," G. R. Jones, J. C. Cacheris, C. A. Morrison; "Ferrite Directional Couplers," A. D. Berk, E. Strumwasser; "Ferrite-Tuned Resonant Cavities," G. E. Fay; "Ferrite-Tunable Microwave Cavities and Introduction of New Reflectionless, Tunable Microwave Filter," C. E. Nelson; "Three New Ferrite Phase Shifters," H. Scharfman; "Ferrite-Tunable Filter for Use in S Band," J. H. Burgess; "Radiation From Ferrite-Filled Apertures," D. J. Angelakos, M. M. Korman. (*EI*, 1956)

1083. MULTIPLE FERROMAGNETIC RESONANCE IN FERRITE SPHERES
White, R. L. and Solt, I. H., Jr.
***The Physical Review*, v. 104, no. 1, pp. 56–62, October 1, 1956**

Ferromagnetic resonance experiments have been performed on single crystal spheres of manganese and manganese-zinc ferrites placed in field configurations having large gradients in the r.f. magnetic field at the sample site. Five major and several minor resonant absorptions are observed extending over a region of 700 oersted at room temperature. The line spacings are essentially independent of sphere size. The absorptions are shown to be attributable to modes of precession of the bulk magnetization of the sample which are more complicated than the spatially uniform precession contemplated by the usual ferromagnetic resonance theory. The lowest order modes are identified and their dynamical properties shown to be consistent with the prediction of an idealized magnetically-coupled-oscillator model. (*PA*, 1957, #1448)

1084. PHYSICAL CONDITIONS FOR FERROMAGNETIC RESONANCE
Mercereau, J. E. and Feynman, R. P.
***The Physical Review*, v. 104, no. 1, p. 63, October 1, 1956**

All but one of the multiple ferromagnetic resonances observed by White and Solt in a sphere are shown to correspond to modes in which the oscillating part of the magnetization is independent of r (the only case ordinarily considered) or varies linearly with r in the sample. (*PA*, 1957, #1449)

1085. EFFECT OF MAGNETOCRYSTALLINE ANISOTROPY ON THE MAGNETIC SPECTRA OF Mg-Fe FERRITES
Rado, G. T., Folen, V. J.,and Emerson, W. H.
***Proceedings of the Institution of Electrical Engineers*, London, Paper no. 2174R, October 1956 (v. 104B, Supplement no. 5, pp. 198–205, 213–215, 1957)**

Results of new experiments on magnesium-iron ferrites at 26 and −196°C are presented. These include measurements of the first-order magnetocrystalline anisotropy constant K of monocrystals, and of the magnetic spectrum (the frequency dependence of the complex initial permeability) of polycrystals. If a newly observed inversion dependence of K is neglected, the values of K at room temperature are represented by $K = -85000_x - 25000$ ergs/cm^3, where x is defined by the formula $(MgO)_{1-x}(FeO)_xFe_2O_3$. Frequencies between zero and 10^4 Mc were used for the magnetic spectra, and two or three pronounced dispersions were observed in each ferrite. Some earlier investigations concerned with the magnetic spectra of sintered ferrites possessing two broad dispersion regions are reviewed. It is concluded from the present and earlier investigations that the r.f. dispersion region and the static initial permeability are primarily due to domain wall displacements, and that the microwave dispersion region is primarily due to domain rotations that occur in an effective field caused by magnetocrystalline anisotropy as well as by static and dynamic magnetic interactions. (*PA*, 1956, #8274)

1086. MAGNETOCRYSTALLINE ANISOTROPY IN COBALT-SUBSTITUTED MAGNETITE SINGLE CRYSTALS
Bickford, L. R., Jr., Brownlow, J. M., and Penoyer, R. F.
***Proceedings of the Institution of Electrical Engineers*, Paper 2188S, October 1956 (v. 104B, Supplement no. 5, pp. 238–244, 245–248, 1957)**

1087. HEAT CHANGES ACCOMPANYING MAGNETIZATION PROCESSES IN FERRITES
Bates, L. F. and Christoffel, D. A.,
***Proceedings of the Institution of Electrical Engineers*, Paper 2212R, October 1956 (v. 104B, Supplement no. 5, pp. 231–237, 245–248, 1957)**

1088. THE PHYSICAL AND CHEMICAL PROPERTIES OF SOME NICKEL–ZINC FERRITE COMPOUNDS
Tombs, N. C. and Watkins, J.
***Proceedings of the Institution of Electrical Engineers*, Paper 2235R, October 1956 (v. 104B, Supplement no. 5, pp. 141–144, 174–178, 1957)**

1089. MICROWAVE RESONANCE RELATIONS IN ANISOTROPIC SINGLE CRYSTAL FERRITES
Artman, J. O.
***Proceedings of the IRE*, v. 44, no. 10, pp. 1284–1293, October 1956**

The ferromagnetic resonance relations in magnetically anisotropic single crystal ferrites are re-examined. Detailed analyses are presented for spherical specimens. Generalized nomograms are shown which relate the resonance frequency to static field H, anisotropy parameter K/M, and the static field orientation. The nature of the susceptibility tensor is discussed. Below magnetic saturation, multidomain structure is expected. Under these conditions, with $\vec{H}$ applied in a [110] direction, a simple multidomain arrangement is suggested by crystal geometry. Ferromagnetic resonance can be used to investigate this structure. The analysis is similar to that employed for uniaxial crystals. The domains are lamellar in form, separated by 180° walls, and lie perpendicular to $\vec{H}$. Corresponding to the two nearby easy directions of magnetization, the domains are of two varieties which alternate in sequence. Two resonance frequencies are found for a given $\vec{H}$, depending on whether the microwave magnetic field is perpendicular or parallel to $\vec{H}$. Nomograms are given relating these resonance frequencies to $\vec{H}$, K/M, and saturation magnetization M. The nature of the magnetization curve for these simple structures is also discussed. The predictions of these analyses are compared with the results of recent experiments. (*PA*, 1957, #3445)

1090. MAGNETIC ANISOTROPY OF THE IRON SULFIDE SINGLE CRYSTAL AT THE α-TRANSFORMATION TEMPERATURE

Kamigaichi, T., Hihara, T., Tazaki, H., and Hirahara, E.

***Journal of the Physical Society of Japan*, v. 11, no. 10, pp. 1123, October 1956**

The temperature variation of the magnetic susceptibility of a single crystal of $FeS_{1.04}$ is found to depend strongly on the angle between the c-axis and the applied field direction. The change of the susceptibility at the transformation temperature (about 110°C) is largest when this angle is 0° and very small when it is 90° (field applied in the basal plane). The properties are similar to those of α-Fe_2O_3. (*PA*, 1957, #5458)

1091. A NOTE ON THE FERROMAGNETIC RESONANCE IN α Fe_2O_3

Shimizu, M.

***Journal of the Physical Society of Japan*, v. 11, no. 10, pp. 1078–1083, October 1956**

Microwave resonance formulae are phenomenologically derived for a ferromagnet with a small hexagonal anisotropy in a basal plane, with uniaxial anisotropy. Comparison with resonance experiments on αFe_2O_3 single crystals is made and satisfactorily explained. A few contradictions with static measurements are pointed out. (*PA*, 1957, #3428)

1092. ON THE PROBLEM OF THE INTERNAL EFFECTIVE FIELD FOR FERROMAGNETIC RESONANCE OF POLYCRYSTALLINE FERRITES

Krupicka, S.

***Czechoslovak Journal of Physics*, v. 6, no. 5, pp. 458–467, October 1956**

A study was made of the ferromagnetic resonance of MnZn ferrite in the temperature region −124° to +182°C in the 3 cm band. The additional internal effective field and its temperature dependence was determined. A comparison with the results of measurements of the initial permeability carried out at the same time pointed to the close relationship between magnetocrystalline anisotropy and the additional field or apparent value of the Landé factor g^*. (*PA*, 1957, #4533)

1093. MAGNETIC PROPERTIES OF THE RARE EARTH FERRITES 5 $Fe_2O_3 \cdot 3M_2O_3$ WITH M = Tb, Dy, Ho, Er, Tm, Yb, Lu

Pauthenet, R.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 20, pp. 1499–1502, November 12, 1956 (in French)**

Reports results of measurements between 2° and 700°K and in fields up to 2×10^4 oersted of the temperature variation of the saturation magnetization and the susceptibility above the Curie point. (*PA*, 1957, #5451)

1094. INVESTIGATION OF THE PARAMETERS OF FERRITES

Mikhailovskii, L. K.

***Izvestia Akademii Nauk SSSR, Seriya Fizicheskaya*, v. 20, no. 11, pp. 1297–1283, 1956 (in Russian)**

The possibility of the coexistence in a limited volume of a transversely magnetized gyromagnetic substance of two wave types, one depending on, the other practically independent of, the applied magnetic field is predicted

theoretically and confirmed experimentally. A method of practical application of the phenomenon of volume resonance is also presented. (*PA*, 1957, #4534)

1095. INTERPRETATION OF THE MAGNETIC PROPERTIES OF THE FERRITES $5Fe_2O_3 \cdot 3M_2O_3$ with M = Y, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu
Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 22, pp. 1737–1740, November 26, 1956 (in French)**

The experimental results are interpreted on the basis of Néel's theory. Below about 100°K the orbital moment of the $\bar{M}$ ions is partially quenched. The magnitude and nature of the interactions is discussed. (*PA*, 1957, #5452)

1096. EFFECT OF PILE IRRADIATION ON THE MAGNETIC PROPERTIES OF ZINC FERRITE
Forestier, H., Eischen, G., and Guiot-Guillain, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 23, pp. 1842–1845, December 5, 1956 (in French)**

Neutron irradiation followed by thermal treatment alters the magnetization of zinc ferrite (paramagnetic before irradiation) through the introduction of defects in the spinel lattice. (*PA*, 1957, #5454)

1097. FORMATION OF MANGANESE FERRITE BY SOLID-STATE REACTION
Kedesdy, H. H. and Tauber, A.
***Journal of the American Ceramic Society*, v. 39, no. 12, p. 425, December 1956**

Investigation of formation of manganese ferrite from oxide mixtures of Mn_3O_4 and Fe_2O_3 to establish trends in magnetic characteristics with changing firing cycles and furnace atmosphere; formation of solid solutions of manganese oxide and ferric oxide, which precedes ferrite formation; surface oxidation and exsolution in ferrite bodies cooled slowly from high temperatures. (*EI*, 1957)

1098. CERAMIC MAGNETS
Scholten, R. A.
***Product Engineering*, v. 27, no. 18, pp. 143–148, December 1956**

This report gives a comparison of barium ferrite magnets with Alnicos: how to utilize high coercive force and potential energy of ceramic magnets; holding, driving and generator applications. (*EI*, 1957)

1099. THE PROBLEM OF THE MECHANISM OF MAGNETIZATION PROCESSES IN CERTAIN Ni–Zn FERRITES IN VERY WEAK FIELDS
Fomenko, L. A.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 31, no. 6, pp. 1092–1093, 1956 (in Russian)**

The author discusses earlier work on the subject and concludes that the predominating significance of boundary shift processes in Ni–Zn ferrites, baked at not too low temperatures, follows also from his own investigations of the magnetic spectra of ferrites in the absolute zero and residual magnetization states. (*PA*, 1957, #4544)

1100. CATION ARRANGEMENT AND MAGNETIC PROPERTIES OF COPPER FERRITE–CHROMITE SERIES
Miyahara, S. and Ohnishi, H.
***Journal of the Physical Society of Japan*, v. 11, no. 12, pp. 1296–1297, December 1956**

X-ray investigations gave the dependence of the relative numbers of Cu ions on tetrahedral and octahedral lattice sites for a range of values of Cr content *c*. The variation with *c* of the Curie temperature and saturation magnetization was also obtained. (*PA*, 1957, #8272)

1101. ANGLES BETWEEN MAGNETIC SPIN DIRECTIONS IN IRON-DEFICIENT MAGNESIUM MANGANESE FERRITES
Osmond, W. P.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 12, pp. 1319–1325, December 1956**

Magnesium manganese ferrites containing less than 50% (mol) Fe_2O_3 must contain tri- or tetravalent manganese if there is to be no oxygen deficiency. For some compositions this entails electronic conduction and ferromagnetic coupling between manganese ions of different valences in the same type of lattice site. Reported magnetic data on a number of such ferrites show significant

departures from the results to be expected with probable ionic distributions in the spinel lattice if all A sublattice spins were anti-parallel to all B sublattice spins. Existing theoretical work on the occurrence of angles between the spin directions of two different kinds of magnetic ions is applied to two groups of ions in one or both sublattices. The Mn^{3+} and exchanging Mn^{2+} ions are treated as one group, the other group consisting of the Fe^{3+} ions and any excess Mn^{2+} ions. In view of the necessary averaging assumptions the degree of agreement found between observed trends and those predicted by the theoretical treatment is satisfactory. The angles concept is here considered as a mathematical expression of average relative spin directions rather than as indicating a physical ordering of spins. Thus other groupings might possibly show the same trends, the basic causes being unaltered. (*PA*, 1957, #2401)

1102. ANGLES BETWEEN PARTIAL MAGNETIZATIONS IN SPINEL FERRITES CONTAINING MANGANESE IONS OF MORE THAN ONE VALENCY

Osmond, W. P.

***The Philosophical Magazine*, Eighth Series, v. 1, pp. 1147–1156, December 1956**

In iron-deficient spinel ferrites containing manganese, but no other constituent of variable valency, all the manganese will not be divalent. Mn^{3+} ions tend to form strong directed semicovalent bonds in octahedral (B) sites but not in tetrahedral (A) sites. The reverse is true for Fe^{3+} ions. The antiparallel A–B indirect exchange interaction should thus be weaker when one interacting ion is Mn^{3+} than when both are Fe^{3+}. Any Mn^{3+} ions are likely to be coupled with parallel spins by double exchange with Mn^{2+} or Mn^{4+} ions in the same type of lattice site. The magnetic ions in either sublattice can then be considered as divided into two groups, one based on Mn^{3+} ions, and the other on Fe^{3+} ions, with different degrees of departure from antiparallelism of their net spins to the net magnetization of the other sublattice. The molecular field approximation as applied by other authors to single ions is extended to such groups of ions, with certain provisos as to the correct interpretation to be given to the mathematical symbols used for interaction coefficients and angles between spin directions. (*PA*, 1957, #3456)

1103. OBSERVATION OF MAGNETIC VISCOSITY OF FERRITES AT LOW TEMPERATURES

Telesnin, R. V. and Lednev, I. A.

***Doklady Akademii Nauk SSSR*, v. 112, no. 1, p. 48, 1957 (in Russian)**

Using the conventional layout for a specimen in the form of a washer, hysteresis loops were observed on an oscilloscope at room and liquid nitrogen temperatures respectively, conditions otherwise being strictly comparable. At 293°K the loop was tall and narrow and of small area. At 78°K the loop was short and wide and of large area. Clearly the lowering of induction on account of viscosity is considerable and it is pointed out that this should be considered when designing apparatus containing ferrites that may have to work at very low temperatures. (*PA*, 1957, #5457)

1104. TEMPERATURE DEPENDENCE OF THE *g*-FACTOR AND RELAXATION TIME FOR FERROMAGNETIC RESONANCE FOR SOME FERRITES

Komar, A. P. and Krivko, N. I.

***Doklady Akademii Nauk SSSR*, v. 114, no. 1, pp. 64–66, 1957 (in Russian)**

Measurements are made of the g-factor and the relaxation time, T, from the magnetic resonance curve position and half-widths at 9.4×10^9 Mc for a series of ferrites. Typical is 20% Li_2O with 80% Fe_2O_3 for which at 290°K $g = 2.03$, $T = 5.1 \times 10^{-10}$ sec and at 4.2°K $g = 1.84$, $T = 3.8 \times 10^{-10}$ sec. (*PA*, 1957, #9266)

1105. FERRIMAGNETIC RESONANCE IN YTTRIUM IRON GARNET

Dillon, J. F., Jr.

***The Physical Review*, v. 105, no. 2, pp. 759–760, January 15, 1957**

Reports results of experiments on a single crystal of $Y_3Fe_2(FeO_4)_3$ at frequencies 9.3 and 24.0 kMc and at temperatures between 3 and 540°K. The resonance line width is anisotropic, reaches a peak value between 20 and 65°K and very low values at high temperatures (8 oersted at 540°K in the [100] direction). Values of K_1 and g were also obtained. (*PA*, 1957, #4540)

1106. FERRITES—LEURS APPLICATIONS INDUSTRIELLES
Cahen, L.
***Technique moderne*, v. 49, no. 1, pp. 9–14, January 1957**

Ferrites: their uses in industry; nature of ferrites is explained and how their properties result from their chemical composition; details about way in which they are prepared for use; properties and applications; most important of magnetic properties in initial permeability for low-flux densities. (*EI*, 1957)

1107. DER FERRIMAGNETISMUS DER FERRITE
Gieseke, W.
***Siemens Zeitschrift*, v. 31, no. 1, pp. 1–12, January 1957**

Ferrimagnetism of ferrites; review of ferrimagnetic behavior of ferrites as depending on their particular ion and bond characteristics; shell models and spinel lattices of typical elements; how coupling of magnetic ions can be influenced. (*EI*, 1957)

1108. INFLUENCE OF METHOD OF PREPARATION ON SOME MAGNETIC PROPERTIES OF A MANGANESE-ZINC FERRITE
Broz, J., Bergstein, A., Krupicka, S., Vintera, J., and Zaveta, K.
***Czechoslovak Journal of Physics*, v. 7, no. 7, no. 1, pp. 66–79, 1957 (in German)**

Several Mn–Zn ferrite specimens containing excess Mn were prepared under different conditions of atmosphere (vacuum, air, nitrogen), temperature (950-1300°C) and time of treatment (up to 3 hr). Magnetic properties measured include saturation magnetization, Curie temperature, g-factor and ferromagnetic resonance line width. (*PA*, 1959, #8315)

1109. ROTATION OF THE PLANE OF POLARIZATION IN A LONGITUDINAL MAGNETIC FIELD (FARADAY EFFECT) IN THE MILLIMETRE WAVEBAND
Mash, D. I.
***Zhurnal Tekhnickeskoi Fiziki*, v. 27, no. 2, pp. 360–363, 1957 (in Russian)**

The Faraday effect in a large number of ferrites has been measured at millimeter wavelengths. The best specimens had an insertion loss of 0.1 to 0.8 db and rotations of up to 360° could be obtained depending on dimensions of specimen and strength of magnetic field. (*PA*, 1957, #9286)

1110. DISPERSION RELATIONS FOR TENSOR MEDIA AND THEIR APPLICATION TO FERRITES
Gourary, B. S.
***Journal of Applied Physics*, v. 28, no. 3, pp. 283–288, March 1957**

The well-known Kronig–Kramers integral relations between the real and imaginary parts of the susceptibility are generalized to the case where the susceptibility is a tensor. The consequences of the principle of energy conservation are discussed. The case of a ferrite is discussed in some detail. (*PA*, 1957, #5449)

1111. MAGNETIC INDUCTION AND COERCIVE FORCE DATA ON MEMBERS OF THE SERIES $BaAl_xFe_{12-x}O_{19}$ AND RELATED OXIDES
Van Uitert, L. G.
***Journal of Applied Physics*, v. 28, no. 3, pp. 317–319, March 1957**

Oxides having the magnetoplumbite structure and a wide range of magnetic properties have been examined. The magnetic saturations of the compositions $M^{II}Fe_{12}O_{19}$ can be lowered by replacing part of the iron with the ions Al^{3+}, Ga^{3+}, Mn^{3+}, Cr^{3+}, and Ge^{3+} among others. M^{II} in the above formula can be Ba^{2+}, Sr^{2+}, or Pb^{2+}. Calcium can replace these ions in part. Even the samples with magnetic saturations below 200 gauss can be prepared as crystallographically oriented compacts. Contrary to its behavior in ferrites, Ga^{3+} does not appear to occupy tetrahedral sites in the magnetoplumbite structure. Evidence is presented for the occurrence of points of magnetic compensation in the $BaAl_xFe_{12-x}O_{19}$ series. As the aluminium contents of the materials increase toward such a point, the ratio $2K/I$ (where K is the magnetocrystalline anisotropy constant and I is the saturation magnetization) also increases. As a consequence the ferromagnetic resonance frequencies associated with the materials move to higher frequencies, and extremely high coercive forces are realized. (*PA*, 1957, #5470)

1112. THEORY OF MAGNETOSTRICTION AND *g*-FACTOR IN FERRITES

Tsuya, N.

***Reports of the Research Institute of Electrical Communication of Tôhoku University*, B, v. 8, no. 4, pp. 161–255, March 1957**

The electronic structures of various ferrites are determined theoretically, using the one-ion model based on the Heitler–London approximation. Spin–orbit interactions are discussed fully by means of perturbation theory, and the *g*-factors calculated for the ferrites agree well with those observed in microwave resonance absorption. The perturbation terms for the various possible mechanisms for magnetostriction are obtained and the predominating mechanism in each ferrite could be determined, as the calculated magneto-mechanical coupling energies agree quite well with the experimental values. (69 refs.) (*PA*, 1959, #5897)

1113. LOW LOSS MAGNESIUM MANGANESE FERRITES

Blackman, L. C. F.

***Journal of Electronics*, v. 2, no. 5, pp. 451–456, March 1957**

The preparation, by the method of thermal decomposition of mixed nitrates, of a Mg–Mn ferrite of low microwave energy loss at Q-band is described. From an observation of the time constant of a toroidal ring of the material, a quick check on the loss is available. (*PA*, 1957, #4539)

1114. RADIATION MAGNETIZATION

Becker, C. H.

***Zeitschrift für Physik*, v. 148, no. 3, pp. 391–401, 1957**

Radiation magnetization represents a new electron induction effect within ferrites resulting in real permanent magnetization, dynamically induced and detected by means of microwaves. (*PA*, 1957, #8725)

1115. TEMPERATURE DEPENDENCE OF SPONTANEOUS MAGNETIZATION IN Co–Zn FERRITES AT LOW TEMPERATURES

Reinov, N. M. and Smel'makh, M. F.

***Radiotekhnika i Elektronika*, v. 2, no. 3, pp. 342–344, 1957 (in Russian)**

The results are given of an experimental investigation of dependence of saturation magnetization of Co–Zn ferrites on temperature from the Curie point to 1.3°K. It is shown that for these materials the expected decrease (Vonsovskii–Agafonova theory) of saturation magnetization was not observed down to 1.3°K. (*PA*, 1958, #8130)

1116. ON THE PROBLEM OF STUDYING THE IDEAL MAGNETIZATION INTENSITY OF MANGANESE FERRITE

Sternberk, J.

***Czechoslovak Journal of Physics*, v. 7, no. 3, pp. 339–343, 1957 (in Russian)**

It was shown experimentally that the ideal magnetization intensity of a toroid specimen can be measured by a modified version of the differential method first proposed by Chernikova, in which one measuring coil only, wound uniformly on the toroid, is used, and that the effect of any irregularity of the winding can be eliminated by correct positioning of the toroid in the static magnetic field. (*PA* 1959, #8316)

1117. A CONTRIBUTION TO THE STUDY OF FERROMAGNETIC RESONANCE IN MANGANESE ZINC FERRITES

Krupicka, S.

***Czechoslovak Journal of Physics*, v. 7, no. 3, pp. 344–350, 1957**

Ferromagnetic resonance experiments on three samples are reported, and the temperature variation given of the effective Landé factor g^* and of the width ΔH of the resonance curve over the range −150 to 100°C. The temperature variation of the saturation magnetization M_s of the same three samples has been measured by Broz and Závéta. The variation of g^* is discussed on the basis of an additional internal field $H_i = h\nu/(2\beta) - H_z$ and it appears that H_i and ΔH are determined by several common factors. It is found that Tsuya's model for the production of H_i, in which $H_i \propto M_s$, is over-simplified. (*PA*, 1959, #8327)

1118. ON THE QUESTION OF THE INFLUENCE OF MAGNETIC INTERACTIONS ON THE INITIAL PERMEABILITY OF SINTERED FERRITES

Sternberk, J.

Czechoslovak Journal of Physics, v. 7, no. 3, pp. 372–374, 1957

If the measured initial permeability is greater than that calculated from the rotation of the spontaneous magnetization vectors, it is usually concluded that boundary displacements also participate in the magnetization process. The author points out that magnetic interactions between crystal grains provide another possible explanation and shows that the properties of several ferrites are consistent with an equation derived from a simple model in which rotation occurs in grains assumed to lie inside spherical cavities surrounded by a medium with homogeneous magnetization. (*PA*, 1959, #8317)

1119. FERRIMAGNETIC RESONANCE OF GADOLINIUM GARNET AT 9300 Mc/s

Paulevé, J.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 14, pp. 1908–1910, April 1, 1957 (in French)**

Reports results of resonance measurements on $5\,Fe_2O_3.3\,Gd_2O_3$ between 4 and 700°K and estimates the values of the g factor from the temperature variation of the resonance field. Below the compensation temperature, 290°K, the results are masked by impurity effects. (*PA*, 1957, #7215)

1120. DOMAIN PATTERNS ON FERRITE SINGLE CRYSTALS

Pearson, R. F.

***Proceedings of the Physical Society*, London, Section B, v. 70, Part 4, p. 441, April 1957**

Domain patterns, obtained by the magnetic colloid technique, are reproduced as photographed on cleaved basal planes of the ferrimagnetic compounds $BaFe_{12}O_{19}$ and $Ba_3Zn_2Fe_{26}O_{41}$. The patterns are interpreted on the lines proposed by Goodenough for materials with high uniaxial anisotropy. (*PA*, 1957, #6353)

1121. THE TEMPERATURE DEPENDENCE OF THE MAGNETIC PROPERTIES OF BARIUM FERRITE

Schwabe, E.

***Zeitschrift für angewandte Physik*, v. 9, no. 4, pp. 183–187, April 1957 (in German)**

The variation of the magnetic properties of barium ferrite magnets with temperature is reversible on the upper, reversible portion of the demagnetization curve. In this region it is determined by the variation with temperature of the saturation magnetization. The temperature coefficient of the apparent remanence also corresponds in this region to a value of about -0.2% per deg C for the temperature coefficient of the saturation magnetization. As the irreversible portion of the hysteresis loop is approached, a large variation of coercive force with temperature is observed (0.5% per deg C) on cooling, while on warming up again there is an irreversible decrease in the apparent remanence, and therefore, in the air gap flux of a magnet system. The application of the results to magnet design is discussed. (*PA*, 1958, #7183)

1122. CONTROLLED CRYSTAL ANISOTROPY AND CONTROLLED TEMPERATURE DEPENDENCE OF THE PERMEABILITY AND ELASTICITY OF VARIOUS COBALT-SUBSTITUTED FERRITES

van der Burgt, C. M.

***Philips Research Reports*, v. 12, no. 2, pp. 97–122, April 1957**

Dynamic elasticity at remanence, piezomagnetic coupling at remanence, and initial permeability of polycrystalline toroids of various cobalt-substituted ferrites were determined in the temperature range from -196°C to $+120$°C at least. The compositions are represented approximately by $(M_{1-y}Zn_y)_{1-x}Co_xFe_2O_4$, where M stands for one of the divalent metal ions $Li^1_{\frac{1}{2}}{}^+Fe^3_{\frac{1}{2}}+$, Ni^{2+} and Mn^{2+}. The first-order magnetocrystalline anisotropy constant K_1 of cobalt ferrite is known to be large and positive (2 to $3 \times 10^5\ J/m^3$). Consequently the incorporation of a small amount of cobalt ferrite in solid solution in other ferrites that have $K_1 < 0$ (ferrous, nickel, manganese ferrites, and presumably lithium ferrites) leads to a compensation of crystal anisotropy at a transition temperature T_0 depending on the amount of cobalt ferrite. At room temperature the compensating effect of cobalt substitutions in ferrous ferrite is nearly four times as strong as expected from simple linear interpolation. On the other hand cobalt substitutions in manganese ferrite appear to be less effective than expected, the compensating amount of cobalt being about four times that expected. Nevertheless the curves T_0 vs. x for all systems of cobalt-substituted mixed ferrites have a similar shape. The fact that the

crystal anisotropy passes through zero at a temperature T_0 implies that around this temperature only strain anisotropy and pore-shape anisotropy remain, so that there exists a small temperature range where the substance is magnetically and magnetoelastically soft. The resulting peaks in the permeability and compliance, together with the over-all increase of these quantities with temperature, lead to temperature ranges somewhere above T_0 where the permeability and the elasticity are substantially temperature independent. (*PA*, 1957, #8011)

1123. EFFECT OF ADDED TITANIUM AND ALUMINUM ON MAGNETIC BEHAVIOUR OF α FERRIC OXIDE

Haigh, G.
***The Philosophical Magazine*, Eighth Series, v. 2, no. 16, pp. 505–520, April 1957**

Magnetic behavior of hematite, α Fe_2O_3, studied in region of antiferromagnetic transition temperature (−15°C) when titanium and aluminum are added in small amounts as impurity; magnetic properties and behavior of some naturally occurring hematites are compared with synthesized materials, and are shown to be very structure sensitive. (*EI*, 1957)

1124. O UTLENIANIU ROZTWOROW STALYCH $MnO–Fe_2O_3$

Braginski, A., Fraczek, K.,and Fraczek, T.
***Archiwum Elecktrotechniki*, v. 6, no. 4, pp. 597–612, 1957**

Solutions of $MnFeO_4 \cdot Mn_2O_3$ produced by oxidation of $MnFeO_4$ have magnetic properties different from $MnFe_2O_4$; quadrivalent manganese does not appear in solutions; density of ferrites after sintering serves as protection against oxidation in air; investigation of influence of increasing density of ferrite addition SiO_2 on oxidation process and on magnetic properties of solutions $MnO\text{-}Fe_2O_3$. (*EI*, 1958)

1125. MAGNETISCHE EIGENSCHAFTEN IM SYSTEM BLEIOXYD-EISENOXYD-SILIZIUMDIOXYD

Pawlek, F. and Reichel, K.
***Archiv fiir das Eisenhuettenwesen*, v. 28, no. 4, pp. 241–244, April 1957**

Measurement of magnetic properties on sintered specimens of $PbO\text{-}Fe_2O_3\text{-}SiO_2$ ternary system; favorable influence of small additions of SiO_2; best permanent magnet properties shown by specimens composed of 25.2% PbO, 74% Fe_2O_3 and 0.8% SiO_2. (*EI*, 1957)

1126. NEW HEXAGONAL FERRIMAGNETIC OXIDES

Summergrad, R. N. and Banks, E.
***Physics and Chemistry of Solids*, v. 2, no. 4, pp. 312–317, 1957**

Oxides were prepared, with magneto-plumbite structure similar to $BaFe_{12}O_{19}$, by substitution of La^{+++} ions and alkali metals for Ba^{++} ions, where alkali metal ions are Na^+, K^+ and Rb^+; new compounds have magnetic properties very close to those of barium compound; Curie temperatures of all compounds are at 440°C plus or minus 10°C. (*EI*, 1957)

1127. PERMANENT MAGNET OXIDES CONTAINING DIVALENT METAL IONS

Van Uitert, L. G. and Swanekamp, F. W.
***Journal of Applied Physics*, v. 28, no. 4, pp. 482–485, April 1957**

Dependence of saturation induction at room temperature upon composition for substitution of non-magnetic ions into $BaFe_{12}O_{19}$, into $BaM_2Fe_{16}O_{27}$, and into mixture $BaNiFe_{14}O_{23}$ is given; evidence presented for existence of points of magnetic compensation in number of series wherein aluminum is substituted for iron. (*EI*, 1957)

1128. DOMAIN STRUCTURE EFFECTS IN AN ANOMALOUS FERRIMAGNETIC RESONANCE OF FERRITES

LeCraw, R. C. and Spencer, E. G.
***Journal of Applied Physics*, v. 28, no. 4, pp. 399–405, April 1957**

Measurements of the intrinsic tensor permeability [μ] of unsaturated Ni ferrite at 9300 Mc, using cavity perturbation techniques, have revealed an anomalous resonance for negative (anti-Larmor) circularly polarized fields. The resonance has a line width of 70 oersted and occurs very near the coercive force, which is 13.2 oersted. The usual resonance for positive (Larmor) circularly polarized fields occurs at 2750 oersted. An interesting consequence of the low-field resonance is that below satura-

tion K'' is negative, where $K = K' - iK''$ is the off-diagonal component of $[\mu]$. Above saturation K'' is positive. The change in sign of K'' is shown not to violate energy considerations. These effects are explained by a theory involving r.f. demagnetizing poles on Bloch walls based on a model with a physically probable domain structure. The theory extends the Polder–Smit mechanism in unmagnetized media to include applied dc fields and circularly polarized r.f. fields. It is applicable to all ferrites, both mono- and polycrystalline, having domain walls free to move in dc fields of the order of the coercive force. Since the anomalous resonance depends upon the domain structure and appears to occur generally, it is a probe of considerable usefulness for the study of magnetization processes and h.f. phenomena in ferrites. (*PA*, 1958, #2402)

1129. FORM OF POLDER TENSOR FOR SINGLE CRYSTAL FERRITE WITH SMALL CUBIC SYMMETRY ANISOTROPY ENERGY

Seidel, H. and Boyet, H.
***Journal of Applied Physics*, v. 28, no. 4, pp. 452–454, April 1957**

The Polder tensor susceptibility is derived for the 110 plane of the cube, and its elements are exhibited as a function of the angle that the applied field makes with a cube edge, as well as of saturation magnetization, applied field, anisotropy constant and frequency. The analysis is valid for ferrites with anisotropy fields much less than externally applied magnetic fields. The tensor is no longer diagonal for circular polarizations, except along the 100 and 111 axes. (*PA*, 1958, #2403)

1130. EFFECTS OF ANNEALING ON THE SATURATION INDUCTION OF FERRITES CONTAINING NICKEL AND/OR COPPER

Van Uitert, L. G.
***Journal of Applied Physics*, v. 28, no. 4, pp. 478–481, April 1957**

The equilibrium distribution of Cu between octahedral and tetrahedral sites in the ferrites varies appreciably with temperature. The rate at which these ions approach their equilibrium distribution at a fixed temperature, after quenching from a higher temperature, is much greater for the slightly reduced materials. Previously unreported deviations from a smooth variation of saturation induction with annealing temperature were observed in ferrites containing Ni and/or Cu, which were prepared to achieve a high degree of homogeneity and hence to be relatively free from defects. (*PA*, 1958, #3236)

1131. INFLUENCE OF POROSITY ON THE *g*-FACTOR OF FERRITES

Snieder, J.
***Applied Scientific Research*, B, v. 6, no. 5, pp. 301–311, 1957**

Starting from the classical description of the ferromagnetic resonance phenomenon by Kittel, the author shows under what circumstances the experimental conditions comply with those taken for granted in the theoretical derivation. It is found that with the necessary corrections the derived resonance equation may be used for the experimental results. With the aid of cavity-techniques with ferromagnetic spheres the value of the spectroscopic splitting factor g was obtained. From quantum-mechanical considerations a g-value of nearly 2 is expected, which is independent of both temperature and frequency. Until now, all measurements on polycrystalline ferrites have given too high a value of g, which is moreover strongly dependent on temperature and frequency. Measurements by others on single crystals of the same material give a smaller g-value with a smaller frequency dependence and almost without any temperature dependence. A theoretical explanation of these discrepancies is given in this article. (*PA*, 1958, #2397)

1132. MAGNETIC DIPOLE EFFECTS IN FERRITES

Johnson, R. A. and Healy, D. W., Jr.
***Journal of Chemical Physics*, v. 26, no. 5, pp. 1031–1035, May 1957**

Presents an analysis of the role which classical magnetic dipole–dipole interactions may play in the physical behavior of ferrites with particular attention to magnetic anisotropy. Included is an evaluation of these effects in magnetite and lithium ferrite where an ordered arrangement of dipoles can exist and a study and calculation of some statistical effects which exist in other ferrites where this ordering is absent. The results obtained from this analysis are then compared with the pertinent experimental data. (*PA*, 1957, #7216)

1133. STRUCTURAL AND MAGNETIC PROPERTIES OF SOLID SOLUTIONS OF LITHIUM FERRITE WITH CADMIUM FERRITE AND WITH LITHIUM ALUMINATE

Carter, A. E., Miles, P. A.,and Welch, A. J. E.
***Proceedings of the Institution of Electrical Engineers*, Paper 2262R, v. 104B, Supplement no. 5, pp. 141–144, 174–178, 1957**

Measurements of magnetization (at temperatures down to 90°K) have been made by means of a Sucksmith magnetometer on lithium ferrite ($LiFe_5O_8$) and the following solid solutions: $LiFe_5O_8 - CdFe_2O_4$ (25, 35, 50, and 75 mol % $CdFe_2O_4$), and $LiFe_5O_8 - LiAl_5O_8$ (10, 20, 30, and 40 mol % $LiAl_5O_8$). The cation distributions in these materials have also been determined as far as possible by X-ray examination. Magnetic and structural measurements both indicate: (a) that cadmium ions enter tetrahedral ion-sites in the first solid-solution series, (b) that aluminium ions in the second series replace ferric ions in both tetrahedral and octahedral sites, with an increasing preference for octahedral sites as the aluminium content increases. The temperature dependence of magnetization for the materials (revealing cases of Néel's *R*-, *P*-, and probably *N*-type behavior, and the effects of changes in *g*-value for the iron atoms are discussed. (*PA*, 1957, #5463)

1134. A NEW CLASS OF OXIDIC FERROMAGNETIC MATERIALS WITH HEXAGONAL CRYSTAL STRUCTURES

Jonker, G. H., Wijn, H. P. J.,and Braun, P. B.
***Proceedings of the Institution of Electrical Engineers*, Paper 2320R, v. 104B, Supplement no. 5, pp. 249–254, 265–266, 1957**

Several new groups of ferromagnetic oxides have been found. They have rather complicated chemical compositions and can be obtained as reaction products of Fe_2O_3, BaO and MeO in various proportions, where Me denotes, in general, an element of the first transition group, or either Mg or Zn. The crystal structures of these new compounds can be described in the hexagonal system and are related to the magnetoplumbite structure. The crystal anisotropy of many of these hexagonal compounds is such that, depending on the chemical composition, the spontaneous magnetization in each crystal is oriented either parallel or perpendicular to the hexagonal axis. In the latter case the magnetization can fairly easily be rotated in the basal plane. Polycrystalline sintered samples of such compounds show an initial permeability of about 10; the permeability remains substantially constant up to about 1000 Mc/s, so that these new materials extend the frequency range where ferromagnetic oxides can be advantageously used as core materials to frequencies much higher than is now possible with ferrites having cubic crystal structures. (*PA*, 1957, #5466)

1135. CRYSTALLINE STRUCTURE AND MAGNETIC PROPERTIES OF FERRITES HAVING THE GENERAL FORMULA $5Fe_2O_3 \cdot 3M_2O_3$

Bertaut, F. and Pauthenet, R.
***Proceedings of the Institution of Electrical Engineers*, v. 104B, Supplement no. 5, pp. 261–264, 265–266, 1957**

A general account of the magnetic properties and crystal structure is given, and is shown that they are in accordance with Néel's ideas. (*PA*, 1957, #7509)

1136. SATURATION MAGNETIZATION OF SOME FERRIMAGNETIC OXIDES WITH HEXAGONAL CRYSTAL STRUCTURES

Gorter, E. W.
***Proceedings of the Institution of Electrical Engineers*, Paper 2355R, v. 104B, Supplement no. 5, pp. 255–260, 265–266, 1957**

Anderson's treatment of super-exchange yields a qualitative rule for the dependence of interaction on angle Me-O-Me. Using this rule and assuming a longer distance to lead to a weaker interaction, low-temperature saturation magnetizations for ferrimagnetic oxides with known crystal structures can often be predicted. The results obtained for some of the materials described in that paper; i.e., $Ba_2Me^{II}_2Fe_{12}O_{22}$(Y), $Ba_2Me^{II}_2Fe_{24}O_{41}$(Z), and $BaMe^{II}_2Fe_{16}O_{27}$(W) (in which Me^{II} may be Mn, Fe, Co, Ni, Mg, or Zn), together with those for $BaFe_{12}O_{19}$M and $KFe_{11}O_{17}$, with related crystal structures, are compared with the results of saturation-magnetization measurements down to 20°K. It is shown that very small differences in crystal structure, such as exist between KFeO and M and between M and Y, can result in drastic differences in spin orientations of neighboring ions. In particular for Y, the experimental data yield some insight into the distribution of the divalent Me ions among the

various lattice sites. The crystal structure of Z is composed of alternating blocks of M and Y, that of W is composed of alternating blocks of M and S(spinel). The saturation magnetizations are obtained by adding those of the composing blocks. (*PA*, 1957, #5472)

1137. EFFECTS OF CERAMIC PARAMETERS ON MICROWAVE PROPERTIES OF NICKEL FERRITE

Blum, S. L., Zneimer, J. E., and Zlotnik, H.
***Journal of the American Ceramic Society*, v. 40, no. 5, pp. 143–149, May 1957**

Apparatus for measuring magnetic loss as function of magnetic field for ferrites at frequency of 10,000 Mc; method of preparing ferrites and physical properties of polycrystalline nickel ferrites as affected by preparation and firing techniques; variation in relative permeability with bulk density of body discussed with reference to domain rotation and domain wall movement. (*EI*, 1957)

1138. MAGNETIC PROPERTIES OF PEROVSKITES CONTAINING STRONTIUM I. STRONTIUM-RICH FERRITES AND COBALTITES

Watanabe, H.
***Journal of the Physical Society of Japan*, v. 12, no. 5, pp. 512–522, May 1957**

Magnetic susceptibilities and electrical conductivities of (La, Sr) (Fe/Co)O_x samples sintered *in vacuo* or in an oxygen stream were measured. Samples containing tetravalent magnetic ions in general have Curie constants smaller than those containing only trivalent ions. This fact and the high conductivity in the former specimens strongly support the combined effect of the double exchange and the usual exchange mechanism in these compounds. The parallel alignment of spins of magnetic ions due to double exchange is partly or completely hindered by the presence of the strongly negative trivalent–trivalent interionic interactions. (*PA*, 1958, #8129)

1139. CONTRIBUTION TO THE EXPLANATION OF MAGNETIC AFTER-EFFECT THROUGH ELECTRON DIFFUSION IN FERRITES

von Kienlin, A.
***Zeitschrift für angewandte Physik*, v. 9, no. 5, pp. 245–250, May 1957 (in German)**

The results are reported on measurements on specimens of a nickel-zinc ferrite, sintered in oxygen and in air at temperatures between 1200 and 1350°C. The electrical resistivity and the ratio of remanent to saturation magnetization decrease as the sintering temperature is increased. The variation of loss angle with temperature shows a maximum whose amplitude increases and moves to a lower temperature, as the sintering temperature is increased. On the assumption that the losses are due to magnetic after-effect, activation energies are deduced for electron diffusion from experiments at frequencies between 2 kc/s and 100 kc/s, and temperatures from −150 to 100°C. A qualitative interpretation of the results is given by assuming that stabilization of the direction of spontaneous magnetization arises from an anisotropic distribution of a small concentration of Fe^{2+} ions and misplaced oxygen atoms, and that magnetic after-effect results from electron exchange between Fe^{2+} ions and Fe^{3+} ions when the direction of magnetization is changed. (*PA*, 1958, #8138)

1140. HYPERFREQUENCY PROPERTIES OF SOME NICKEL-ZINC FERRITE CHROMITES

Guillaud, C., Vautier, R., and Kagan, W.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 23, pp. 2781–2784, June 3, 1957 (in French)**

Reports results of waveguide measurements of the Faraday rotation and the attenuation of these substances, $Fe_2O_3 \cdot Cr_2O_3$ NiO · ZnO, with different relative compositions at a frequency 9.575 k Mc. Both these factors in general decrease as the Cr_2O_3 content increases. (*PA*, 1957, #9261)

1141. VARIATION OF THE RESONANCE FIELD IN NICKEL–ZINC FERRITE CHROMITES

Vautier, R. and Kagan, W.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 25, pp. 3040–3043, June 17, 1957 (in French)**

Both the saturation magnetization and the resonance field decrease as the chromium content increases, contrary to expectation. (*PA*, 1957, #9262)

1142. A NEW METHOD OF OBSERVING MAGNETIC TRANSFORMATIONS
Blackman, M., Haigh, G.,and Lisgarten, N. D.
***Nature*, v. 179, pp. 1288–1290, June 22, 1957**

Magnetic transformations are demonstrated visually on the fluorescent screen of an electron diffraction camera, the electron beam, which is focused either above the specimen or on the screen, being affected by the stray magnetic fields emanating from the magnetic domains. Observations were made on single crystals of haematite, magnetite and pyrrhotite, and on powder specimens of maghemite, magnetite and haematite. A reversing ferrite was also investigated. (*PA*, 1957, #9753)

1143. THE K_1- AND TRUE *g*-VALUES OF POLYCRYSTALLINE FERRITES
Snieder, J.
***Applied Scientific Research*, B, v. 6, no. 6, pp. 471–473, 1957**

A continuation of previous work on mixed Ni – Zn ferrites without porosity. Ferromagnetic resonance measurements were carried out between −40 and 100°C, and *g* was found to be independent of temperature and frequency, varying between 2.00 and 2.11 as the NiO content varied from 0 to 50 percent; the K_1 values are temperature dependent. (*PA*, 1958, #2398)

1144. MAGNETIC ANNEALING EFFECT IN IRON–NICKEL FERRITES
Aiyama, Y., Sekizawa, H. and Iida, S.
***Journal of the Physical Society of Japan*, v. 12, no. 6, p. 742, June 1957**

The dependence of the uniaxial anisotropy of Fe–Ni ferrites on the concentration of cation vacancies has been studied. The cation/anion ratio was varied by varying the degree of oxidation of the specimens, and the results show that the magnitude of the uniaxial anisotropy increases with the degree of oxidation. (*PA*, 1958, #1133)

1145. MAGNETIC AND ELECTRICAL ANISOTROPIES OF THE IRON SULFIDE SINGLE CRYSTAL
Hihara, T., Murakami, M.,and Hirahara, E.
***Journal of the Physical Society of Japan*, v. 12, no. 6, p. 743, June 1957**

An extension of previous work to temperatures up to 400°C, covering the Néel point, 330°C. Discontinuities in the slope of the susceptibility and resistivity curves in the two principal directions are observed at this temperature, and these are interpreted in terms of the spin coupling. (*PA*, 1958, #1128)

1146. FERROXPLANA, HEXAGONAL FERROMAGNETIC IRON-OXIDE COMPOUNDS FOR VERY HIGH FREQUENCIES
Jonker, G. H., Wijn, H. P. J.,and Braun, P. B.
***Philips Technical Review*, v. 18, no. 6, pp. 145–154, 1956–1957**

Some properties of new ferromagnetic materials which are compounds of BaO, Fe_2O_2 and MeO, Me representing divalent ion from series Mu, Fe, Co, Ni, Zn, Mg; they are prepared by ceramic process and are related as regards crystal structure, to ferroxdure; like ferroxdure some of these materials show preferred direction for magnetization, parallel to *c*-axis. (*EI*, 1957)

1147. THEORY OF UNIAXIAL ANISOTROPY INDUCED BY MAGNETIC ANNEALING IN FERRITES
Taniguchi, S.
***Science Reports of the Research Institutes*, Tôhoku University, Series A, v. 9, no. 3, pp. 196–214, June 1957**

Critical examination of explanation based on preferentially oriented precipitation of second phase; magnetocrystalline cubic anisotropy of ferrite; uniaxial magnetic anisotropy induced by magnetic annealing; theory of S. Taniguchi and M. Yamamoto on induced uniaxial anisotropy in metallic solid solutions has been extended to cases of ferrites and general expression for induced uniaxial anisotropy energy obtained. (*EI*, 1957)

1148. RICHTER-TYPE MAGNETIC AFTER-EFFECT IN [NON-STOICHIOMETRIC] MANGANESE FERRITE
Krupička, S. and Vilím, F.
***Czechoslovak Journal of Physics*, v. 7, no. 6, pp. 723–728, 1957**

1149. EFFECTIVE GYROMAGNETIC RATIO FOR TRIANGULAR FERRIMAGNETIC STATES
Eskowitz, A. and Wangsness, R. K.
***The Physical Review*, v. 107, no. 2, pp. 379–380, July 15, 1957**

It is shown from the semiclassical equations of motion and the molecular-field approximation that the triangular ferrimagnetic state can also be described by an effective gyromagnetic ratio. This effective ratio depends explicitly on the ratio of the inter- to intrasublattice molecular field constants rather than on the static sublattice magnetizations as in the antiparallel state. It is estimated that the shift in g-values for $FeCr_2O_4$ should be observable if there is a transition from a triangular to an antiparallel state. (*PA*, 1958, #650)

1150. THE PREPARATION OF POLYCRYSTALLINE FERRIMAGNETIC GARNET MATERIALS FOR MICROWAVE APPLICATIONS
Wolf, W. P. and Rodrigue, G. P.
Harvard University, Gordon McKay Lab. of Applied Physics, Cambridge
AF 19(604)-1084, Scientific R-9, AFCRC-TN-57-572, July 15, 1957 (ASTIA AD-117,296)

A simple chemical method is described for preparing high density, polycrystalline, magnetic garnets suitable for microwave applications. The formula is $3M_2O_3 \cdot 5Fe_2O_3$, where M is a rare earth from Sm to Ln, or yttrium. The effect on the dielectric loss of small deviations from the ideal M:Fe composition and the effect of porosity on the ferrimagnetic resonance line width are reported.

1151. RESONANCE MEASUREMENTS ON NICKEL–COBALT FERRITES AS A FUNCTION OF TEMPERATURE AND ON NICKEL FERRITES–ALUMINATES
Pippin, J. E. and Hogan, C. L.
Harvard University, Gordon McKay Lab. of Applied Physics, Cambridge
AF 19(604)-1084, Scientific R-10, AFCRC-TN-57-573, July 20, 1957 (ASTIA AD-117,297)

The variation of line width and effective g factor with cobalt content and with temperature is studied in a series of ferrites of composition $Ni_{1-\alpha}Co_\alpha Mn_{0.02}Fe_{1.9}O_{4\pm}$ ($0 < \alpha < 0.09$ and $20° \leqq T \leqq 340°$).

1152. FERROMAGNETIC RESONANCE IN SOME POLYCRYSTALLINE RARE EARTH GARNETS
Rodrique, G. P., Pippin, J. E., et al.
Harvard University, Gordon McKay Lab. of Applied Physics, Cambridge
AF 19(604)-1084, Scientific R-11, AFCRC-TN-57-574, July 25, 1957 (ASTIA AD-117,298)

Ferrimagnetic resonance measurements have been carried out on a series of polycrystalline garnets of composition $5Fe_2O_3 \cdot 3M_2O_3$ (M = Y, Sm, Gd, Dy, Ho, Er, and Yb). The temperature range was 20°C to the Curie points (approximately 280°C). The variations of line widths and effective g-values are reported, and several technical applications are discussed.

1153. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF FERROUS BROMIDE AND IODIDE
Bizette, H., Terrier, C., and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 5, pp. 507–509, July 29, 1957 (in French)**

Reports results up to 300°K of susceptibility measurements made parallel and perpendicular to the principal axes. In both directions the susceptibilities are independent of field strength and an antiferromagnetic transition occurs at 10°K for both substances. The results are discussed in relation to the crystal structure. (*PA*, 1957, #9268)

1154. ORDERING IN COBALT–FERROUS FERRITES
Wijn, H. P. J., van der Heide, H.,and Fast, J. F.
***Proceedings of the Institution of Electrical Engineers*, Paper 2322R, v. 104B, Supplement no. 7, pp. 412–417, 433–435, 1957**

Various cobalt–ferrous ferrites show a constricted hysteresis loop. After magnetic annealing of the samples the loop becomes rectangular. It appears that the magnetic annealing creates in each crystal a uniaxial anisotropy in a direction which is not necessarily the direction of the applied magnetic field but a crystallographic direction nearest to it. It is suggested that directional ordering is the most probable origin of the anisotropy found. (*PA*, 1957, #7233)

1155. DIELECTRIC SPECTROSCOPY OF FERROMAGNETIC SEMICONDUCTORS
Miles, P. A., Westphal, W. B.,and von Hippel, A.
***Review of Modern Physics*, v. 29, no. 3, pp. 279–307, July 1957**

A review of recent measurements of the complex dielectric permittivity and magnetic permeability of ferromagnetic spinels (ferrites) over the frequency range from static measurements to ultraviolet frequencies. The measuring techniques applicable to different parts of the frequency range are briefly described. There is a general discussion of the interpretation of electric and magnetic spectra, and a detailed discussion of the magnetic effects in the ferrites. (*PA*, 1958, #3065)

1156. OBSERVATIONS ON THE MAGNETIC TRANSITION IN HEMATITE AT −15°C
Haigh, G.
***The Philosophical Magazine* Eighth Series , v. 2, pp. 877–890, July 1957**

An examination is made of the magnetic behavior of hematite, αFe_2O_3, in the region of the antiferromagnetic transition temperature (−15°C). In this examination it is shown that the magnetic properties of hematite may be ascribed to two magnetically independent components of ferromagnetism, one dependent upon the antiferromagnetic transition while the other is independent of this transition. The magnetic properties of these two components have been determined first from a series of measurements with an astatic magnetometer, and then, by direct measurement at low temperature (− 75°C), the magnetic properties of one component have been measured directly. These observations are critically discussed with reference to the magnetic structure for hematite proposed by Néel, and the inadequacy of this magnetic structure in accounting for some of the observations is pointed out. (*PA*, 1957, #8714)

1157. EFFECT OF HEAT TREATMENTS ON THE MAGNETIC PROPERTIES OF THE $FeTiO_3$–Fe_2O_3 SOLID SOLUTION SERIES
Ishikawa, Y. and Akimoto, S.
***Journal of the Physical Society of Japan*, v. 12, no. 7, pp. 834–835, July 1957**

Describes the effect of heat treatments on the intensity of magnetization of $0.5FeTiO_2$–$0.5Fe_2O_3$. The intensity of magnetization changes rapidly with the temperature of heat treatment when the specimen is cooled slowly, the maximum intensity of magnetization corresponding to a temperature of about 1050°C. It is suggested that the strong ferromagnetism is acquired on cooling through the order-disorder transformation temperature only when some short-range order has been created by heat treatment at the higher temperature. (*PA*, 1958, #4130)

1158. SYNTHESIS OF SOME FERRITES
Kedesdy, H. and Tauber, A.
***Mining Engineer*, v. 9, no. 7, pp. 784–792, July 1957**
(See also *Journal of Metals*, v. 9, no. 7, pp. 1140–1148, September 1957)

Results of systematic investigations of formation of basic ferrite, such as Ni ferrite, mixed ferrite, such as NiZn–ferrite, and ferrite involving complex formation process, such as Mn–ferrite; trends in magnetic characteristics are related to change in firing cycle and furnace atmosphere; specimen preparation and testing procedures. (*EI*, 1957)

1159. MAGNETIC AND MAGNETOSTRICTIVE PROPERTIES OF MAGNESIUM–NICKEL FERRITES
Hoffman, P. O.
***Journal of the American Ceramic Society*, v. 40, no. 7, pp. 250–252, July 1957**

Study to determine whether or not magnetic and magnetostrictive properties of mixed Ni–Mg ferrites having various compositions were superior to those of simple Ni ferrite: tests of Young's modulus, remanence, coercivity, reversible permeability, static magnetostriction, electromechanical coupling coefficient, and dynamic magnetostrictive constant. (*EI*, 1957)

1160. STUDY BY NEUTRON DIFFRACTION AT 4.2°K OF THE ANTIFERROMAGNETIC STRUCTURE OF $FeCl_2$
Herpin, A. and Mériel, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 6, pp. 650–653, August 5, 1957 (in French)**

Measurement of the intensities of the neutron beams diffracted by $FeCl_2$ at 4.2°K suggests that the Fe atoms

in successive planes normal to the *c*-axis have their magnetic moments antiparallel along the *c*-axis direction. (*PA*, 1957, #9265)

1161. FERRIMAGNETIC RESONANCE IN GADOLINIUM IRON GARNET

Calhoun, B. A., Overmeyer, J., and Smith, W. V.
***The Physical Review*, v. 107, no. 4,**
pp. 993–994, August 15, 1957

Ferrimagnetic resonance was observed from −192°C to 72°C. The apparent *g*-factor and line-width have their maximum values at the compensation point (13°C). The coincidence of the maximum *g* with the vanishing of the magnetization implies that the *g*-factors of the Gd^{+3} and Fe^{+3} are equal. The temperature dependence of the integrated intensity of the absorption is very similar to that of the magnetization. Below −150°C, both *g* and the line-width increase with decreasing temperature. (*PA*, 1958, #230)

1162. PARAMAGNETIC STUDY OF THE FERRITES $5Fe_2O_3$, $3M_2O_3$ WITH M = Gd, Dy, Er

Aléonard, R. and Barbier, J. C.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 8,**
pp. 831–834, August 19, 1957 (in French)

Describes measurements, at temperatures above the Curie point, of the susceptibilities of certain ferrites. The results are discussed in terms of the Néel theory of ferrimagnetism. (*PA*, 1957, #9269)

1163. THE MAGNETIC PROPERTIES OF IRON SELENIDE SINGLE CRYSTALS

Hirakawa, K.
***Journal of the Physical Society of Japan*, v. 12,**
no. 8, pp. 929–938, August 1957

Large single crystals of Fe_7Se_8 and Fe_3Se_4 were prepared, and their magnetic properties below the Curie point were investigated by a torque magnetometer. The results obtained on Fe_7Se_8 at room temperature show similar characteristics to that of natural pyrrhotite (Fe_7Se_8), i.e., the crystals can be magnetized only in the *c*-plane. As the temperature is lowered, however, the *c*-axis becomes the direction of easy magnetization. This change in direction seems to occur gradually. In the case of Fe_3Se_4, such a change in direction of easy magnetization does not take place. The obtained saturation magnetizations for Fe_7Se_8 and Fe_3Se_4 are respectively 68 and 80 *g* at the liquid air temperature. (*PA*, 1958, #3234)

1164. MAGNETIC ANISOTROPY OF COBALT FERRITE ($Co_{1.01}Fe_{2.00}O_{3.62}$) AND NICKEL COBALT FERRITE ($Ni_{0.72}Fe_{0.20}Co_{0.08}Fe_2O_4$)

Shenker, H.
***The Physical Review*, v. 107, no. 5,**
pp. 1246–1249, September 1, 1957

A method of measuring the first magnetic anisotropy constant, K_1, of cubic crystals having a large anisotropy was developed which utilized measurements of the torque for directions of the applied field near the direction of easy magnetization. By this method K_1 of a cobalt ferrite crystal was found to be closely approximated by the empirical relationship $K_1 = 19.6 \times 10^6 \exp(-1.90 \times 10^{-5}T^2)$ ergs/cm³ from 20° to 325°K. Above 325° the measured anisotropy depended upon the length of time the crystal was in the magnetic field. For a nickel cobalt ferrite crystal K_1, as measured by the usual torque method, was given empirically by $K_1 = [8.08 \exp(-3.57 \times 10^{-5}T^2) - 9.78 \exp(-0.863 \times 10^{-5}T^2)] \times 10^4$ ergs/cm³ from 20° to 600°K while K_2 increased from -4.7×10^4 ergs/cm³ at 20.5°, passed through zero at 190°, rose to a maximum of 1×10^4 at 280°K, and then above this temperature decreased rapidly to zero. The relationships for K_1 are of the same form as those found by Brükhatov and Kirensky for metallic ferromagnetic materials. (*PA*, 1958, #2405)

1165. MAGNETIZATION OF ILMENITE–HEMATITE SYSTEM AT LOW TEMPERATURES

Bozorth, R. M., Walsh, D. E. and Williams, A. J.
***The Physical Review*, v. 108, no. 1,**
pp. 157–158, October 1, 1957

Reports results of magnetization measurements between 1.3°K and room temperature and in fields up to 11,000 oersted on the substances $Fe_{1+x}Ti_{1-x}O_3 (0<x<1)$. The effective Bohr magneton numbers are deduced, and only agree with a simple linear variation near 20% Fe_2O_3 where p_B has its maximum value 3. (*PA*, 1958, #236)

1166. MAGNETIC ANNEALING EFFECT IN COBALT-SUBSTITUTED MAGNETITE SINGLE CRYSTALS

Penoyer, R. F. and Bickford, L. R. Jr.
***The Physical Review*, v. 108, no. 2, pp. 271–277, October 15, 1957**

The effect of magnetic annealing at 375°K on the room-temperature anisotropy of a series of six single crystals in the composition series $Co_xFe_{3-x}O_4$, in the range of x values between 0.0 and 0.15, is investigated. The anneal-induced anisotropy is shown to be represented by the equation $W_U = -F\Sigma_{i\alpha i}{}^2\beta_i{}^2 - G\Sigma_{i>j\alpha i\alpha j\beta i\beta j}$, where α_i and β_i are direction cosines of the magnetization during measurement and during the annealing process, respectively. F and G are shown to vary with x in a regular fashion: $F \cong 10.1 \times 10^6 x^2$ ergs/cm³ and $G \cong 9.25 \times 10^6 x$ ergs/cm³. These results cannot be explained by the Néel orientation-ordering model or by the precipitate model of magnetic annealing. A new model, involving cobalt ions individually rather than in pairs or larger agglomerates, is introduced. (*PA*, 1958, #6040)

1167. MAGNETICKE TEPELNE CITLIVE MATERIALY A JEJICH POUZITI

Hora, O.
***Elektrotechnicky Obzor*, v. 46, no. 10, pp. 524–532, October 1957**

Magnetic heat-sensitive materials and their application; analysis of temperature dependent variations of magnetic properties of ferromagnetic materials; measuring results for some ferrites; explanation of temperature dependent variations of current and voltage in heat sensitive reactance coils and transformers, together with simple method for their calculation. (*EI*, 1957)

1168. LES FERRITES

Vassiliev, A.
***Annales de Radioélectricité*, v. 12. no. 47, pp. 15–32, January 1957, pp. 337–362, October 1957**

Review of essential elements of modern theory of ferromagnetism along with brief study of theory of ferrimagnetism; properties of ferrites; characteristics of main composition groups; examples of ferrite applications. (66 refs.) (*EI*, 1957)

1169. NICKEL–COPPER FERRITES WITH A NARROW RESONANCE ABSORPTION CURVE AT UHF

Fabrikov, V. A., Kudryavtsev, V. D. and Gushchina, Z. M.
***Radiotekhnika i Elektronika*, v. 2, no. 10, pp. 1299–1300, 1957 (in Russian)**

Gives details of the preparation of ferrites for use at resonant absorption at frequencies in the region of 10 Gc/s. The half-width of the resonance absorption curve for these materials is about 100–150 oersted. Microphotographs of two samples of material of different composition are shown. (*PA*, 1959, #446)

1170. THE INFLUENCE OF MAGNETIC VISCOSITY ON THE FREQUENCY CHARACTERISTICS OF FERRITES

Telesnin, R. V. and Shishkov, A. G.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 4(10), pp. 839–844, 1957 (in Russian)**

An investigation is made of the magnetic viscosity of a series of nickel–zinc ferrites under conditions of free and induced variations of magnetization. The viscosity characteristics taken on the same samples by both methods were obtained for the first time. An estimate is given of the constant of viscosity friction. (*PA*, 1958, #5118)

1171. MAGNETOCRYSTALLINE ANISOTROPY IN COBALT–SUBSTITUTED MAGNETITE SINGLE CRYSTALS

Bickford, L. R., Jr., Brownlow, J. M. and Penoyer, R. F.
***Proceedings of the Institution of Electrical Engineers*, Paper No. 2188S**
(To be published in Vol. 104B, 1957)

The growth of single crystals corresponding to $x = 0$ (high-purity magnetite), $x = 0.01$ and $x = 0.04$ in the composition series $Co_xFe_{3-x}O_4$ is described. First- and second-order anisotropy constants of these crystals are determined by the torque method over the temperature range 120–450°K. The substitution of small amounts of Co for Fe is found to add a positive contribution to K_1 and a negative contribution to K_2. At low Co concentrations the magnitude of this contribution is a linear function of the amount of Co added. It is suggested that the effect of Co on the anisotropy is enhanced by the presence of divalent Fe in magnetite, and it is concluded

that the change in sign of K in magnetite at about 130°K is not caused by the presence of Co or any other foreign impurity. (*PA*, 1956, #8275)

1172. HEAT CHANGES ACCOMPANYING MAGNETIZATION PROCESSES IN FERRITES

Bates, L. F. and Christoffel, D. A.
***Proceedings of the Institution of Electrical Engineers*, Paper 2212R (To be published in Vol. 104B, 1957)**

A brief survey is given of the method of measurement of the small thermal changes which accompany changes in magnetization, together with an outline of the procedure for the discussion of experimental data based on current theories of ferromagnetic processes. New measurements are described on a series of ferrites which include nickel–zinc, manganese–zinc, magnesium–zinc and lithium–chromium specimens. Evidence is presented that domain boundary movements occur in low fields; in high fields rotation of domain vectors are paramount. The manganese–zinc ferrite shows a peak in the thermal changes in low fields, whereas with all the other specimens at room temperature a "dip" is observed. The magneto-thermal behavior of lithium–chromium ferrite is in accord with its unusual magnetic properties. (*PA*, 1957, #532)

1173. THE PHYSICAL AND CHEMICAL PROPERTIES OF SOME NICKEL–ZINC FERRITE COMPOUNDS

Tombs, N. C. and Watkins, J.
***Proceedings of the Institution of Electrical Engineers*, Paper 2235R (To be published in Vol. 104B, 1957)**

The work reported forms part of a general investigation aimed at elucidating the mechanisms giving rise to magnetic and dielectric losses in ferrites. For this purpose the nickel–zinc ferrite system was chosen as a simple system containing materials whose properties fall within a convenient range for measurement. In particular, the paper describes the preparation and some properties of a series of nickel–zinc ferrites in which the iron content has been made less than the stoichiometric value. The primary aim in preparing these materials was to find to what extent the resistivity at microwave frequencies could be increased in such iron-deficient preparations. Although an increase of the resistivity at 9.6 Gc/s from about 50 ohm-cm to 500 ohm-cm is obtained, this alone would not be adequate for practical materials. Other properties of the materials have been measured and their variation with iron content explained. (*PA*, 1957, #1445)

1174. MAGNETIC PROPERTIES OF THE $FeTiO_3$–Fe_2O_3 SOLID SOLUTION SERIES

Ishikawa, Y. and Akimoto, S.
***Journal of the Physical Society of Japan*, v. 12, no. 10, pp. 1083–1098, October 1957**

Magnetic properties of the synthesized solid solution $x\ FeTiO_3 \cdot (1-x)Fe_2O_3$ of ilmenite ($FeTiO_3$) and hematite (Fe_2O_3) were investigated in detail for the whole range of $0 \leqq x \leqq 1$. The most suitable method for preparing the specimen with the largest intensity of magnetization was found experimentally. Changes of the Curie point, estimated intensity of magnetization at 0°K, the Curie constant and the asymptotic paramagnetic Curie point with the composition were presented. It was found that the magnetic properties of the solid solution $x\ FeTiO_3 \cdot (1-x)Fe_2O_3$, could be divided into three parts, (1) $x = 1$, (2) $1 > x \geqq 0.5$ and (3) $0.5\ x \geqq 0$: Pure ilmenite ($FeTiO_3$) is antiferromagnetic below 55°K and the specimens for $1 > x \geqq 0.5$ are very strongly ferromagnetic and for $0.5 > x \geqq 0$ they are again antiferromagnetics on which feeble parasitic ferromagnetism is superimposed. These magnetic properties are discussed by using the approximation of molecular field. It is shown that one could explain an outline of the magnetic properties of the solid solution if it is assumed that the tetravalent Ti ions always occupy one of the two sublattices in the specimens for $1 \geqq x \geqq 0.5$, while such an ordering of Ti ions and Fe ions is disturbed for $0.5 > x \geqq 0$. (*PA*, 1959, #8289)

1175. EFFET FARADAY ET BIREFRINGENCE DANS LES FERRITES EN HYPER-FREQUENCE

Mayer, F.
***Annales des Telecommunications*, v. 12, no. 7–10, pp. 279–288, July–August 1957, pp. 305–332, September 1957, pp. 334–342, October 1957**

Faraday effect and double refraction in ferrites at hyperfrequency; investigation of pyromagnetic effects in ferromagnetic medium subject to magnetic field, particularly of double refraction of circular or straight components of plain h.f. wave. (85 ref.) (*EI*, 1958)

1176. INTERPRETATION OF THE VARIATIONS OF THE FERRIMAGNETIC RESONANCE FIELD OF GADOLINIUM GARNET WITH TEMPERATURE
Paulevé, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 19, pp. 1604–1607, November 4, 1957 (in French)**

Discusses previous results of the author and of Calhoun, et al., for the resonance field near the compensation temperature. A fairly satisfactory explanation is given in terms of the author's model for gadolinium garnet. (*PA*, 1958, #3220)

1177. SOME INVESTIGATIONS ON Li–Zn FERRITES
Valeev, Kh. S., Drozdov, N. G. and Frumkin, A. L.
***Zhurnal Teknicheskoi Fiziki*, v. 27, no. 11, pp. 2517–2527, 1957 (in Russian) (English translation in: *Soviet Physics–Technical Physics*, New York, v. 2, no. 11, pp. 2341–2350, November 1957)**

A study was made of the sintering and physical properties. The sintering process was studied mainly by means of thermograms. On the basis of these, conclusions were drawn as to the formation temperature of Li ferrites and the reaction of the ferrite with the atmosphere during sintering, etc. A comparison was made between Li and Ni ferrites. As a result of studying the effect of composition and sintering temperature on the magnetic properties of Li–Zn ferrites, materials have been obtained which have small losses in the range 20-75 Mc. The frequency dependences of the real and imaginary parts of the magnetic permeability were determined for this range. The magnetic permeability of the ferrites was also measured in the very high-frequency region. Data were obtained on the dependence of absorption in the ferrite at a wavelength of 3.2 cm on constant magnetic fields. The thermal expansion of Li–Zn ferrite was measured over a wide temperature range. It was found that an anomaly in the temperature dependence of the coefficient of thermal expansion occurs at the Curie point. (*PA*, 1959, #5896)

1178. MANGAN-ZINK-FERRITE MIT HOHER PERMEABILITAET UND GERINGEN VERLUSTEN
Heister, W.
***Technische Mitteilungen Krupp*, v. 15, no. 6, pp. 130–144, November 1957**

Manganese zinc ferrites with high permeability and small losses; report on new ferrite type, Hyperox D 1 S, developed by Krupp, Essen; magnetic, dielectric, metallographic and electron microscopic investigations; influence of crystal size on magnetic properties. (*EI*, 1958)

1179. INTERPRETATION OF THE MAGNETIC PROPERTIES OF YTTRIUM GARNET WITH Al^{3+}, Ga^{3+} AND Cr^{3+} IONS SUBSTITUTED FOR Fe^{3+} IONS
Villers, G. and Loriers, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 23, pp. 2033–2036, December 4, 1957 (in French)**

Reports results of measurements of the variation with x of the saturation magnetization of the substances $(5-x)Fe_2O_3 \cdot \chi M_2O_3 \cdot 3Y_2O_3$ $(0 \leq x \leq 1)$; for M = Cr p_B increases with x up to 0.5. The results are discussed on the basis of Néel's theory. The Curie temperatures were also measured; they decrease linearly with increasing x extrapolating to zero at $x = 5$. (*PA*, 1958, #3231)

1180. ELEMENTARY DOMAINS ON THE {100} FACES OF NICKEL FERRITE CRYSTALS AND ON THE (0001) FACE OF BARIUM FERRITE CRYSTALS
Paulus, M.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 25, pp. 2227–2230, December 16, 1957 (in French)**

Powder patterns are shown for the two ferrites and the results discussed; striking maze patterns were observed for the barium ferrite. (*PA*, 1958, #1125)

1181. MAGNETIC MATERIALS WITH THE PERMINVAR EFECT. II. THE IMPORTANCE OF COMPOSITION, IN FERRITES WITH SMALL COBALT CONTENT, FOR THE PERMINVAR EFFECT
Kienlin, A. v.
***Zeitschrift für angewandte Physik*, v. 9, no. 12, pp. 631–640, December 1957 (in German)**

The effects on the initial permeability and the hysteresis loops of an iron-rich nickel ferrite and of magnetite, caused by adding small amounts of cobalt were studied

at temperatures between −200°C and 100°C. The initial permeability–temperature curves show maxima which occur at higher temperatures for greater cobalt content. The results for magnetite are in qualitative agreement with those of Bickford et al. For specimens of nickel and slowly cooled magnetite, constricted hysteresis loops of the Perminvar type were observed above the temperature of the initial permeability maxima. Hysteresis loops for quenched and slowly cooled magnetite specimens, for temperatures between −100°C and 125°C, and for applied field amplitudes up to about 4 oersted, are given. The results are interpreted as arising from a change in the sign of the anisotropy constant K_1, at a temperature which increases with increasing cobalt content. (*PA*, 1958, #8125)

1182. FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE FERRITES

Snieder, J.
University of Delft,Dissertation, 1958

An experimental and theoretical study is made of the propagation of TE_{11}-waves of 3.2 cm wavelength in a circular waveguide containing a cylinder of Ferroxcube IV magnetized along the axis. The Faraday rotation with ellipticity was determined as a function of field strength and temperature between −30°C and 100°C. The theory of ferromagnetic resonance was used to obtain values of the permeability tensor in terms of the experimental parameters. The influence of porosity on various factors is discussed. (*PA*, 1958, #7177)

1183. ON MAGNETIC SUPERVISCOSITY OF FERRITES

Telesnin, R. V. and Karchagina, E. V.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 34, no. 1, pp. 23–28, 1958 (in Russian)**

Behavior of the magnetic superviscosity curves of the series of NiZn ferrites fused at temperatures from 1200 to 1400°C was studied at 78°K. A second maximum of the viscous e.m.f. was detected at field strengths smaller than the coercive force and corresponding to the rapidly rising part of the differential magnetic susceptibility curve. The decrease of the viscous e.m.f. curves after the second maximum is of hyperbolic type. With increase of the field the second maximum merges with the main maximum and the viscous e.m.f. curve begins to resemble an exponential curve. The observed phenomena can be explained within the framework of Néel's theory. (*PA*, 1958, #7182)

1184. TIME DEPENDENT CONSTRICTED HYSTERESIS LOOPS IN A SINGLE CRYSTAL OF MANGANESE FERROUS FERRITE

Enz, U.
***Physica*, v. 24, no. 1, pp. 68–70, January 1958**

The time-dependent permeability decrease after ac demagnetization is strongly dependent on temperature as a result of the blocking of domain wall motion; this also causes hysteresis loop constrictions. (*PA*, 1958, #4133)

1185. RESONANCE MEASUREMENTS ON NICKEL–COBALT FERRITES AS FUNCTION OF TEMPERATURE AND ON NICKEL FERRITE–ALUMINATES

Pippin, J. E. and Hogan, C. L.
***IRE Transactions on Microwave Theory and Techniques*, v. MTT6, no. 1, pp. 77–82, January 1958**

Performance of microwave ferrite devices with large average power variations or in fluctuating ambient temperatures depends strongly on temperature dependence of properties of ferrite; variation of line width and effective g factor with cobalt content and with temperature is studied in ferrites of varying composition; resonance data presented. (*EI*, 1958)

1186. UNIAXIAL ANISOTROPY IN IRON–COBALT FERRITES

Iida, S., Sekizawa, H., and Aiyama, Y.
***Journal of the Physical Society of Japan*, v. 13, no. 1, pp. 58–71, January 1958**

The uniaxial anisotropy induced by the magnetic annealing in both single and polycrystals of iron–cobalt ferrites was studied experimentally. It is shown that the magnitudes of the uniaxial anisotropy depend essentially on the degree of oxidation of the specimens and become almost zero after deoxidizing heat treatments. Contrary to the conclusion by Bozorth et al., the dependence of the magnitude of the uniaxial anisotropy on the direction of the annealing magnetic field is observed for a cobalt rich single crystal, showing a maximum along <100> and a minimum along <110> in (001) plane. Relaxation behavior of the uniaxial anisotropy is studied by measuring directly the change of torque at high temperatures (240–~350°C) with a polycrystalline cobalt ferrite. It has been found that the results can be described by a simple

empirical formula, supporting that the magnetic annealing effect has no critical temperature. The variation of electrical conductivity with temperature has also no anomaly at the effective temperature range. Considering all the experimental results obtained, the conclusion was reached that the uniaxial anisotropy in these ferrites is due to the presence of directional short range order among various cations and cation vacancies in the spinel matrix. The nearest neighbor pair of a cobalt ion and a vacancy seems to play a principal role in this mechanism. (*PA*, 1959, #8319)

1187. FERRIMAGNETIC RESONANCE IN SOME POLYCRYSTALLINE RARE EARTH GARNETS

Rodrigue, G. P., Pippin, J. E. and Hogan, C. L.
***IRE Transactions on Microwave Theory and Techniques*, v. MTT-6, no. 1, pp. 83–91, January 1958**

Ferrimagnetic resonance measurements were carried out on a series of polycrystalline garnets of composition $5Fe_2O_3$-$3M_2O_3$ with M = Y, Sm, Gd, Dy, Ho, Er, and Yb. These measurements were made over a temperature range from 20°C to the Curie points (approximately 280°C). The variations of line widths and effective g values over this temperature range are reported. Y, Yb, and Sm garnets have g values of approximately 2.0 at room temperature while those of Dy, Ho, and Er are appreciably less than 2.0. High-density yttrium garnet has a line width of approximately 50 oersted at room temperature; line widths of other members of this series were found to vary from 400 to greater than 3000 oersted. The effective g value and line width of the gadolinium garnet tend to very high values as its compensation point (17°C) is approached. The narrow line width of the yttrium garnet is found to depend strongly on the density of the sample. When the density decreases from 96% to approximately 92% of the theoretical value, the line width increases from 50 to about 150 oersted. Several technical applications in which these materials might be particularly advantageous are discussed briefly. (*PA*, 1959, #424)

1188. ON THE INFLUENCE OF ELECTRIC POLARIZATION ON THE MAGNETIC PROPERTIES OF FERRITES

Zȳryanov, P. S. and Skrotskii, G. V.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 34, no. 1, pp. 222–223, 1958 (in Russian)**

In ferrites, spin-orbital interactions of the d-electrons lead to a dependence of the effective magnetic susceptibility on the polarization of the electron clouds. In metals this effect is obscured, at radio frequencies, by the strong polarizability of the conduction electrons. Quantitative calculation shows a displacement of the resonance frequency and a widening of the absorption line. The calculation is a generalization of one by Ament and Rado. (*PA*, 1959, #4814)

1189. VARIATION OF MAGNETIC PROPERTIES OF MIXED COPPER–NICKEL FERRITES AS A FUNCTION OF THE COPPER FERRITE/NICKEL FERRITE RATIO

Lăbuşçă, E. and Constantinescu, F.
***Revue de Physique*, Bucharest, v. 3, no. 2, pp. 141–150, 1958 (in German)**

In the audiofrequency range NiZn ferrite has a low loss tangent ($\tan \delta \sim 3 \times 10^{-3}$) and a low permeability ($\mu \sim 50$), whereas CuZn ferrite has large losses ($\tan \delta \sim 50$) on account of its higher conductivity and a higher permeability ($\mu \sim 250$). In an effort to produce a material which combines high permeability with low losses a number of mixed NiCuZn ferrites were made. Measurements of loss tangent and permeability as a function of magnetic field are reported for these materials at 10 kc/s. While some NiCuZn ferrites were practically nonmagnetic the others showed properties intermediate between those of NiZn ferrite and CuZn ferrite. The importance of heat treatment during manufacture is stressed but no details are given. (*PA*, 1959, #8320)

1190. DETERMINATION OF GYROMAGNETIC RATIO AND MAGNETIC RESONANCE DAMPING COEFFICIENT OF FERRITES

Reljers, H. G.
***Philips Research Reports*, v. 13, no. 1, pp. 10–16, February 1958**

Experiments on polycrystalline ferrite spheres in microwave cavity with linearly polarized magnetic field; derivation of fundamental quantities, like g-factor and damping coefficient of ferrite; calculation of damping coefficient either from line width measurement or from maximum amount of absorption in ferrite at resonance. (*EI*, 1958)

1191. FERRITES: OUTLINE OF THEIR STRUCTURE. PROPERTIES AND APPLICATIONS
Jackson, W.
***Metropolitan Vickers Gazette*, Manchester, England, v. 29, no. 463, pp 59–68, February 1958**

1192. THE PROCESS OF MAGNETIZATION BY CHEMICAL CHANGE
Haigh, D.
***The Philosophical Magazine*, Eighth Series, v. 3, pp. 267–286, March 1958**

In this paper the well-known processes of magnetization of rocks are discussed and compared and contrasted with the magnetization formed when a ferromagnetic mineral undergoes a chemical change within the influence of an external magnetic field. The thermal stability of the "chemical magnetization" so produced is examined and compared with the magnetizations produced isothermally and thermo-remanently in iron oxides under similar field conditions. The theoretical aspects of such a process of magnetization are considered and the nature of the resulting magnetization is accounted for theoretically. Possible applications in rock magnetic studies are also discussed. (*PA*, 1958, #1780)

1193. RADIOFREQUENCY [$2 \times 10^5 \times 6 \times 10^7$ c/s] SPECTRA OF PERMEABILITY AND PERMITTIVITY OF THE BODY [TELA] AND SUBSTANCE [VESHCHESTVA] OF MnZn FERRITES
Fomenko, L. A.
***Zhurnal Tekhnicheskoi Fiziki*, v. 28, no. 3, pp. 506–510, 1958 (in Russian)**

1194. NATURAL FERROMAGNETIC RESONANCE IN NICKEL, MAGNESIUM AND COBALT FERRITES
Perekalina, T. M. and Askochenskii, A. A.
***Zhurnal Tekhnicheskoi Fiziki*, v. 28, no. 3, pp. 511–517, 1958 (in Russian)**

The complex magnetic permeability spectra of sintered Ni, Mg and Co ferrites were investigated in a wide frequency range (0.45–20,000 Mc), embracing both the rotation and the displacement of the magnetic domains boundaries processes. The experimental results, given in the form of graphs showing the variation of the real and imaginary parts of permeability with frequency, are correlated with the theoretical curves plotted from the formulae derived by Kittel for μ_r (permeability due to the rotational processes) and μ_d (permeability associated with the boundary displacement). Although no definite conclusions were reached regarding the low frequency range, the validity of the Landau and Lifshitz theory in the form given by Kittel was confirmed. (*PA*, 1958, #8916)

1195. CATION SUBSTITUTIONS IN $BaFe_{12}O_{19}$
Mones, A. H. and Banks, E.
***Journal of Physics and Chemistry of Solids*, v. 4, no. 3, pp. 217–222, 1958**

The variation in magnetic intensity of $BaFe_{12}O_{19}$ was studied as a function of the substitution of ions such as Al^{III}, Ga^{III}, Cr^{III}, and Zn^{II} for Fe^{III}. All the substituted ions, with the exception of Cr^{III} were nonmagnetic. The fields employed were not sufficient for magnetic saturation of the polycrystalline preparations; single crystals of some preparations, principally in the Ga^{III} series, were magnetically saturated. From the magnetic saturation and nonsaturation data, some tentative conclusions are drawn regarding the preference of the substituted ions in the available sites, which are octahedrally and tetrahedrally surrounded by oxygen in the structure. (*PA*, 1959, #3641)

1196. FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE FERRITES
Snieder, J.
***Applied Scientific Research*, B, v. 7, no. 3, pp. 185–192, 1958**

An experimental and theoretical study is made of the propagation of TE_{11}-waves of wavelength 3.2 cm in a round waveguide containing a concentric round rod of Ferroxcube IV (NiZn ferrite) magnetized by a static magnetic field in a longitudinal direction. The Faraday rotation and the ellipticity when the wave has passed a given length of rod is determined as a function of the static field strength through resonance and of the temperature over a range from -30 to 100°C. On the basis of the theory of ferromagnetic resonance with damping the elements of the gyromagnetic permeability tensor are computed. Using them the rotation angle and ellipticity can be expressed in terms of the angular frequency of the wave, the radius of the waveguide, the radius and length of the rod, the static field strength, the static magnetization, the

gyromagnetic ratio and the damping constant. The gyromagnetic ratio is determined from resonance measurements on spheres of Ferroxcube while the damping constant is chosen so as to give the best agreement between theory and experiment. An interpretation of the values of the gyromagnetic ratio and of the resonance width in terms of the porosity of the ferrites is given. The behavior of the damping constant as a function of porosity is briefly discussed. (*PA*, 1958, #6034)

1197. SPONTANEOUS MAGNETIZATION OF SOME GARNET FERRITES AND THE ALUMINUM SUBSTITUTED GARNET FERRITES

Pauthenet, R.
***Journal of Applied Physics*, v. 29, no. 5, pp. 253–255, March 1958**

Magnetic properties are reported of $5Fe_2O_3 \cdot 3M_2O_3$, where M represents the Y ion or one of the ions of the series from Sm to Ln inclusive. The results are interpreted using Néel's molecular field model. A study of the Al substituted gadolinium garnets shows a preference for Al ions to occupy *d*-sites. (*PA*, 1958, #8879)

1198. MAGNETIC RESONANCE OF FERRITES WITH A COMPENSATION TEMPERATURE

Pauleve, J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 259–263, March 1958**

Calculations of the resonance fields as a function of temperature and of resonance frequency as a function of field for temperatures near the compensation temperature for lithium–chromium ferrite and gadolinium garnet are given. For the latter case, a comparison is made between the assumption of zero anisotropy and an assumed negative anisotropy. (*PA*, 1958, #8880)

1199. MULTIPLICITIES OF THE UNIFORM PRECESSIONAL MODE IN FERRIMAGNETIC RESONANCE

Solt, I. H., Jr., White, R. L., and Mercereau, J. E.
***Journal of Applied Physics*, v. 29, no. 3, pp. 324–325, March 1958**

There exists some uncertainty connected with the uniform precessional mode. The uniform mode is of most importance since it is for this mode that values of line widths, *g* values, and anisotropy constants are usually quoted in the literature. It can be distinguished experimentally from the higher order modes since: (a) its intensity of absorption is proportional to the uniform component of the r.f. magnetic field over the sample and (b) its intensity decreases much less rapidly with diminishing sphere size than for the higher order modes. It is observed, however, that there are several lines possessing these characteristics of the uniform mode. The relative intensities of these lines are strong functions of both temperature and frequency, they have different anisotropy constants, and their separation decreases with sphere radius. Data exhibiting these properties are presented for experiments on spherical single crystals of MnZn ferrites performed in the microwave frequency range of 8,000–12,000 Mc/s. A discussion of several possible mechanisms that might give rise to this phenomena is given. (*PA*, 1958, #8870)

1200. FERROMAGNETIC RESONANCE AND NONLINEAR EFFECTS IN YTTRIUM IRON GARNET

LeCraw, R. C., Spencer, E. G. and Porter, C. S.
***Journal of Applied Physics*, v. 29, no. 3, pp. 326–327, March 1958**

A study of ferromagnetic resonance at 9300 Mc and 3000 Mc in single crystals of yttrium iron garnet is described. Cavity perturbation techniques were used with polished spherical samples 9 to 11 mils in diam. The line widths along the hard axis [100] were found to be 2.3 and 5.7 oersted respectively, at 9300 Mc and 3000 Mc. It is believed the 2.3 oersted is the narrowest resonance line yet observed on spheres of ferromagnetic material at room temperature. Because of the narrow line-widths, the nonlinear behavior of these crystals is of particular interest. At 9300 Mc the r.f. field, h_{crit}, for saturation of the main resonance line is 46 millioersted. Using Suhl's spin-wave theory of nonlinear effects in ferromagnets, the 46 millioersted (associated with a *z*-directed spin-wave) predicts a spin-lattice relaxation time T_1 of 7.4×10^{-8} sec, in good agreement with the 7.0×10^{-8} sec measured by other independent methods. This T_1 then predicts an "intrinsic" line width of 1.54 oersted. Thus the observed line-width of these crystals at 9300 Mc is within a factor 1.5 of its theoretical limiting value. At 3000 Mc, where the subsidiary resonance coincides with the main resonance, h_{crit} is 5.0 millioersted (associated with spin-waves not *z*-directed). As the temperature is increased toward

340°K, an interesting effect is observed. The h_{crit} rises quite abruptly; in fact it changes by 10.5 db between 335°K and 340°K. This and other observations are compared with Suhl's nonlinear theory with good results. (*PA*, 1958, #8891)

1201. ORIGIN OF FERROMAGNETIC RESONANCE LINE BROADENING IN MANGANESE-RICH MANGANESE FERRITES

Harrison, S. E., Belson, H. S.,and Kriessman, C. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 337–338, March 1958**

Ferromagnetic resonance line widths in dense polycrystalline and single crystal specimens, the magnetic moment and the anisotropy field (K_1/M_s) have been measured as a function of temperature. Between room temperature and the Curie point the excess resonance line width, which is given by ΔH(excess)–ΔH (polycrystal)–ΔH (single crystal), is found to have the same temperature dependence as the saturation magnetization. This result is obtained even though the polycrystalline density ($> 98\%$) is sufficiently high to be in the range where the excess line width has usually been attributed to anisotropy broadening. In the region below room temperature ΔH(excess) becomes dependent on the anisotropy field. An approximate criterion, that is suggested by the data, to determine whether the anisotropy field or the magnetic moment is responsible for the broadening is the ratio $K_1/M_s^2 \gtrless 0.25$. The compositions measured were $Mn_{1.24}Fe_{1.76}O_4$ and $Mn_{1.49}Fe_{1.51}O_4$. The polycrystalline g factor (g_p) is greater than the single crystal g factor (g_s) and both g factors are functions of the temperature. The shift in the polycrystalline resonance peak is discussed with reference to the Standley Stevens theory and limited agreement is found. The anisotropy constant, K_1, has been found to vary as the fifth power of M_s for these ferrite compositions. (*PA*, 1958, #8866)

1202. FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE NICKEL FERRITE ALUMINATE

Schlomann, E. and Zeender, J. R.
***Journal of Applied Physics*, v. 29, no. 3, pp. 341–343, March 1958**

Line broadening because of crystalline anisotropy and the random orientation of the crystallites is investigated for the case in which the anisotropy field is much larger than the saturation magnetization. The theory predicts an absorption line with shoulders on each side which correspond to grains in which a hard or an easy direction is aligned with the dc field. With increasing anisotropy the low-field side of the line becomes more prominent and for $\gamma H_a/\omega > \sim 0.5$ a secondary absorption peak occurs on the low-field side of the main resonance. Measurements in nickel ferrite aluminates at X-band agree reasonably well with the predictions, if it is assumed that the first-order anisotropy constant is negative and that all higher order anisotropy constants are zero. (*PA*, 1958, #8868)

1203. EFFECT OF HYDROSTATIC PRESSURE AND TEMPERATURE ON THE MAGNETIC PROPERTIES OF A NICKEL–ZINC FERRITE

Adams, C. Q. and Davis, C. M., Jr.
***Journal of Applied Physics*, v. 29, no. 3, pp. 372–373, March 1958**

Magnetic properties of a nickel-zinc ferrite (15% NiO, 35% ZnO, 50% Fe_2O_3) were measured over a temperature range of 23 to 110°C at hydrostatic pressures up to 40,000 psi.

The relationship between the shift in Curie temperature, ΔT_c, and the change in pressure, Δp, was empirically found to be

$$\Delta T_c = 0.078(\Delta p)^{0.316}.$$

It is shown that if magnetic anisotropy and internal strains limit the magnetizing processes, the relation between coercive force, H_c, maximum flux density, B_m, and initial permeability, μ_0, is given by

$$H_c = \delta B_m/\mu_0,$$

where δ is a proportionality constant. The experimental results obtained over the entire range of temperature and pressure verify the above relation. The value of δ is 2.56 for the ferrite investigated. (*PA*, 1958, #5113)

1204. PREFERENTIAL VOLATILIZATION OF CATIONS FROM FERRITES DURING SINTERING

Brownlow, J. M.
***Journal of Applied Physics*, v. 29, no. 3, pp. 373–375, March 1958**

The abnormal plots of reduced magnetization vs. temperature for ferrites containing zinc are found to be

associated with a concentration gradient in zinc that is generated by the preferential loss of zinc during sintering. The variation of the gradient in samples of zinc–iron spinels is correlated with sintering and annealing treatment and with sample dimensions. (*PA*, 1958, #8898)

1205. SOME PROPERTIES OF QUENCHED MAGNESIUM FERRITES

Epstein, D. J. and Frackiewicz, B.
***Journal of Applied Physics*, v. 29, no. 3, pp. 376–377, March 1958**

A study has been made of the magnetic properties of the system of quenched magnesium ferrites $(Mg_x^{II}Fe_{1-x}^{III})(Mg_{1-x}^{II}Fe_{1-x}^{III})O_4$, where x, the fraction of magnesium ions in tetrahedral sites, varies from 0.14 to 0.26. Included among the properties examined are: saturation moment, Curie point, initial permeability, and coercive force. A limited study of the kinetics of the cation redistribution has also been made. Samples quenched from 1100°C and then tempered at 600°C require somewhat less than 16 hours to attain an equilibrium cation distribution at the latter temperature. The approach to equilibrium is consistent with a model in which the rate of approach is proportional to $\exp(-\theta_0' + \theta_1' x)/T$ where θ_0' and θ_1' are activation constants. (*PA*, 1959, #425)

1206. IONIC VALENCES IN MANGANESE–IRON SPINELS

Eschenfelder, A. H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 378–380, March 1958**

Because both manganese and iron assume multiple valences in oxide structures, it is possible to fabricate spinels over a continuous range of composition from Mn_3O_4 to Fe_3O_4. Magnetic-moment data for samples fabricated within this range are reported and an interpretation of the data in terms of the distribution of ions of manganese and iron is presented. The data agree with previous indications that manganese ferrite, $MnFe_2O_4$, is an almost completely normal spinel with Mn^{2+} on A sites and Fe^{2+} on B sites. In addition, the usual assumption that excess iron replaces manganese as Fe^{2+} on B sites is substantiated. However, the data are not compatible with the previously held assumption that Fe^{3+} is replaced by excess manganese as Mn^{3+}. Instead, the variation of magnetic moments and Curie temperatures with composition is interpreted in terms of a model in which excess manganese replaces Fe^{3+} as Mn^{4+} and an equal amount of iron is converted to Fe^{2+}. When the manganese content gets so high that all the iron is Fe^{2+} (Mn_2FeO_4), manganese then replaces the iron as Mn^{3+} and reconverts an equal amount of Mn^{4+} to Mn^{3+}, and the Mn^{3+}, because of its tetragonal nature, introduces spinel twinning. It is proposed that the Mn^{4+}–Fe^{2+} pair in octahedral coordination is stabilized with respect to a Mn^{3+}–Fe^{3+} pair because of the interaction of the manganese orbitals with the $2p$ orbitals of the surrounding oxygen anions. (*PA*, 1959, #426)

1207. SUBSTITUTION FOR IRON IN FERRIMAGNETIC YTTRIUM–IRON GARNET

Gilleo, M. A. and Geller, S.
***Journal of Applied Physics*, v. 29, no. 3, pp. 380–381, March 1958**

In yttrium-iron garnet, iron may be entirely replaced by aluminum and gallium; chromium, scandium, and indium may be substituted for iron to a limited extent. Substitution proceeds on a steric basis for the nonmagnetic ions: Al^{3+} and Ga^{3+}, which are smaller than Fe^{3+}, preferentially occupy the smaller, tetrahedrally coordinated positions, 24(d); the Sc^{3+} and In^{3+} ions, which are larger than Fe^{3+}, preferentially occupy the larger, octahedrally coordinated positions, 16(a). The Cr^{3+} ion, though smaller than Fe^{3+}, preferentially occupies the octahedral position, presumably because of its electronic configuration. The magnetic moment initially increases with octahedral substitution and decreases with tetrahedral substitution. The Curie temperature is decreased by the substitution of nonmagnetic ions for iron as a consequence of the decrease in the number of Fe^{3+}-O^{2-}-Fe^{3+} interactions. (*PA*, 1959, #427)

1208. EFFECT OF THERMAL HISTORY ON THE ANTIFERROMAGNETIC TRANSITION IN ZINC FERRITE

Grimes, D. M. and Vestrum, E. F., Jr.
***Journal of Applied Physics*, v. 29, no. 3, pp. 384–385, March 1958**

Quenched zinc ferrite is ferrimagnetic, annealed ferrite paramagnetic at 300°K. Although annealed zinc ferrite has a lambda-type heat capacity transition at about

9.5°K, quenched zinc ferrite retains only elementary vestigia of this transition. A similar effect exists in $Li_{0.05}Zn_{0.90}Fe_{2.05}O_4$ in which the transition temperature is slightly lowered relative to that of zinc ferrite. This temperature shift does not appear to exist for $Ni_{0.1}Zn_{0.9}Fe_2O_4$. The magnetic entropy at 300°K is essentially unaltered by lithium substitution or thermal history. (*PA*, 1958, #8900)

1209. MEASUREMENT OF THE PROPERTIES OF VARIOUS FERRITES USED IN MAGNETICALLY TUNED RESONANT CIRCUITS IN THE 2.5–45 Mc/s REGION

Lombardini, P. P., Schwartz, R. F., and Doviak, R. J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 395–396, March 1958**

An investigation was conducted to secure data for choosing the best ferrite to be used in the Penn-Princeton 3 Bev high-intensity proton synchrotron being built at Princeton University. The ferrite samples tested were from American and European manufacturers and were in the form of small rings 2 in. or less in diam. Measurements were required of μ and Q under varying magnetic bias, at various r.f. flux levels, in the band frequencies 2.5 to 45 Mc. At the beginning of this research no clear method existed for a proper choice of ferrite, and generally speaking the manufacturers' data were inadequate. Therefore a novel technique of measurement was devised, and an effort was made to establish a minimum number of parameters for defining ferrite properties for this application. A description of the techniques used is given, with a résumé of the results obtained. (*PA*, 1958, #8902)

1210. SPIN–LATTICE RELAXATION TIME IN YTTRIUM IRON GARNET

Farrar, R. T.

***Journal of Applied Physics*, v. 29, no. 3, pp. 425–426, March 1958**

The spin-lattice relaxation time in yttrium iron garnet (YIG) has been measured by a pulsed ferromagnetic resonance method similar to that of Bloembergen and Wang and Damon, in which the z component of magnetization is directly observed.

A microwave pulse with 2×10^{-8} sec rise and decay time, 5×10^{-7} sec long, and 2 w peak power is applied to a TE_{102} rectangular cavity operating at 9300 Mc. The z component of magnetization M_z changes at the beginning and at the end of the r.f. pulse. The time of decay of the changing M_z signal at the trailing edge of the pulse (at which time the applied r.f. field is zero) is a measure of the spin-lattice relaxation time.

A spherical sample of YIG, 0.03 in. diam, is placed in a quartz tube, 0.05 in. o.d., about which a five turn coil of No. 38 wire is wound. The coil with sample is inserted in the center of the cavity with the axis of the coil in the z direction. At this position, the r.f. magnetic field is maximum and the electric field is a minimum. The presence of the coil does not measurably change the properties of the cavity. The voltage induced in the coil is proportional to the change in M_z and is observed on a high speed oscilloscope. The time constant of the equipment is approximately that of the exciting pulse. Thus the spin-lattice relaxation time can be accurately determined directly if it is appreciably larger than this value.

The ferromagnetic resonance line width is 2.3 oersted and the measured spin-lattice relaxation time is 7×10^{-8} sec. Discussion is given relating these measurements to those reported in the accompanying papers. (*PA*, 1958, #8904)

1211. FERRIMAGNETIC RESONANCE IN GADOLINIUM IRON GARNET

Calhoun, B. A., Smith, W. V., and Overmeyer, J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 427–428, March 1958**

Ferrimagnetic resonance in single crystals of gadolinium iron garnet has been observed at 9479 and 23,725 Mc. Crystals from two different preparations have different compensation points (13 and 32°C). The resonance behavior is discussed in terms of a two sublattice theory. g_{Gd} is equal to 2,006 above −90°C and increases at lower temperatures. The gadolinium ions contribute to the anisotropy below −40°. An extra resonance observed near the compensation point is attributed to inclusions in the crystals. The gadolinium apparently contributes substantially to the total damping of the magnetization. (*PA*, 1958, #8871)

1212. FERROMAGNETIC RESONANCE IN YTTRIUM IRON GARNET AT LOW FREQUENCIES

Spencer, E. G., LeCraw, R. C., and Porter, C. S.
***Journal of Applied Physics*, v. 29, no. 3, pp. 429–430, March 1958**

Single crystals of yttrium iron garnet (YIG) exhibit the narrowest resonant line of all known ferromagnetic materials, being as low as 2.3 oersted for the full width at half height for polished spheres at 9300 Mc. Ferromagnetic resonance on polished YIG disks was observed at frequencies as low as 44 Mc, for an applied dc field of 1000 oersted. Conversely, resonance was observed for fields as low as 300 oersted, for a frequency of 2000 Mc.

Nonlinear effects in ferromagnetic materials can be evidenced by the excitation of unstable spin wave modes, such as were discovered at x band by Bloembergen and his colleagues. In their case the dc fields required for this subsidiary resonance were approximately one half that required for resonance of uniform precession. When measurements are made on a sphere at a frequency low enough so that $H_{res} < 8\pi M_s/3$, Suhl's theory shows that the dc field required for the minimum threshold of the subsidiary resonance is identical with that required for resonance of the uniform precession. In this case the critical r.f. fields required are particularly low being given in terms of the line width to an order of magnitude as $h_{crit} = \Delta H^2/4\pi M_s$.

Measurements have been made of h_{crit}, for the subsidiary resonance as a function of frequency for polished single crystal spheres of YIG. Based on a $4\pi M_s$ of 1725, the frequency below which coincidence of the uniform precession and subsidiary resonances occur, is 3220 Mc. Below 1610 Mc the dc fields for resonance are insufficient to saturate the sphere and domains are formed. Values are given for h_{crit}, spin-wave angle θ, and spin-wave number k for frequencies of 1610 to 3220 Mc. At 2200 Mc a min in h_{crit} occurs. At this frequency $h_{crit} = 2.0$ milli-oersted, the power incident on the cavity is 20 microwatts and the power absorbed by the sample is of the order of a microwatt. The experimental results are discussed in terms of Suhl's theory. (*PA*, 1959, #398)

1213. MICROWAVE PROPERTIES OF POLYCRYSTALLINE RARE EARTH GARNETS

Sirvetz, M. H. and Zneimer, J. E.
***Journal of Applied Physics*, v. 29, no. 3, pp. 431–433, March 1958**

A number of garnets including yttrium garnet, $Y_3Fe_5O_{12}$, and mixed garnets of the forms $(Y_{1-\alpha}Sm_\alpha)_3Fe_5O_{12}$ and $(Y_{1-\beta}Gd_\beta)_3Fe_5O_{12}$ were prepared. x-band ferromagnetic resonance and saturation magnetization were measured as a function of temperature. At room temperature samarium substitution for yttrium produces an approximately linear increase of line-width with samarium content with practically no change in magnetization. Gadolinium substitution, on the other hand, has a much smaller effect on line-width but produces an approximately linear decrease in saturation magnetization. Possible microwave application of these materials are discussed. (*PA*, 1959, #430)

1214. FERRIMAGNETIC RESONANCE IN SINGLE CRYSTALS OF RARE EARTH GARNET MATERIALS

Jones, R. V., Rodrigue, G. P., and Wolf, W. P.
***Journal of Applied Physics*, v. 29, no. 3, pp. 434–435, March 1958**

The preliminary results of a study of the ferrimagnetic resonance properties of single crystals of rare earth iron garnet containing samarium, gadolinium, dysprosium, holmium, erbium, and ytterbium are presented. The measurements were conducted in the temperature region from 77 to 550°K at microwave frequencies in the x-band. The effective g values and line widths are consistent with the previously reported measurements on polycrystalline samples. In this temperature region the anisotropy energy of the Sm, Gd, Er, and Yb crystals can be represented by the usual cubic form with a negative first order term. The line widths exhibit a large anisotropy which increases with decreasing temperature. (*PA*, 1959, #431)

1215. MAGNETOCRYSTALLINE ANISOTROPY OF Mg–Fe FERRITES: TEMPERATURE DEPENDENCE, IONIC DISTRIBUTION EFFECTS, AND THE CRYSTALLINE FIELD MODEL

Folen, V. J. and Rado, G. T.
***Journal of Applied Physics*, v. 29, no. 3, pp. 438–440, March 1958**

The magnetocrystalline anisotropy constant (K_1) and saturation magnetization (M_s) of magnesium–iron ferrite

monocrystals containing 6 to 50 mole percent magnetite were measured as a function of temperature (T) and ionic distribution. For crystals containing 6 to 25 mole percent magnetite, K_1 was found to vary more rapidly with temperature when the ionic distribution in a crystal corresponds to a relatively high M_s than when it corresponds to a relatively low M_s in the same crystal. The observed changes in K_1 resulting from alterations of the ionic distribution are shown to be consistent with a phenomenological one-ion anisotropy model. On this basis, the measurements yield a positive anisotropy for a ferric ion in a tetrahedral site (A) and a negative anisotropy for this ion in an octahedral site (B). Finally, the data obtained on one Mg-Fe ferrite crystal (containing 6 mole percent magnetite) were used in the Yosida-Tachiki anisotropy theory. The ferric ion cubic crystalline field splitting parameters a_A and a_B occurring in this theory were determined for two different states of ionic distribution in the crystal. It was found that $a_A = -0.0092$ cm^{-1} and $a_B = +0.0232$ cm^{-1} for the state corresponding to a relatively high M_s, and $a_A = -0.0135$ cm^{-1} and $a_B = +0.0250$ cm^{-1} for the state corresponding to a relatively low M_s. The theoretical anisotropy curves obtained by using these a values are in very good agreement with experiment. Furthermore, the a_B values agree with $a_B = +0.0205$ cm^{-1} determined by Low from paramagnetic resonance measurements on ferric ions in MgO. (*PA*, 1959, #399)

1216. EFFECT OF CATION VACANCIES ON THE MAGNETIC ANNEALING OF COBALT-SUBSTITUTED MAGNETITE

Bickford, L. R., Jr., Brownlow, J. M., and Penoyer, R. F.

***Journal of Applied Physics*, v. 29, no. 3, pp. 441–442, March 1958**

Five crystals of nominal composition $Co_{0.1}Fe_{2.9}O_4$, grown from the melt under different partial pressures of oxygen, were subjected to magnetic annealing at 100°C. The relaxation time characterizing the annealing process is shown to increase from several minutes for crystals known to contain cation vacancies to a value too large to be determined for a crystal essentially stoichiometric with respect to oxygen content. The observed changes in relaxation time and magnitude of the anneal-induced anisotropy are interpreted as the effect of cation vacancies on the ease of movement of cobalt ions between equivalent cation sites during the annealing process. (*PA*, 1958, #8905)

1217. MAGNETIZATION PROCESSES IN HEAT-TREATED SINGLE CRYSTAL COBALT FERRITE

Foner, S. and Artman, J. O.

***Journal of Applied Physics*, v. 29, no. 3, pp. 443–444, March 1958**

The results of a series of magnetization measurements, ranging from 4.2°K to 300°K, on a heat-treated single crystal of cobalt ferrite are summarized. A simple domain picture accounts for the results and agrees with many related experimental observations. Derived values of cubic anisotropy and induced uniaxial anisotropy are presented. Low-temperature hysteresis and remanance observations are also described. A mechanism which could account for the unusual magneto-thermally induced uniaxial behavior is outlined briefly. (*PA*, 1959, #456)

1218. CRYSTALLOGRAPHIC AND MAGNETIC STUDIES OF THE SYSTEM $(NiFe_2O_4)_{1-x} + (NiMn_2O_4)_x$

Baltzer, P. K. and White, J. G.

***Journal of Applied Physics*, v. 29, no. 3, pp. 445–447, March 1958**

The system $(NiFe_2O_4)_{1-x} + (NiMn_2O_4)_x$ was selected to study the role of the Mn^{3+} ion in determining the crystallographic and magnetic properties of spinels. The ionic distribution was investigated by means of X-ray diffraction. A cubic spinel structure is obtained throughout the system, the lattice parameter increasing monotonically with x from 8.34 to 8.39 Å. It is found that in the range $0 \leq x \leq 0.5$ that manganese progressively replaces iron on the six-coordinated sites. Whereas, in the range $0.5 \leq x \leq 1$, the manganese progressively replaces iron on the four-coordinated sites. Therefore, manganese is not able to displace nickel from the six-coordinated sites and $NiMn_2O_4$ is a cubic inverse spinel. These results are consistent with the thesis that the tetragonal distortions of $ZnMn_2O_4$, Mn_3O_4, $MgMn_2O_4$, and $Li_{0.5}Mn_{2.5}O_4$ are because of the six-coordinated sites in these compounds essentially all being occupied by manganese ions. Magnetostriction measurements were made as a function of applied field to determine the sign and order of magnitude of the magnetic anisotropy of the polycrystalline samples. The magnetic anisotropy is found to pass

through zero with increasing x, becoming highly positive ($K \cong +10^5$ ergs/cm^3) at $x = 0.5$. Heretofore only the Co^{2+} ion has been found to produce a positive anisotropy in the spinel structure. Magnetic moment measurements indicate that all of the manganese is trivalent in the range $0 \leq x \leq 0.5$. However, magnetic moment measurements over the range $0.5 \leq x \leq 1$ indicate that at $x = 1$, $NiMn_2O_4$, the manganese is divalent and quadravalent on the four-and six-coordinated sites respectively. $NiMn_2O_4$ appears to become ferrimagnetic at approximately 100°K. (*PA*, 1959, #432)

1219. ORIGIN OF MAGNETIC ANISOTROPY IN $Co_xFe_{3-x}O_4$

Slonczewski, J. C.
***Journal of Applied Physics*, v. 29, no. 3, pp. 448–449, March 1958**

A model is proposed to explain the large part of the ferromagnetic anisotropy energy of $Co_xFe_{3-x}O_4$ (where x is small) which is caused by the presence of Co^{2+}. The residual orbital angular momentum $\alpha (\sim 1)$ of Co^{2+} is constrained by the crystal field to lie parallel to the axis of threefold symmetry. Spin-orbit energy $\lambda L \cdot S$ couples the spin to this axis, accounting for the anisotropy energy. By fitting the theory to experimental anisotropy data, one finds that $|\alpha\lambda\ Co^{3+}| = 132$ cm^{-1}. The assumption that cations are mobile at higher temperatures leads to an explanation of the anisotropy induced by magnetic annealing. (*PA*, 1959, #400)

1220. RELATIONSHIP BETWEEN SINGLE CRYSTAL AND EFFECTIVE POLY-CRYSTALLINE ANISOTROPY CONSTANTS IN FERRITES

Kriessman, C. J., Harrison, S. E., and Belson, H. S.
***Journal of Applied Physics*, v. 29, no. 3, pp. 452–453, March 1958**

In polycrystalline ferrites the natural spin resonance of electrons in the effective resonance field, detected by initial permeability measurements, allows the determination of an effective anisotropy constant, K_e. It is shown from measurements of K_1 on single crystals by microwave techniques that $K_e = 2K_1$. This result is based on work on $Mn_{1+x}Fe_{2-x}O_4$, $NiFe_2O_4$, and $MgFe_3O_4$. (*PA*, 1959, #8906)

1221. PREPARATION AND PROPERTIES OF CRYSTAL-ORIENTED FERROXPLANA SAMPLES

Stuijts, A. L. and Wijn, H. P. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 468–469, March 1958**

Samples of the hexagonal ferroxplana materials (a generic name of new groups of soft magnetic oxidic materials with hexagonal crystal structure), with a preferential plane for the magnetization, show an increased resonant frequency compared to samples of cubic ferrites with the same permeability. It appeared possible to use the large stiffness for rotation of the magnetization out of the preferential plane, in order to orientate the single crystal particles of a ferroxplana powder in a magnetic field. In this way samples with two different textures were obtained. In one case the basal planes of the crystals have one direction more or less in common (fan texture); in the other case all basal planes lie more or less parallel to each other (foliate texture). In both cases the permeability is appreciably increased, while the resonant frequency is only slightly decreased. Permeabilities of 56 at 90 Mc and 28 at 230 Mc, both for tan $\sigma = 0.1$, were found. This large increase in permeability is caused mainly by an elimination of the effect of the anisotropic permeability of the crystals. (*PA*, 1959, #2509)

1222. EFFECT OF COBALT ON THE RELAXATION FREQUENCY OF NICKEL ZINC FERRITE

Schnettler, F. J. and Monforte, F. R.
***Journal of Applied Physics*, v. 29, no. 3, pp. 477–478, March 1958**

The complex permeabilities of a number of Ni-Zn-Co ferrites were measured as a function of frequency from 0.1 to 250 Mc. These ferrites were prepared under identical conditions from reagent grade chemicals. Their compositions differed in the relative amounts of cobalt, nickel and zinc they contained, the amount of iron being held constant. A number of specimens of each composition were prepared at different firing temperatures, so as to include a variation in the degree of reaction. An analysis of the data was made in which the initial permeability and relaxation frequency were correlated with certain composition and structure variables. They include the

quantity of cobalt, the nickel–zinc ratio, the firing temperature, and the amount of shrinkage which occurred during firing. It was found that these variables would account for 86 percent of the variations of the initial permeability and 70 percent of the variations of the relaxation frequency. A further result of the analysis defines the conditions for obtaining maximum quality ($\mu_0 f_0$) at a given value of initial permeability. (*PA*, 1958, #8907)

1223. ANTIFERROMAGNETIC DOMAIN WALLS AND THE MAGNETIZATION PROCESS IN α-Fe_2O_3

Jacobs, I. S. and Bean, C. P.
***Journal of Applied Physics*, v. 29, no. 3, pp. 537–538, March 1958**

The magnetic properties of α-Fe_2O_3 are of interest since it is a prototype of the class of antiferromagnetic substances possessing a weak ferromagnetism superimposed on the normal antiferromagnetic susceptibility. Two possible sources of the weak ferromagnetism, i.e. moment bearing antiferromagnetic domain walls and special ferromagnetic forms of Fe_2O_3, are considered from the standpoint of their magnetization processes. It is noted that moment-bearing or non-moment-bearing domain walls may be required by the presence of certain edge and screw dislocations. The net moment of a domain wall may reverse by a wall displacement process or by the motion of a boundary within the domain wall, i.e. a Bloch line. Measurement of the rotational hysteresis in α-Fe_2O_3 proves that the weak ferromagnetism is not caused by a nonepitaxial second phase ferrimagnetic impurity. It is concluded that the behavior of α-Fe_2O_3 at room temperature can be ascribed to moment bearing domain walls magnetizing by Bloch line motion, and/or ferrimagnetic Fe_2O_3 basal intergrowths in exchange contact with the antiferromagnetic lattice (Meiklejohn effect). The low-temperature state can also be qualitatively understood with this model. (*PA*, 1959, #460)

1224. PYROMAGNETIC EFFECT: A METHOD FOR DETERMINING CURIE POINTS

Chynoweth, A. G.
***Journal of Applied Physics*, v. 29, no. 3, pp. 563–566, March 1958**

A dynamic technique has been developed for studying the pyromagnetic effect (the change in the intensity of magnetization, I, with temperature, T). The thermal transients produced a crystal of gadolinium iron garnet when subjected to brief, intense, flashes of light, result in transient changes in the intensity of magnetization. The magnitude of the signal picked up by the detector coil is determined by the pyromagnetic coefficient (dI/dT), and the rate of change of the temperature. No externally applied magnetic field is necessary to obtain these signals and, furthermore, the net state of magnetization of the crystal is determined nondestructively. As (dI/dT) possesses a very sharp peak at the Curie point, the latter can be determined simply and with some precision; the actual temperature change produced in the crystal by the light can be kept to a small fraction of a degree. The Curie point for gadolinium iron garnet was found to be $564 \pm 3°K$. The technique may prove to be useful for studying the behavior of (dI/dT) at low temperatures. (*PA*, 1959, #435)

1225. MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF SUBSTITUTED YTTRIUM–IRON GARNET

$3\,Y_2O_3 \cdot xM_2O_3 \cdot (5 - x)\,Fe_2O_3$
Gilleo, M. A. and Geller, S.
***The Physical Review*, v. 110, no. 1, pp. 73–78, April 1, 1958**

A solid solution of yttrium–iron garnet with yttrium–gallium or yttrium–aluminum garnet is formed over the entire range of composition; the lattice constant variation is nearly linear. The trivalent ions, Sc^{3+}, In^{3+} and Cr^{3+} may be substituted for Fe^{3+} to a limited extent. Substitution proceeds on a steric basis for nonmagnetic ions; those smaller than Fe^{3+}, namely Al^{3+} and Ga^{3+}, preferentially occupy the smaller, tetrahedrally coordinated sites, 24(d); larger ions, In^{3+} and Sc^{3+}, preferentially occupy larger, octrahedrally coordinated sites, 16(a). The Cr^{3+} ion, though smaller than Fe^{3+}, preferentially occupies the octahedral site, presumably because of its electronic configuration. The magnetic moment initially rises with octahedral substitution of nonmagnetic ions and falls with tetrahedral substitution because the moment corresponds to the difference in the moments of the Fe^{3+} ions in the two octahedral sites and the three tetrahedral sites per formula unit, $Y_3Fe_2(FeO_4)_3$. The Curie temperature is decreased by the substitution of nonmagnetic ions for iron on account of the decrease in the number of Fe^{3+}–O^{2-}–Fe^{3+} interactions. (*PA*, 1958, #8913)

1226. MAGNETO-ACOUSTIC RESONANCE IN YTTRIUM IRON GARNET
Spencer, E. G. and LeCraw, R. C.
***Physical Review Letters*, v. 1, p. 241, 1958**

1227. ON THE MAGNETIC BEHAVIOUR OF FERROUS FLUOSILICATE
Palumbo, D.
***Il Nuovo Cimento*, v. 8, no. 2, pp. 271–281, April 16, 1958**

A theoretical interpretation of some new results of Jackson on the temperature dependence of the susceptibility of $FeSiF_6 \cdot 6H_2O$, parallel and perpendicular to the crystal axis, over the range 1.57°K to room temperature. The lower energy levels of the Fe^{++} ion are studied when a trigonal component T is included in the crystal field. Spin-Hamiltonians are defined for the cases when T is: (a) much stronger than the spin–orbit interaction and (b) of the same order. In both cases the calculated susceptibility is in qualitative agreement with experiment but good quantitative agreement is obtained only in case (a). One of the three parameters involved is introduced to take approximate account of the effect of covalent bonds. (*PA*, 1958, #6050)

1228. EFFECTS OF SOME ADDITIONS ON MAGNETIC PROPERTIES OF Ba AND Sr OXIDE MAGNETS
Kojima, H.
***Science Reports of Research Institutes*, Tohoku University, Series A, v. 10, no. 2, pp. 175–182, April 1958**

It was found that additions of SiO_2, B_2O_3, GeO_2 and Cr_2O_3 are fairly effective while CdO, SnO, CoO and CuO are not effective; V_2O_5 has very damaging influence upon technical magnetic properties of Ba and Sr oxide magnets. (*EI*, 1958)

1229. MAGNETICALLY SOFT FERRITES
Williams, M. O.
***ATE Journal* (Automatic Telephone and Electric Co., Liverpool), v. 14, no. 2, pp. 129–144, April 1958**

Elements of modern theory of ferro- and ferrimagnetism, and principles that have guided development of modern ferrites; their special properties at frequencies above those at which conventional magnetic materials are applicable are examined and related to modern theory. (*EI*, 1958)

1230. MAGNETIC MATERIALS WITH THE PERMINVAR EFFECT. III. THE DEPENDENCE BETWEEN OVER-STOCHIOMETRIC OXYGEN CONTENT AND PERMINVAR EFFECT IN FERRITES CONTAINING COBALT
von Kienlin, A.
***Zeitschrift für angewandte Physik*, v. 10, no. 4, pp. 167–169, April 1958 (in German)**

Hysteresis loop measurements on specimens of magnetite and a mixed ferrite, each containing small amounts of cobalt are reported. The contribution of metal ion vacancies to the Perminvar effect in these materials is discussed. (*PA*, 1959, #5894)

1231. THE SUBSTITUTION OF Fe BY Al, Ga AND Cr IN BARIUM HEXAFERRITE $BaO \cdot 6Fe_2O_3$
Bertaut, F., Deschamps, A., and Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 18, pp. 2594–2597, May 5, 1958 (in French)**

Reports results of measurements of the saturation magnetization, the lattice parameters and X-ray intensities of $BaO \cdot (6 - x)Fe_2O_3 \cdot xM_2O_3$, and draws conclusions as to the distribution of the M ions among the lattice sites. (*PA*, 1958, #7194)

1232. DOMAIN PATTERNS ON A SINGLE CRYSTAL OF MANGANESE FERRITE
Bates, L. F., Craik, D. J., and Griffiths, P. M.
***Proceedings of the Physical Society*, London, v. 71, Part 5, pp. 789–796, May 1958**

Powder patterns were obtained on the cleaved surface of a single crystal of manganese ferrite by using a modification of the normal powder-pattern technique. Two types of patterns were observed, a large scale pattern having a "fern"-like structure, and an underlying structure of exceptional fineness and unusual configuration. (*PA*, 1958, #4152)

1233. FERRIMAGNETIC FLUORIDE—$Na_5Fe_3F_{14}$
Knox, K. and Geller, S.
***The Physical Review*, v. 110, no. 3, pp. 771–772, May 1, 1958**

A preliminary announcement of relatively strong ferrimagnetism with a Curie point about 80°K, and a discussion of the possible crystal structure. (*PA*, 1958, #6048)

1234. THE COMPLEX DIELECTRIC CONSTANT AND PERMEABILITY OF Ni–Cd FERRITE SYSTEM AT MICROWAVE FREQUENCIES
Takemoto, S.
***Memoirs of the College of Science*, University of Kyoto, A, v. 28, no. 4, pp. 327–335, May 1958**

The dielectric constant and permeability of the polycrystalline sintered ferrite system $Ni_{1-x}Cd_xFe_2O_4$ at 9300 and 24,000 Mc were measured at room temperature. The mechanisms of conductivity and of dispersion of permeability at microwave frequencies are discussed, and the relationship between conductivity and dielectric constant are also discussed. (*PA*, 1959, #4548)

1235. MAGNETIC SPECTRA OF MANGANESE FERRITES
Harrison, S. E., Kriessman, C. J., and Pollack, S. R.
***The Physical Review*, v. 110, no. 4, pp. 844–849, May 15, 1958**

The complex initial permeability of a series of polycrystalline manganese-rich manganese ferrites ($Mn_{1+x}Fe_{2-x}O_4$) was measured between 20 and 200 Mc. Three resonances are detected; the two lower-frequency resonances, which occur below 200 Mc, are associated with domain wall motion. The higher-frequency resonance, which varies between 300 and 600 Mc depending on the composition, allows the calculation of an effective polycrystalline anisotropy constant, K_e. Microwave resonance measurements on single crystals of the same composition give the real anisotropy constant K_1. Comparison of these two experiments shows that $K_e \approx 2K_1$. Measurement of the magnetic moment indicates that in these compounds the Mn^{3+} ion assumes a value of approximately two Bohr magnetons instead of the expected four Bohr magnetons. (*PA*, 1959, #443)

1236. ORIGIN OF MAGNETIC ANISOTROPY IN COBALT-SUBSTITUTED MAGNETITE
Slonczewski, J. C.
***The Physical Review*, v. 110, no. 6, pp. 1341–1348, June 15, 1958**

The large part of the ferromagnetic anisotropy of $Co_xFe_{3-x}O_4$ attributed to the presence of Co^{2+} is explained, for small x, by means of a one-ion model. The residual orbital angular momentum $\alpha(\cong 1)$ of Co^{3+} is constrained by the crystal electric field to lie parallel to the axis of trigonal symmetry. Spin-orbit energy $\lambda L \cdot S$ couples the spin to this axis, accounting for the anisotropy energy. By fitting the theory to cubic anisotropy data one finds $\alpha\lambda = -132$ cm^{-1}. The assumption that cations are mobile at higher temperatures leads to a quantitative explanation of the annealing-induced anisotropy energy. The mean orbital magnetic moment μ_L of Co^{2+} is predicted to be large ($\mu_L \cong 0.5$ Bohr magneton) and anisotropic ($\Delta\mu_L \cong 0.1$ Bohr magneton) at low temperatures. (*PA*, 1958, #5116)

1237. DIPOLAR ENERGY. APPLICATION TO THE MAGNETOSTATIC ENERGY OF α-Fe_2O_3
Bertaut, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 24, pp. 3335–3337, June 16, 1958 (in French)**

The dipole interaction cannot account for the weak ferromagnetism nor the magnetic anisotropy of haematite. (*PA*, 1958, #7170)

1238. LOW-FREQUENCY ROTATIONAL HYSTERESIS LOSSES IN FERRITES
Seiwatz, H.
***Journal of Applied Physics*, v. 29, no. 6, pp. 994–995, June 1958**

Rotational hysteresis losses in various ferrites were measured in the frequency range from 5 to 55 cps using magnetic field strengths up to 11,000 oersted. For sufficiently strong magnetic fields, the rotational hysteresis losses are found to become independent of magnetic field strength. In some ferrites the rotational hysteresis loss per cycle is found to be essentially independent of frequency. (*PA*, 1958, #7178)

1239. MAGNETIZATION IN SINGLE CRYSTALS OF SOME RARE-EARTH ORTHOFERRITES
Bozorth, R. M., Kramer, V., and Remeika, J. P.
***Physical Review Letters*, v. 1, no. 1, pp. 3–4, July 1, 1958**

Describes results of measurements between 1.3°K and room temperature for different directions in crystals of $MFeO_3$ (M = Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu); the results are discussed in terms of the orbital moment and the crystalline anisotropy due to spin–orbit coupling. For some of the ferrites the moment becomes large (up to 3 μ_B) at low temperatures, and thus ceases to be "parasitic". (*PA*, 1958, #6043)

1240. MAGNETIC MATERIALS FOR USE AT HIGH MICROWAVE FREQUENCIES (50–90 kMc/sec)
du Pré, F. K., De Bitetto, D. J., and Brockman, F.G.
***Journal of Applied Physics*, v. 29, no. 7, pp. 1127–1128, July 1958**

Experiments show that by suitable partial substitution of Fe_2O_3 by Al_2O_3 in oriented ferroxdure, $BaO \cdot 6Fe_2O_3$, the no-field resonance frequency can be made to occur at any frequency in the 50–90 kMc range. A similar effect is found in $SrO \cdot 6Fe_2O_3$. (*PA*, 1958, #7179)

1241. NEUTRON STUDIES OF MAGNETISM
Ericson, M., De Gennes, P. G., Herpin, A., Jacrot, B., and Mériel, P.
***Journal de Physique et le Radium*, v. 19, no. 7, pp. 617–623, July 1958 (in French)**

Describes two series of experiments on neutron scattering by magnetic substances. Series A gives the antiferromagnetic structure of $FeCl_2$, and the effect of a magnetic field on the spin orientations as measured with a crystal spectrometer. In series B, the critical magnetic scattering of iron near the Curie point was investigated with a time of flight spectrometer. The result gives both the range of the spin correlations and the scattering constant which is related to their decay in time. (*PA*, 1959, #4783)

1242. RELATION BETWEEN DISACCOMMODATION AND MAGNETIC PROPERTIES OF MANGANESE–FERROUS FERRITE
Enz, U.
***Physica*, v. 24, no. 7, pp. 609–624, July 1958**

Initial permeability, crystalline anisotropy and magnetostriction were measured on a single crystal of manganese–ferrous ferrite. The initial permeability shows a high disaccommodation, i.e., a decrease with time. This decrease can be as high as 95 per cent of the value immediately after demagnetization. Disaccommodation is a time-dependent blocking of domain walls, the cause of which is supposed to be a transition of electrons between different ions. The blocked walls cause constricted minor hysteresis loops which indeed have been found. Manganese–ferrous ferrites have in general an extra peak of the permeability as a function of temperature not understood up till now. It is shown that this is an effect of disaccommodation. (*PA*, 1958, #7181)

1243. THEORY OF THE ANISOTROPY OF THE FERROMAGNETIC RESONANCE ABSORPTION LINE WIDTH
Skrotskii, G. V. and Kurbatov, L. V.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 1 (7), pp. 216–220, 1958 (in Russian)**

The dependence of the width of a resonance absorption line on the internal field is derived by using the Landau–Lifshits equations. As examples ferrites of single-axis and cubic symmetry are considered. (*PA*, 1959, #2495)

1244. THE INTERPRETATION OF THE MAGNETIC PROPERTIES OF ERBIUM GARNET IN WHICH Al^{2+} AND Cr^{3+} IONS HAVE BEEN SUBSTITUTED FOR Fe^{3+}
Villers, G., Loriers, J. and Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l' académie des sciences*, Paris, v. 247, no. 5, pp. 587–590, August 4, 1958 (in French)**

A series of compounds were prepared with the formula $(5 - x)Fe_2O_3$, $x\ Me_2O_3$, $3Er_2O_3$ in which Me designates Al or Cr and x varies between 0 and 1. Measurements were made of the spontaneous magnetization temperature of compensation and the Curie temperatures. The results can be interpreted by supposing that the Al^{2+} ions occupy tetrahedral sites and the Cr^{3+} ions octahedral sites. (*PA*, 1959, #3638)

1245. FERROMAGNETIC RESONANCE IN SOME FERRITES AT LOW TEMPERATURES
Krivko, N. I.
***Zhurnal Tekhnicheskoi Fiziki*, v. 28, no. 8, pp. 1703–1710, 1958 (in Russian)**

Results are reported of an experimental investigation on ferromagnetic resonance at low temperatures at a frequency of approximately 9.4 Gc/s. The materials studied included Ni–Zn and Li–Zn ferrites with different molar percentages of the constituent components. The basic parameters were g-factor and T, the relaxation time determined according to Pilschikov's formula, from the extremes of the curves of loss and dispersion. The relaxation times were shown to have a weak temperature dependence and a value of the order of 10^{-9} sec at 4.2°K. An interesting fact was the observation of a reduction in g-factor with decreasing temperature for ferrites of the following composition: 16.7% NiO, 37.3% ZnO, 46% Fe_2O_3; 18% NiO, 42% ZnO, 40% Fe_2O_3; 20% Li_2O, 80% Fe_2O_3. An explanation for this reduction can be found on the basis of allowing for interaction between the sublattices in the real ferrite lattice. (*PA*, 1959, #449)

1246. MAGNETIZATION PROCESSES IN A POLYCRYSTALLINE MANGANESE ZINC FERRITE
Bates, L. F., Clow, H., Craik, D. J., and Griffiths, P. M.
***Proceedings of the Physical Society*, London, v. 72, Part 2, pp. 224–232, August 1958**

A description is given of Bitter figure, magneto-thermal and Barkhausen studies of the behavior of a polycrystalline manganese zinc ferrite during magnetization, from which it is concluded that the processes of magnetization are entirely rotational. (*PA*, 1958, #8140)

1247. FERRIMAGNETISM IN THE SYSTEM Na_2O_3–ZnO–Fe_2O_3
Mones, A. H. and Banks, E.
***Journal of Physics and Chemistry of Solids*, v. 6, no. 2–3, pp. 267–270, August 1958**

Mixtures of Na_2CO_3, ZnO, and Fe_2O_3 were fired at elevated temperatures in a flowing oxygen atmosphere. Most of the preparations resulted in single phases with the spinel structure, which were strongly magnetic. The intensity of magnetization of the materials could be accounted for on the basis of Néel's theory for ferrimagnetism. It was found that when K_2CO_3 was substituted for Na_2CO_3 a nonmagnetic material resulted. MgO could be substituted for ZnO with the retention of strong magnetic properties. (*PA*, 1959, #8322)

1248. FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE FERRITES WITH LARGE ANISOTROPY. I. GENERAL THEORY AND APPLICATION TO CUBIC MATERIALS WITH A NEGATIVE ANISOTROPY CONSTANT
Schlomann, E.
***Journal of Physics and Chemistry of Solids*, v. 6, no. 2–3, pp. 257–266, August 1958**

If the anisotropy field is much larger than the single-crystal line width and the saturation magnetization, the shape of the resonance line is essentially determined by the spreading of resonance frequencies for different grains due to crystalline anisotropy. More precisely, if $w(H)dH$ is proportional to the number of grains that have their resonance in the range of applied dc field between H and $H + dH$, the absorption versus field curve should be a smeared-out image of the distribution function $w(H)$. The distribution function has characteristic singularities arising from the stationary points of the resonance field versus orientation surface. The behavior of $w(H)$ in the vicinity of the singularities is calculated for first-order cubic anisotropy, and $w(H)$ is obtained by interpolation. For small anisotropy fields, the calculated line shape has a single peak which corresponds to grains in which a [110] direction is aligned with the dc field. For larger anisotropy fields ($\lambda H_a/\omega > 0.5$), a secondary peak occurs. It corresponds to grains in which an easy axis is aligned with the dc field. The theory accounts for secondary resonance peaks at low fields observed in ferrimagnetics near the compensation point. (*PA*, 1959, #8328)

1249. EFFECT OF DIVALENT ION SUBSTITUTIONS ON THE MAGNETO-MECHANICAL PROPERTIES OF NICKEL FERRITE
Ferebee, S. F. and Davis, C. M., Jr.
***Journal of the Acoustical Society of America*, v. 30, no. 8, pp. 747–750, August 1958**

Magnetostrictive properties of cobalt-substituted nickel ferrous-ferrite were investigated to determine its suit-

ability for use in electromechanical transducers. Toroidal samples were sintered at 1400°C and cooled by quenching in air. The following parameters were measured and compared with the corresponding parameters of previously investigated magnetostrictive materials: electromechanical coupling coefficient, reversible permeability, dynamic magnetostrictive constant, maximum stress, and the product of characteristic frequency times the thickness squared. The results of the investigation indicate that a ferrite having the formula $(NiO)_{1-x-y}(CoO)_x(FeO)_y(Fe_2O_3)$ with $0.015 \leq x \leq 0.04$ and $0.02 \leq y \leq 0.065$ moles per mole of ferrite meets the requirements for transducer applications. The electromechanical coupling coefficient for this range of compositions varies from 0.28 to 0.37. The value of the characteristic frequency times the thickness squared (4200) is approximately 1700 times that of nickel. The maximum stress increases with ferrous iron, reaching a value of 68×10^6 dyn/cm² for 0.06 mole of FeO per mole of ferrite as compared with 32×10^6 dyn/cm² for no ferrous iron. (*PA*, 1958, #8143)

1250. EINFLUSS DER GLUEHGASE AUF DIE MAGNETISCHEN EIGENSCHAFTEN DER FERRITE

Heck, C. and Weber, H.

***Archiv für das Eisenhuettenewesen*, v. 29, no. 8, pp. 495–504, August 1958**

Factors affecting magnetic properties of ferrites, particularly gases during sintering; permeability and hysteresis losses of Mn–Zn ferrites; importance of oxygen and of specimen surface area vs. volume. (*EI*, 1958)

1251. FIELD DEPENDENCE OF NEUTRON SCATTERING BY SPIN WAVES

Brockhouse, B. N.

***The Physical Review*, v. 111, no. 5, pp. 1273–1274, September 1, 1958**

The energy distribution of neutrons scattered in the vicinity of the 111 reciprocal lattice point of magnetite have been measured with and without a magnetic field along the scattering vector. The intensity with a magnetic field was greater than with no field by a factor of 1.41 in approximate agreement with the theoretical value of 1.5, showing that one-quantum spin wave scattering depends on the orientation of the spin system in the way predicted by theory. For spin waves of very low energy, competing effects of opposite sign apparently exist which render small the over-all effect of a magnetic field on the diffuse scattering. (*PA*, 1959, #3628)

1252. FERRIMAGNETIC RESONANCE IN YTTRIUM IRON GARNET AT LIQUID HELIUM TEMPERATURES

Dillon, J. F., Jr.

***The Physical Review*, v. 111, no. 6, pp. 1476–1478, September 15, 1958**

Ferrimagnetic resonance experiments were performed on single crystal spheres of yttrium iron garnet $[Y_3Fe_2(FeO_4)_3]$ at 24kMc. At 4.2° the line width measured with the steady field along [100] is 15 oersted as compared with 30 oersted at 295°, 400 oersted at 65°K. At liquid helium temperatures the crystal is apparently cubic. There is a strong anisotropy in line width. Except for the case of the field along [100], the line width varies strongly with temperature in this temperature region. A large magnetocrystalline anisotropy is indicated by the variation in field for resonance with direction. This ranges over 3000 oersted. The maxima and minima in this field indicate that terms of higher order than the K_1 and K_2 terms used hitherto will be necessary for the description of the anisotropy energy surface. Thus, at 4.2°K, apparently [100], [110], and [111] are all hard directions, and the easy directions are exactly or close to [112], [221], and [123]. (*PA*, 1959, #4812)

1253. FERROMAGNETIC CERAMICS

Economos, G.

***Materials in Design Engineering*, v. 48, no. 3–4, pp. 96–101, September 1958, pp. 109–114, October 1958**

The following subjects are discussed: how ferrites work; typical properties of proprietary grades of soft ferrites supplied by various manufacturers; applications; properties of commercial square loop ferrites, microwave ferrites and permanent magnet ceramics. (*EI*, 1958)

1254. MAGNETOSTATIC MODES IN FERRIMAGNETIC SPHERES

Dillon, J. F., Jr.

***The Physical Review*, v. 112, no. 1, pp. 59–63, October 1, 1958**

Ferrimagnetic resonance experiments (9000 Mc, 300°K) were performed using single-crystal spheres of yttrium iron garnet. RF magnetic fields of several different con-

figurations were used to excite specific magnetostatic modes. A mounting technique was employed such as to eliminate dielectric inhomogeneities near the sample. Such inhomogeneities arise from the usual quartz or sapphire mounting rods. They have been observed to be responsible for the excitation of more complicated modes than would be expected from the unperturbed cavity fields. It was found that supposedly spherical specimens produced by the usual tumbling procedures deviate slightly from true sphericity. In these experiments highly polished truly spherical samples were used. With these conditions there is no ambiguity about the identity of the mode representing the spacially uniform precession of the entire spin system. The spacings of the various modes do not vary with the crystal direction along which H_{dc} is applied. These results contrast with those of White and Solt on manganese ferrite in several respects, viz. the clear identity of the uniform precession and the constant mode spacing for the various crystal directions. (*PA*, 1959, #4813)

1255. MAGNETIZATION STUDIES AND POSSIBLE MAGNETIC STRUCTURE OF BARIUM FERRATE III

Henry, W. E.

***The Physical Review*, v. 112, no. 2, pp. 326–327, October 15, 1958**

An approach to the absolute saturation magnetization of polycrystalline, magnetically hard $BaO \cdot 6Fe_2O_3$ was achieved by using magnetic fields up to 60,000 gauss and temperatures down to 1.3°K where the saturation magnetization and remanence (about one-half of the saturation magnetization) become temperature-independent. The magnetization in the highest fields approaches 1.64 Bohr magnetons per atom of Fe at 1.3°K and 1.13 at 295°K. Inferences are drawn as to a possible magnetic structure from such a saturation magnetization. A sample displacement ballistic technique is used. (*PA*, 1959, #4800)

1256. MAGNETIC ANISOTROPY CONSTANT OF YTTRIUM IRON GARNET AT 0°K.

Cooper, B. R.

***The Physical Review*, v. 112, no. 2, pp. 395–396, October 15, 1958**

The anisotropy energy of yttrium iron garnet is separated into two parts, the normal part predominant at high temperatures, and the anomalous part important below 50°K. By comparison with ferrite data, the cause of the normal anisotropy is expected to be the coupling of the Fe^{3+} ions to the crystalline field. The following expressions for K_1, the first-order anisotropy constant, as a function of the fine structure coupling constants a_{24} (tetrahedral sites) and a_{16} (octahedral sites) is obtained: K_1/unit cell $= -46.6a_{24} - 13.6a_{16}$. (*PA*, 1959, #4798)

1257. LOW-TEMPERATURE TRANSITION OF MAGNETIC ANISOTROPY IN NICKEL–IRON FERRITE

Menyuk, N. and Dwight, K.

***The Physical Review*, v. 112, no. 2, pp. 397–405, October 15, 1958**

A study of the magnetic properties of single crystal samples with the composition

$$Fe_{1.00}^{3+}[Ni_{0.79}^{2+}Fe_{0.36}^{2+}Fe_{0.90}^{3+}]O_4$$

has revealed an abrupt transition in the magnetic anisotropy characteristics at 10°K. Above this temperature the anisotropy energy is small and has cubic symmetry; below 10°K the anisotropy energy increases rapidly with decreasing temperature and contains a uniaxial annealing term in addition to the cubic terms. The uniaxial term is of the form $\Sigma_i \alpha_i^2 \beta_i^2$, where α_i and β_i are the direction cosines of the magnetization at the measuring temperature and at the annealing temperature, respectively. The observed characteristics of this material below the transition cannot be explained on the basis of long-range order. A model is proposed which assumes the excess cations of the sample to be located at normally vacant octahedral lattice sites. The theory of magnetic anneal introduced by Taniguchi and Yamamoto, and independently by Néel, is then applied to this model. The resulting predictions are in accord with our experimental findings. (*PA*, 1959, #4799)

1258. TEMPERATURE DEPENDENCE OF THE PARAMAGNETIC SUSCEPTIBILITY OF NICKEL–ZINC FERRITES

Chechernikov, V. I. and Volkov, Yu. D.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 4 (10), pp. 875–879, 1958 (in Russian)**

An investigation of the temperature dependence of the paramagnetic susceptibility of nickel–zinc ferrites was carried out. The results of the measurements are in good agreement with theory. (*PA*, 1959, #2506)

1259. FERRITE LINE WIDTH MEASUREMENTS IN CROSS-GUIDE COUPLER
Stinson, D. C.
***IRE Transactions on Microwave Theory and Techniques*, v. MTT-6, no. 4, pp. 446–450, October 1958**

Theoretical and experimental results presented to show that line width and g factor of spherical ferrite sample can be measured in cross-guide coupler; method is much easier to instrument than usual cavity method and measurements are much easier to perform; experimental vertification with cavity perturbation system indicates that measured quantities are sufficiently accurate for most purposes. (*EI*, 1958)

1260. MEASUREMENTS OF THE PERMEABILITY TENSOR FOR "FERROXCUBE" AT 24,000 Mc/s
Robbrecht, G. G. and Verhaeghe, J. L.
***Nature*, v. 182, p. 1080, October 18, 1958**

Spheres and disks of Ferroxcube IVB were placed in a reflection cavity in magnetic fields up to 15000 oersted, and the absorption of circularly polarized microwave radiation was measured. The real and imaginary parts of the effective permeability were deduced and a g-value of 2.11 was calculated. (*PA*, 1959, #2498)

1261. VARIATION OF THE g-FACTOR OF YTTRIUM GARNET IN WHICH THE Cr^{3+} IONS HAVE BEEN SUBSTITUTED FOR THE Fe^{3+} IONS
Vautier, R. and Berteaud, A. J.
***Comptes rendus hebdomadaires des séances de l' académie des sciences*, Paris, v. 247, no. 17, pp. 1322–1324, October 27, 1958 (in French)**

Values of g measured at a wavelength of 3 cm and extrapolated to zero specimen diameter increase with the amount of chromium added, but in a non-uniform manner. (*PA*, 1959, #2497)

1262. MAGNETIC STRUCTURES OF Fe_4N
Frazer, B. C.
***The Physical Review*, v. 112, no. 3, pp. 751–754, November 1958**

Examined in a neutron diffraction study. The results are in agreement with a model proposed by Wiener and Berger on the basis of magnetic measurements on a series of related compounds. Ferromagnetically aligned moments of $3\mu_B$ and $2\mu_B$ are found for the corner and face-center Fe atoms (respectively) in the cubic unit cell. The difference in moments is apparently due to bonding interaction between nitrogen, at the body-center position, and the face-center Fe atoms, (*PA*, 1959, #4801)

1263. THE VARIATION OF THE WIDTH OF THE ABSORPTION CURVE OF YTTRIUM IRON GARNET WITH SUBSTITUTION OF Cr^{3+}
Vautier, R. and Berteaud, A. J.
***Comptes rendus hebdomadaires des séances de l' académie des sciences*, Paris, v. 247, no. 19, pp. 1574–1577, November 10, 1958 (in French)**

Measurements were made at 8915 Mc. The variations can be explained by the variation of density with the percentage of chromium. (*PA*, 1959, #4811)

1264. ORIGIN OF WEAK FERROMAGNETISM IN RARE-EARTH ORTHOFERRITES
Bozorth, R. M.
***Physical Review Letters*, v. 1, no. 10, pp. 362–363, November 15, 1958**

The compounds have the formula $MFeO_3$ with M = Sm(62) to Lu(71) inclusive. An argument is given to show that the ferromagnetism is due to the disturbing action of the crystal field on the much stronger exchange field. The direction of the spontaneous moment depends on the type of ordering and also on the direction of the Fe^{3+} ions. (*PA*, 1959, #2500)

1265. MAGNETIC STRUCTURE AND VACANCY DISTRIBUTION IN γ-Fe_2O_3 BY NEUTRON DIFFRACTION
Ferguson, G. A., Jr. and Hass, M.
***The Physical Review*, v. 112, no. 4, pp. 1130–1131, November 15, 1958**

The diffraction pattern indicates a cubic defect spinel structure with vacancies located at octahedral lattice sites. (*PA*, 1959, #5885)

1266. ANTIFERROMAGNETIC PROPERTIES OF THE IRON GROUP TRIFLUORIDES
Wollan, E. O., Child, H. R., Koehler, W. C., and Wilkinson, M. K.
***The Physical Review*, v. 112, no. 4, pp. 1132–1136, November 15, 1958**

A neutron diffraction study was made of the trifluorides of 3*d* transition group elements. The arrangement of the magnetic ions and the anions in these trifluorides is similar to that in the compounds $LaMO_3$. No antiferromagnetic transition was observed in VF_3. In the compounds CrF_3, FeF_3, and CoF_3 the magnetic ions are observed to couple antiferromagnetically via the intervening anion to each of their six nearest neighbors. This is the same structure as that found in the compounds $LaCrO_3$ and $LaFeO_3$. In the trifluorides the distortions from cubic symmetry have made it possible to determine the orientation of the spin moments relative to the crystallographic axes and in one case (CrF_3) the antiferromagnetic domain properties were studied with magnetic fields applied to the sample. In MnF_3 an antiferromagnetic layer structure is found of the type previously observed for $LaMnO_3$. The indirect magnetic coupling in these compounds is correlated with the orbitals which result from the splitting of the *d*-levels by the crystalline field. (*PA*, 1959, #5899)

1267. ANOMALOUS MAGNETIC PROPERTIES OF Ba FERRITE AS A FUNCTION OF SINTERING TEMPERATURE
Heimke, G.
***Naturwissenschaften*, v. 45, no. 11, pp. 260–261, 1958 (in German)**

The density and remanence decrease and the coercivity increases on raising the sintering temperature of $BaO{\cdot}6Fe_2O_3$ containing 1 percent SiO_2 (in the form $CaO{\cdot}SiO_2$) from 1150 to 1180°C, due to a phase change of the silicate at 1150°C. (*PA*, 1958, #7180)

1268. COBALT OXIDES IN FERRITES
Bradley, F.
***Ceramic Age*, v. 72, no. 3, pp. 31–32, September 1958, pp. 33–34, November 1958**

This article presents the following: effects observed when cobalt oxide is introduced into ferrites; ionic radius; typical ferrite composition for high product 0.5 and 2.0 megacycles; factors in control of cooling time and temperature; note on use of cobalt oxide in high *Q* cores, tuning slugs and antenna rods; stabilizing effect of cobalt oxide in complex electronic systems such as aircraft communications; tables show composition and properties of commercial ferramic and ferrocube type ferrites. (*EI*, 1958)

1269. SYMMETRY OF MAGNETIC STRUCTURES: MAGNETIC STRUCTURE OF CHALCOPYRITE
Donnay, G., Corliss, L. M., Donnay, J. D. H., Elliott, N., and Hastings, J. M.
***The Physical Review*, v. 112, no. 6, pp. 1917–1923, December 15, 1958**

The transformation properties of magnetic moments under symmetry and antisymmetry operations lead to 1421 possible space groups for ferromagnetic and antiferromagnetic crystal structures. (*PA*, 1959, #4802)

1270. MAGNETIC MATERIALS WITH THE PERMINVAR EFFECT. IV. PERMINVAR EFFECT AND MAGNETIC ANNEALING EFFECT IN CONNECTION WITH AFTER-EFFECT PHENOMENA IN FERRITES CAUSED BY ELECTRON DIFFUSION
von Kienlin, A.
***Zeitschrift für angewandte Physik*, v. 10, no. 12, pp. 562–565, December 1958 (in German)**

Samples of Mn ferrite and of Co Mn ferrite that showed temperature and frequency dependent after-effects at room temperature were found to have Permivar-type hysteresis loops at − 180°C. This effect is attributed to the freezing-in of the electron diffusion responsible for the after-effect. In the temperature region between − 180 and − 50°C a magnetic annealing effect occurs. At − 100°C the effect of the measuring field alone quickly produces markedly rectangular hysteresis loop. (*PA*, 1959, #5895)

1271. MAGNETIC AND ELECTRICAL ANISOTROPIES OF IRON SULFIDE SINGLE CRYSTALS
Hirahara, E. and Murakami, M.
***Journal of the Physics and Chemistry of Solids*, v. 7, no. 4, pp. 281–289, December 1958**

Single crystals of iron sulphide of stoichiometric and near-stoichiometric compositions were prepared by a

method similar to the Bridgman technique, and their anisotropies of magnetic susceptibility and electrical conductivity have been observed. Consideration of the experimental results leads to the conclusion that the preferred direction of the antiferromagnetic spins is parallel to the c-axis of the crystal below T_α (the temperature of the α-transformation) and perpendicular to the c-axis above T_α. The behavior of the spin orientation in the temperature range between T_α and T_N (the Néel temperature) has been clarified. It appears that the anisotropy of conductivity can be explained qualitatively in terms of the dependence of electron scattering on the spin orientation of each magnetic ion in the crystal. Anomalous behavior of the susceptibility, which appears just below T_α in the cooling process, is reported briefly. (*PA*, 1959, #8294)

1272. INITIAL AND REMANENT PERMEABILITY SPECTRA OF YTTRIUM IRON GARNET

Harrington, P. D. and Rasmussen, A. L.
***Proceedings of the IRE*, v. 47, no. 1, p. 98, January 1959**

The complex permeability of polycrystalline garnet was measured as a function of frequency. A relaxation, probably due to domain wall displacements, occurs at about 10 Mc, and a resonance probably associated with domain rotation, occurs at about 150 Mc. The present attempts to improve the low-frequency performance by decreasing the saturation magnetization are, therefore, likely to affect only part of the low-field loss. (*PA*, 1959, #3639)

1273. MAGNETIC DOMAINS IN α-Fe_2O_3

Williams, H. J., Sherwood, R. C. and Remeika, J. P.
***Journal of Applied Physics*, v. 29, no. 12, pp. 1772–1773, December 1958**

1274. NEUTRON DIFFRACTION INVESTIGATIONS OF THE MAGNETIC ORDERING IN $FeBr_2$, $CoBr_2$ $FeCl_2$, AND $CoCl_2$

Wilkinson, M. K., Cable, J. W., Wollan, E. O., and Koehler, W. C.
***The Physical Review*, v. 113, no. 2, pp. 497–507, January 15, 1959**

Neutron diffraction experiments have been performed on anhydrous $FeBr_2$, $CoBr_2$, $FeCl_2$, and $CoCl_2$, at temperatures from 295 to 4.2°K to investigate the existence of magnetic ordering in these hexagonal layer-type structures. All four compounds have an antiferromagnetic transition at low temperatures to structures in which the atomic magnetic moments within a metal layer form ferromagnetic sheets and the moments in adjacent layers are antiparallel. In the iron compounds the moments are oriented parallel to the hexagonal c-axis and in the cobalt compounds the moment orientation is perpendicular to that axis. Values of the atomic magnetic moments are close to those expected for the divalent metallic ions if the orbital contribution is quenched. Small-angle scattering experiments on $FeCl_2$ and $CoCl_2$ have shown that the ferromagnetic coupling between moments within a layer is much stronger than the antiferromagnetic coupling between atoms in adjacent layers, and single-crystal investigations on these two compounds have determined the method by which large net magnetization values are obtained at temperatures below T_N in moderate magnetic fields. (*PA*, 1959, #4784)

1275. DOMAIN CONFIGURATIONS ON FERRITES

Craik, D. J. and Griffiths, P. M.
***Proceedings of the Physical Society*, London, v. 73, Part 1, pp. 1–13, January 1959**

The domain structures of Mn, MnZn, Ni, Cu and Ba ferrite crystals were examined by the conventional and modified Bitter figure techniques. In the cases of Mn, Ni and Ba ferrites the patterns observed are in accordance with the nature of their magnetic constants. The MnZn ferrite crystal examined gave anomalous patterns considered to be due to a strain induced uniaxial anisotropy. (*PA*, 1959, #2501)

1276. DOMAIN BEHAVIOR IN SOME MAGNETIC TRANSPARENT OXIDES

Sherwood, R. C., Remeika, J. P., and Williams, H. J.
***Journal of Applied Physics*, v. 30, no. 2, pp. 217–225, February 1959**

Magnetic domains were observed by means of the Faraday effect and by the Bitter technique in a number of compounds having the spinel, magnetoplumbite, and perovskite-like structures. The latter compounds are orthorhombic and have the general formula $MFeO_3$ where M is Y, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, or Lu. Domain boundaries in these compounds move for

fields less than 1 oersted, and after saturation, crystals as large as ($\sim 0.2 \times 0.2 \times 0.1$ in.) remain single domains. Fields of 2500 oersted are required to reverse the magnetization in the single domain crystals. Reversal occurs by nucleation and growth of a reverse domain. This is evident from the unusual torque curves. The fact that domain walls occur and move in such weak fields in these compounds indicate that the slight or parasitic magnetization is a uniform body property of the crystals. The parasitic magnetization of these compounds was determined from torque measurements. These crystals are well suited for light modulators because a uniaxial anisotropy holds the magnetization vectors normal to the large surfaces of thin flat crystals and weak fields produce changes in magnetization. Absorption coefficients were measured for some compounds for radiation having wavelengths from 0.6 to 13μ. Thin sections were found to be transparent to light at the red end of the visible spectrum. The Faraday rotation was measured for $Li_{0.5}Fe_{2.5}O_4$, $MgFe_2O_4$, $YFeO_3$, and $PbFe_{11}Al_1O_{19}$. (*PA*, 1959, #7161)

1277. DOMAIN WALL MOTION AND FERRIMAGNETIC RESONANCE IN A MANGANESE FERRITE

Dillon, J. F., Jr. and Earl, H. E., Jr.
***Journal of Applied Physics*, v. 30, no. 2, pp. 202–213, February 1959**

From a single crystal of manganese ferrite, specimen cores have been cut which are capable of supporting single domain walls. These cores have been proportioned in two ways, one favoring a movable (110) wall, the other favoring a wall system perpendicular to the (110) plane. The basic experiment consists in applying rectangular current pulses to a winning, and observing the rate of change of flux as presented by the voltage in another winding. At low driving fields, the wall, once torn free of the surface, moves through the crystal at a velocity proportional to the applied field less an internal coercive force. At high fields the pulse shapes indicate complex domain structure. Ferrimagnetic resonance experiments have also been performed on samples cut from the same crystal, and the results of these are given. It is particularly interesting to compare the loss parameter for the equation of motion which is derived from the resonance experiments with that obtained from the wall motion experiment. (*PA*, 1959, #2511)

1278. THE FIELD DEPENDENCE OF THE MAGNETIZATION OF UNIAXIAL SUBSTANCES: APPLICATION TO $BaO\text{-}6Fe_2O_3$

Giron, V. S. and Pauthenet, R.
***Comptes rendus hebdomadaires des séances de l' académie des sciences*, Paris, v. 248, no. 7, pp. 943–946, February 16, 1959 (in French)**

The law of approach to saturation for rotational magnetization changes is derived, including terms in H^{-2} and H^{-3}. Interactions between grains and the effect of a finite second-order anisotropy constant are also considered. Application is made to barium ferrite whose anisotropy field is in this way found to be 1.6×10^4 oersted. (*PA*, 1959, #7170)

1279. LINE WIDTHS IN POLYCRYSTALLINE YTTRIUM IRON GARNET

Van Uitert, L. G., Swanekamp, F. W., and Haszko, S. E.
***Journal of Applied Physics*, v. 30, no. 3, pp. 363–365, March 1959**

The line widths at the half-power point for ferromagnetic resonance in a number of polycrystalline yttrium iron garnet samples have been measured at 16 kMc. It has been determined that, starting with mixtures of Y_2O_3 and Fe_2O_3, sound parts with small grain size and having line widths as low as 35 to 40 oersted can be obtained on the iron-rich side of stoichiometry in $Y_3Fe_3O_{12}$. However, narrower line widths (~ 20 oersted) in large-grained materials are obtained by using less than the stoichiometric amount of iron and firing at temperatures higher than 1450°C. This is due to minimizing the disrupting influences of oxygen loss in iron-rich areas at high temperatures. Line widths do not appear to be broadened by the addition of small amounts of nickel, cobalt, or manganese to convert excess iron to high-resistance forms of spinel in the iron-rich compositions. (*PA*, 1959, #7176)

1280. NEUTRON DIFFRACTION STUDY OF ANTIFERROMAGNETIC $FeTiO_3$ AND ITS SOLID SOLUTIONS WITH α-Fe_2O_3

Shirane, G., Pickart, S. J., Nathans, R., and Ishikawa, Y.
***Physics and Chemistry of Solids*, v. 10, no. 1, pp. 35–43, April 1959**

While $FeTiO_3$ and α-Fe_2O_3 are both antiferromagnetic, some solid solutions of the two possess strong magnetic

moments which are believed to be related to an ordering of the Fe and Ti atoms. Neutron powder patterns confirm the X-ray picture of $FeTiO_3$ as alternating layers of Fe and Ti along the [111] axis of the rhombohedral cell with intervening oxygen layers, and provide more accurate oxygen parameters. Data taken below the Néel point of 68°K suggest a model for the spin structure in which Fe^{2+} moments are ferromagnetically coupled within a (111) sheet and directed perpendicular to it. Studies on the solid solutions connect the presence of the spontaneous moment with ordering of the Ti and Fe atoms, and show that the spin arrangement in most of these compositions is of the α-Fe_2O_3 type with spins ferromagnetically coupled and lying within (111) sheets. The fact that no long-range ordered spin structure is observed down to 4.2°K for the sample containing 12% hematite can be explained on the basis of an inhomogeneous magnetic structure. (*PA*, 1959, #7173)

1281. INITIAL PERMEABILITY SPECTRA IN FERRITES AND GARNETS

Pippin, J. E. and Hogen, C. L.
Harvard University, Gordon McKay Lab of Applied Science, Cambridge,
AF 19(604)-1084, Scientific R-1,
AFCRC-TN-59-169, April 1959
(ASTIA AD-214,412)

Domain wall motion and domain rotation in ferrites are considered. The experimental method and the materials chosen are described and results are given for nickel ferrites, nickel-cobalt ferrites, nickel–zinc ferrites, nickel ferrite-aluminates, and magnetic garnets.

1282. FERRITE SPECIMENS WITH TEMPERATURE INDEPENDENT GYROMAGNETIC PROPERTIES

Haken, W. and von Haza-Radlitz, C.
***Archiv der elektrischen Übertragung*, v. 13, no. 4, pp. 157–160, April 1959 (in German)**

It is shown that the temperature variation of the gyromagnetic resonance frequency in a constant magnetic field, arising from the temperature variation of saturation magnetization, may be compensated by suitable specimen dimensions. These dimensions are calculated for ferrite strips in rectangular waveguides, and experimentally verified. (*PA*, 1959, #8314)

1283. MICROWAVE RESONANCE IN GADOLINIUM-IRON GARNET CRYSTALS

Smith, W. V., Overmeyer, J., and Calhoun, B. A.
***IBM Journal of Research and Development*, v. 3, no. 2, pp. 153–162, April 1959**

Ferrimagnetic resonance has been observed in single crystals of gadolinium–iron garnet at 9479 and 23725 Mc. The resonance behavior is discussed in terms of a two-sublattice theory. The gadolinium g-factor is 2.006 above −90°C, and increases at lower temperatures. The gadolinium ions contribute to the anisotropy below −40°C. The assignment of separate damping constants to each sublattice explains the sharp variation in over-all damping with temperature near the compensation point. (*PA*, 1959, #7177)

1284. EFFECT OF A SMALL PROPORTION OF COBALT ON THE MAGNETIC DISPERSION OF NICKEL–ZINC FERRITES

Marais, A.
***Comptes rendus hebdomadaires des séances de l' académie des sciences*, Paris, v. 248, no. 16, pp. 2303–2305, April 20, 1959 (in French)**

The product of permeability and resonant frequency is approximately proportional to the saturation magnetization for different nickel–zinc ratios. A small amount of cobalt increases the constant of proportionality. This result is contrary to that expected from consideration of the resonance of rotation of spins of domains. (*PA*, 1959, #8307)

1285. MAGNETIC PROPERTIES OF SUBSTITUTED MANGANESE-TIN SPINELS

Gilleo, M. A. and Mitchell, D. W.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 20S–21S, April 1959**

1286. MAGNETIC PROPERTIES AND GRAIN STRUCTURE OF Mn-Zn FERRITES

Heister, W.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 22S–24S, April 1959**

The relations between sintering temperature, grain size, and magnetic properties of a manganese zinc ferrite of composition $MnO:ZnO:Fe_2O_3 = 28:19:53$ are reported. With proper preparation, very low loss materials can be obtained.

1287. REMAGNETIZATION EXPERIMENTS IN $Mn_{1+x}Fe_{2-x}O_4$
Matcovich, T. J. and Kriessman, C. J.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 26S–27S, April 1959

The remagnetization time has been measured as a function of external field for the series of manganese ferrites. Physical properties which enter into the domain wall model of Menyuk and Goodenough and the rotational model of Gyorgy have also been measured. Correlation of data with theory depends upon further insight into the loss mechanism.

1288. ON THE ORIGIN OF LOW MOMENTS IN CHROMIUM-CONTAINING SPINELS
Baltzer, P. K. and Wojtowicz, P. J.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 27S–29S, April 1959

It is proposed that the origin of the low moments in the chromites is the spin-quenching effect imposed on the C_r^{3+} ions by the appropriate Jahn-Teller distortions of their neighbors. It is emphasized that a macroscopically distorted phase is not required for this effect.

1289. MEASUREMENTS OF ROTATIONAL MAGNETIC LOSSES IN FERRITES AT VERY LOW FREQUENCIES
Parker, H. M., Bullock, B. W., and Dancy, W. H., Jr.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 32S–33S, April 1959

The measuring apparatus is detailed. From tests of many samples, the Ferroxcube 3^B was found to have the lowest losses.

1290. SOME CRYSTALLOGRAPHIC AND MAGNETIC PROPERTIES OF SQUARE-LOOP MATERIALS IN FERRITE SYSTEMS CONTAINING COPPER
Greifer, A. P. and Croft, W. J.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 34S–36S, April 1959

1291. MAGNETIC PROPERTIES OF NICKEL-IRON FERRITE
Menyuk, N. and Dwight, K.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 36S–37S, April 1959

The magnetic anisotropy of a single crystal of composition $Fe^{3+}_{1.00}[Ni^{2+}_{0.79}Fe^{3+}_{0.36}\text{–}Fe^{3+}_{0.90}]O_4$ is given between 450 and 4.2°K.

1292. INITIAL PERMEABILITY PROCESSES IN NICKEL-COBALT FERRITES OF VARIOUS DENSITIES
Pippin, J. E. and Thiess, G. H.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 80S–81S, April 1959

1293. IN-PILE MEASUREMENTS OF RADIATION EFFECTS IN MAGNETIC MATERIALS
Alley, R. E., Jr.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 284S–285S, April 1959

No permanent effect was observed in any ferrite. In-pile changes in ferrite properties are identified with changes due to temperature variations resulting from gamma ray absorption. Permanent damage was observed in all metallic samples tested. Change in shape of hysteresis loop, increase in coercive force and decrease in initial permeability resulted. Supermendur and Deltamix were least affected; Supermalloy was most damaged.

1294. REDUCTION OF SATURATION MAGNETIZATION OF γ-Fe_2O_3 AND Fe_3O_4 BY PILE IRRADIATION
Henry, W. E. and Salkovitz, E. I.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 286S–287S, April 1959

The saturation magnetization has been obtained through measurements of the magnetization as a function of magnetic field at 4.2°K, before and after radiation. A sample motion ballistic method was used in magnetic fields up to 60,000 gauss.

1295. MAGNETIC PROPERTIES OF THE RARE EARTH GARNETS
Pauthenet, R.
Journal of Applied Physics, v. 30, no. 4 (Supplement), p. 290S–292S, April 1959

The magnetic properties, in static fields, of the rare earth garnets are described. The Néel molecular field theory of ferrimagnetism is extended to treat three sublattices of magnetic ions and is shown to account quantitatively for the observed properties. At low temperatures

magnetic moments of rare earth ions having nonzero orbital angular momentum, are much less than the moments of the free ions, due to quenching by the crystalline field.

1296. MAGNETIC ANNEALING OF YTTRIUM IRON GARNET

Calhoun, B. A.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 293S–294S, April 1959

The magnetic annealing effect is described. The magnetic behavior of the annealed cores at −195°C is explained qualitatively by assuming that the domain walls do not move under the influence of magnetic fields less than a critical value.

1297. TEMPERATURE-DEPENDENT LAG IN POLYCRYSTALLINE YTTRIUM-IRON GARNET

Epstein, D. J. and Frackiewicz, B.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 295S–296S, April 1959

1298. SOME ELECTRICAL AND MAGNETIC PROPERTIES OF GARNETS

Anderson, E. E.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 299S–300S, April 1959

Measurements are reported for yttrium-iron garnet and substituted yttrium-iron garnets.

1299. SOME NEW MAGNETIC PHENOMENA OF HEMATITE SINGLE CRYSTAL

Lin, S. T.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 306S–307S, April 1959

Three sets of measurements have been carried out in the temperature range from 488 to 4.2°K: magnetization isotherms along a certain direction in the basal plane, confirming Néel's model; isotherms along the ternary axis; and remanent magnetization along the ternary axis.

1300. ON THE MAGNETIC ANISOTROPY IN MANGANESE-IRON SPINELS

Penoyer, R. F. and Shafer, M. W.
Journal of Applied Physics, v. 30, no. 4 (Supplement), pp. 315S–316S, April 1959

The magnetic anisotropy energy is measured as a function of temperature in eleven single crystal compositions corresponding to $Mn_xFe_{3-x}O_4$, where x is varied from 0.00 to 1.90. The temperature was varied from 76 to 320°K.

1301. COOPERATIVE MAGNETISM IN OXIDE STRUCTURES. I. ANTIFERROMAGNETISM AND FERROMAGNETISM

Blackman, L. C. F.
Research, v. 12, no. 5, pp. 164–171, May 1959

A discussion of the antiferromagnetic and ferromagnetic properties of certain oxide systems. A brief account is given of the current theories of indirect magnetic exchange interaction. (*PA*, 1959, #7156)

1302. STUDY OF ORIENTED POLYCRYSTALLINE FERRITES WITH CUBIC ANISOTROPY

Kooi, C. F., Moss, R. W., and Stinson, D. C.
Journal of Applied Physics, v. 30, no. 6, pp. 895–898, June 1959

A study was made of crystallite orientation in cubic ferrites when pressed in a magnetic field. One easy axis orients in the field direction, the other easy axes lying at random in or near a perpendicular plane. Experimental torque curves have the theoretically predicted shape. The magnetic field required for microwave resonance is lower than in the same nonoriented ferrite if the axis of alignment and the field are parallel. This occurs because the anisotropy field H_a is no longer randomly oriented but helps to supply part of the resonant field requirement. Values of saturation magnetization (M_s), anisotropy energy (K), and resonant field (H_r) at 14,775 Mc were measured on a series of oriented polycrystalline nickel cobalt ferrites. Values of the measured resonant field are compared with values obtained from Kittel's resonance relation using the independently measured values of M_s and K. (*PA*, 1959, #8318)

1303. DIRECT OBSERVATION OF MAGNETIC DOMAINS IN CEMENTITE

Hillert, M. and Lange N.
Journal of Applied Physics, v. 30, no. 6, p. 945, June 1959

The observation of magnetic domain patterns in cementite (Fe_3C), using the Kerr magneto-optic effect is reported. Photographs show that the variation of domain pattern with applied magnetic field as the specimen is taken through an hysteresis cycle. (*PA*, 1959, #8299)

VI. MAGNETIC PROPERTIES OF NON-FERROUS METALS AND ALLOYS

A. Films, Thin Layers, Particles, Whiskers and Wires

1304. THIN FILMS OF FERROMAGNETIC MATERIALS
Crittenden, E. C. and Hoffman, R. W.
Reviews of Modern Physics, v. 25, no. 1, pp. 310–315, January 1953

Magnetic properties of thin evaporated films of Ni are observed.

1305. FERROMAGNETISM OF THIN NICKEL FILMS
Jensen, H. and Nielsen, A.
Akademiet forde Tekniske Videnskaber, Copenhagen, 1953

1306. MAGNETIC BEHAVIOR OF THIN SINGLE-CRYSTAL NICKEL FILMS
Collins, L. E. and Heavens, O. S.
The Philosophical Magazine, v. 45, no. 362, pp. 283–289, 1954

1307. FERROMAGNETISM OF THIN NICKEL FILMS AT LOW TEMPERATURES
Dupré, A.
Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie, no. 52, 49 pp., 1955 (in Dutch)

Results are given of measurements of the change of resistance of evaporated Ni films in magnetic fields up to about 6×10^3 oersted and at temperatures up to about 100°K. The coercive force is deduced as being that where $\Delta R/R$ is a maximum. Its values were obtained parallel and perpendicular to the film surface (occasionally also at intermediate angles) as a function of temperature. The structure of the films was investigated by electron diffraction. (*PA*, 1957, #2427)

1308. THE INFLUENCE OF THE INTERNAL STATE ON THE POSITION OF THE POLES IN MAGNETIZED NICKEL WIRE
Schwink, C.
Zeitschrift für Physik, v. 143, no. 2, pp. 205–218, 1955 (in German)

The electron optical shadow method of Marton, Simpson and Lachenbruch which resembles the optical schlieren technique, has been modified in order to investigate the field distribution around magnetized wires of nickel. The influence of the internal state (i.e., strain and texture) on the position of the point poles has been demonstrated; the poles can be located to an accuracy of better than 0.025 mm. In the region of plastic deformation the phenomena can be explained in terms of current theories of the plastic behavior of polycrystalline metals. For the region of mixed plastic–elastic deformation a model is proposed, resting essentially on the assumption of a surface layer, of thickness approximately 0.03 mm, which is more easily deformable than the internal core. Experiments appear to support this assumption. (*PA*, 1956, #2227)

1309. SOME MAGNETIC PROPERTIES OF DILUTE FERROMAGNETIC ALLOYS
Bate, I. G., Schofield, D., and Sucksmith, W.
The Philosophical Magazine, v. 46, pp. 621–631, June 1955

The theory of the coercivity of non-spherical, single domain particles of ferromagnetic material in a non-magnetic matrix has been developed independently by Néel (1947) and Stoner and Wohlfarth (1948). Appropriate conditions for the study of the growth of these domains are to be found in suitable dilute ferromagnetic alloys where there is an increase of solubility of the ferromagnetic constituent with temperature. Such characteristics are found in the copper-rich alloys of copper–cobalt and copper–iron. The magnetic properties of appropriate alloys with increase of heat treatment are followed from the normal paramagnetism of the solid solution to the ordinary magnetization curve of the precipitated ferromagnetic. At a suitable stage a maximum in the coercivity is found which the writers believe to be associated with single domain precipitates. The characteristics of the hysteresis loops at this stage indicate the presence of high coercivities of more than 1,000 oersted. (*PA*, 1955, #6297)

1310. THE COERCIVE FORCE OF NICKEL POWDER AT LOW TEMPERATURES

Weil, L.

Comptes rendus hebdomadaires des séances de de l'académie des sciences, Paris, v. 241, no. 5, pp. 470–472, August 1, 1955 (in French)

The coercive force was found to depend on temperature, the details of the applied heat treatment with or without the application of a magnetic field, the previous thermal history and the time. (*PA*, 1956, 468)

1311. CONCERNING THE EXISTENCE OF A NEGATIVE BARKHAUSEN EFFECT

Fischer, J.

Czechoslovak Journal of Physics, v. 6, no. 1, pp. 65–73, January 1956 (in Russian with English summary)

Kirenskii and Ivlev published results showing a negative Barkhausen effect in an annealed specimen of Ni wire. The present author has investigated some 45 specimens of iron, nickel and sundry alloys and found no evidence of a negative Barkhausen effect. An experiment with a specimen very like that used by Kirenskii and Ivlev also failed to disclose the negative effect. It is suggested that the results found by Kirenskii and Ivlev were due to distortions produced by the ac amplifier they used. In the author's experiment a dc amplifier was employed. (*PA*, 1956, #8863)

1312. THE BEHAVIOR OF FERROMAGNETICS UNDER STRONG COMPRESSION

Stacey, F. D.

Canadian Journal of Physics, v. 34, no. 3, pp. 304–311, March 1956

Specimens in the form of thin disks have been subjected to strong compression simultaneously with high magnetic fields by means of a new design of permeameter, with which their magnetizations have been measured. Magnetization curves extending to saturation have been plotted for a number of materials at (non-hydrostatic) pressures up to 10,000 atm. The most interesting result is the strong increase in saturation magnetization shown by nickel and the nickel–copper alloys. (*PA*, 1956, #3030)

1313. FERROMAGNETIC PROPERTIES OF THIN NICKEL FILMS

Crittenden, E. C., Jr. and Hoffman, R. W.

Journal de physique et le Radium, v. 17, no. 3, pp. 270–273, March 1956 (in French)

The ferromagnetic properties of thin films of nickel in the thickness range 20 to 495 Å are reported as a function of temperature between 4 and 475°K. The behavior of the hysteresis loops is consistent with Kittel's theory. The data on saturation magnetization as a function of temperature is as yet not able to settle the question of the slope at $T = 0$, although better data is anticipated soon. The theory of Klein and Smith fits the observations of Curie temperature as a function of thickness surprisingly well. (*PA*, 1956, #6778)

1314. MEASUREMENTS ON THE ELECTRICAL AND MAGNETIC PROPERTIES OF THIN FILMS AT LOW TEMPERATURE

van Itterbeek, A.

Journal de physique et le Radium, v. 17, no. 3, pp. 241–249, March 1956 (in French)

A brief report is given of early measurements on the electrical and magnetic properties of nickel and iron films at low temperatures. Also the dependence of the resistance on the current together with the change of the resistance under the influence of a longitudinal magnetic field (parallel to the current) are briefly discussed. From these measurements the coercive force and its variation with temperature were determined. Earlier measurements on the superconductivity of tin film obtained by cathodic sputtering are also discussed. The essential properties of these films are: (1) The transmission temperature is higher than for bulk tin. (2) The values for the magnetic threshold field (H_c) are much higher than for bulk material. The same can be said from the critical value of the current density i_c. The Silsbee rule cannot be considered as valid for the relation between H_c and i_c. (3) By increasing the current, the form of the transition curve changes. The curves become sharper by increasing the current. (4) A large difference is found between the value of H_c–transversal parallel to the film and H_c–transversal perpendicular. New measurements have now been done on nickel and tin films condensed in vacuum (10^{-6} mm Hg). For some of the tin films the support was kept at a temperature of liquid air during the condensation. A special technique is described for the manipulation of

those films. The tin film condensed at room temperature has the same transition temperature as the bulk metal, while the cooled film has a transition temperature which is much higher. The ratio between the transversal parallel threshold field and the transversal perpendicular one was studied. A strong variation is found for this ratio as a function of temperature. This can be explained by considering the anisotropy of tin crystals. Also for the nickel film measurements were made in the two field directions. A large difference was found, which can be explained by considering the anistropy factor for nickel crystals and by supposing that the films are formed of crystals with the (110) plane parallel to the plane of the film. (*PA*, 1956, #6645)

1315. A NEW METHOD OF MEASUREMENT OF THE MAGNETIC PROPERTIES OF THIN FILMS BY MEANS OF THE FARADAY EFFECT

Reimer, L.

***Zeitschrift für Naturforschung*, v. 11a, no. 7, p. 611, July 1956 (in German)**

The rotation φ of the plane of polarization was measured as a function of field strength H for a Ni film of thickness 450 Å evaporated on glass. To avoid large demagnetizing effects H was applied parallel to the film surface and the incident light at 45° to the normal. The (φ H) curve is a hysteresis loop with coercive force about 30 oersted. (*PA*, 1957, #5371)

1316. EFFECT OF A MAGNETIC FIELD ON THE ELECTRICAL RESISTANCE OF THIN FILMS OF NICKEL

Rappeneau, T.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 19, pp. 1403–1406, November 5, 1956 (in French)**

Results are given of room temperature measurements on evaporated nickel films at fields up to 6000 oersted. If the magnetization is perpendicular to the current the resistance decreases in the field, and if it is parallel the resistance increases, hysteresis being observed in low fields. In high fields there is a slight decrease of resistance in both cases. (*PA*, 1957, #4380)

1317. ON THE ORIGIN OF THE MAGNETO-MECHANICAL PHENOMENON IN AN ALTERNATING MAGNETIC FIELD

Mísek, K.

***Czechoslovak Journal of Physics*, v. 7, no. 2, pp. 247–248, 1957**

From observations on the damping of torsional oscillations of nickel wires of different diameters as a function of longitudinal alternating magnetic field, it is concluded that the pronounced internal friction peak previously observed arises from microscopic eddy currents due to reversible Bloch wall displacements. (*PA*, 1959, #8305)

1318. MAGNETIC ELECTRICAL AND ELECTRON-OPTICAL INVESTIGATIONS ON THE THERMAL CHANGE IN SPUTTERED NICKEL FILMS

Reimer, L.

***Zeitschrift für Physik*, v. 149, no. 4, pp. 425–431, 1957 (in German)**

Magnetic measurements show that sputtered nickel films, which have a hexagonal structure when laid down that changes to cubic when heated to about 400°C, become ferromagnetic at the change point. The course of the change is investigated by measurements of electrical resistance at various temperatures, and the structure of the films is investigated by electron diffraction and electron microscopy. (*PA*, 1958, #7174)

1319. MAGNETIC DOMAIN PATTERNS ON THIN FILMS

Williams, H. J. and Sherwood, R. C.

***Journal of Applied Physics*, v. 28, no. 5, pp. 548–555, May 1957**

Magnetic domain patterns were observed on evaporated films of Fe, Co, Ni, and several different alloys of these elements. The films were deposited in the presence of a magnetic field to establish a uniaxial direction of easy magnetization. It was found that the direction of easy magnetization, in films of all compositions, could be changed by re-heat-treating them in a magnetic field with a new orientation. This is of special interest because bulk specimens of the elements do not respond to heat treatment in a magnetic field. Nucleation and growth of domains were observed for fields applied at various angles to the uniaxial direction of easy magnetization in some

of the films. Patterns were obtained on films ranging in thickness from approximately 50 to 12,000 Å. Domain walls in films ranging from 50 to 500 Å in thickness tend to aggregate in pairs. (*PA*, 1958, #3239)

1320. STRESS IN EVAPORATED FERROMAGNETIC FILMS

Macdonald, J. R.

***The Physical Review*, v. 106, no. 5, pp. 890–892, June 1957**

Ferromagnetic resonance and oscillation magnetometer measurements on a thin evaporated nickel film annealed in a magnetic field are described. Observations of the dependence of the resonant field magnitude on the angle in the plane of the film between the direction of the magnetic field during annealing and the static resonance field direction show that magnetic annealing produced a preferred magnetic axis in the plane of the film. The good agreement between theory and experiment allows one to establish that the film had bulk-nickel g and saturation magnetization values, a large isotropic tension in the plane, and a lesser uniaxial compression in the plane in the direction of the preferred magnetic axis. In the light of these results, it is suggested that part of the discrepancy between theory and ferromagnetic resonance experiments found recently by Conger and Essig for the dependence of saturation magnetization on evaporated film thickness may have arisen from their omission of stress corrections to the resonance condition. Further, part of the difference between film-switching times derived from resonance line widths and those directly measured on the same films by these authors may have been caused by the narrowing of ferromagnetic line widths for thin films, as compared with bulk material, produced by the strong dependence on resonant absorption of power transmission entirely through sufficiently thin films. (*PA*, 1957 #7219)

1321. ON THE DEPENDENCE OF THE COERCIVE FORCE OF COBALT AND COBALT–CHROMIUM ALLOY POWDERS ON THE PARTICLE SIZE

Kandaurova, G. S.

***Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 548–550, 1957 (in Russian)**

The coercivity (H_c) of cobalt and cobalt +9.6% chromium powders was measured as a function of particle size in the range 0–1300 microns. Results are shown in graphs which also show the effect on H_c of heating the powders to 600°C. In general H_c rises as the particle size falls, but a more complex behavior is observed with particles of diam. $< 40\ \mu$. (*PA*, 1958, #4127)

1322. INFLUENCE OF PARTICLE SIZE ON COERCIVE FORCE OF COBALT AND COBALT–CHROMIUM ALLOY POWDERS

Kandaurova, G. S.

***Physics of Metals and Metallography* (Translation of *Fizika Metallov i Metallovedenie*, v. 4, no. 3, pp. 135–136, 1957)**

Principal results of measurements shown: curves presented illustrate relation between particle size of Co powder and H_c for specimens before and after annealing at 600°C, and relation between particle size of Co–Cr alloy powder and H_c for three series of specimens before annealing, and after annealing at 600 and 900°C. (*EI*, 1958)

1323. HALL EFFECT AND FERROMAGNETISM OF VERY THIN NICKEL FILMS

Coren, R. and Juretschke, H. J.

***Journal of Applied Physics*, v. 28, no. 7, pp. 806–809, July 1957**

Results are given of Hall effect measurements to determine two Hall constants and magnetic properties of nickel films less than 100 Å thick at room temperature: extraordinary Hall constant R_1 is found to be very much larger than in bulk nickel; in thicker films, it shows resistivity dependence predicted by R. Karplus and J. M. Luttinger; for some thinnest films direction normal to film plane was one of very hard magnetization. (*EI*, 1957)

1324. COMPARISON OF THE MAGNETIC PROPERTIES OF ELECTROLYTICALLY DEPOSITED NICKEL FILMS FROM BALLISTIC MEASUREMENTS AND FROM THE CHANGE OF ELECTRICAL RESISTANCE IN A MAGNETIC FIELD

Reimer, L.

***Zeitschrift für Naturforschung*, v. 12a, no. 7, pp. 558–561, 1957 (in German)**

The coercive force and the shape of the hysteresis loop derived from measurements of the change of resistance

in a magnetic field are compared with results on the same films obtained by ballistic measurements. The results are discussed in relation to the magnetization process in single-domain films. (*PA*, 1959, #5889)

1325. MAGNETIC PROPERTIES OF MAGNETICALLY ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. I. MAGNETIZATION CURVES AND PARTICULAR CYCLES OF THE HYSTERESIS LOOP

Shtol'ts, E. V., Shur, Ya. S., and Kandaurova, G. S.
***Fizika Metallov i Metallovedenie*, v. 5, no. 3, pp. 412–420, 1957 (in Russian)**

Experiments are described relating the magnetic properties of MnBi powder compacts to particle size. It is concluded that fine powder particles may have a single domain structure or a structure transitional between a one-domain and a multi-domain structure. A model for this transitional structure is proposed. (*PA*, 1959, #417)

1326. MAGNETIC PROPERTIES OF MAGNETICALLY ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. II. THE DEPENDENCE OF THE MAGNETIZATION CURVES ON THE MECHANISM OF FORMATION OF A DEMAGNETIZED STATE

Shur, Ya. S., Shtol'ts, E. V., and Kandaurova, G. S.
***Fizika Metallov i Metallovedenie*, v. 5, no. 3, pp. 421–427, 1957 (in Russian)**

Further experiments confirm the existence of the transition structure discovered in fine powder compacts of MnBi. (*PA*, 1959, #418)

1327. MAGNETIC INVESTIGATIONS ON ELECTROLYTICALLY DEPOSITED THIN COBALT FILMS

Reimer, L.
***Zeitschrift für Naturforschung*, v. 12a, no. 12, pp. 1014–1015, 1957 (in German)**

Cobalt films, deposited electrolytically on copper, have a cubic structure. By extrapolation in accordance with an exponential law the crystal anisotropy constants of cubic cobalt at 20 and −190°C have been found, and the measured coercive forces of thin films are in agreement with those calculated using these values. The coercive force is much less than the value calculated from the anisotropy constant of hexagonal cobalt. (*PA*, 1959, #5890)

1328. SURFACE PARAMAGNETISM OF GERMANIUM FILMS

Sandler, Y. L.
***The Physical Review*, v. 108, no. 6, p. 1642, December 15, 1957**

The orthro–para conversion of hydrogen absorbed on sputtered Ge films indicates a low-temperature conversion having all the characteristics of magnetic spin inversion. The effect is attributed to the presence of unpaired electrons on the atomically clean parts of the film surface, possibly up to one per Ge surface atom. (*PA*, 1958, #2412)

1329. THIN FERROMAGNETIC FILMS. ELECTRICAL PROPERTIES OF THIN NICKEL FILMS

Goureaux, G. and Colombani, A.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 5, pp. 741–744, February 3, 1958 (in French)**

Reports conductivity measurements on films with thicknesses varying from 20 to 1100 Å in the temperature range from 0 to 420°C. Graphs of resistivity against temperature for various thicknesses show that both the paramagnetic and ferromagnetic Curie temperatures decrease with decreasing thickness, while their difference increases. (*PA*, 1958, #6046)

1330. STUDY OF PRECIPITATE PARTICLES IN Cu–Co EMPLOYING FERROMAGNETIC RESONANCE

Rodbell, D. S.
***Journal of Applied Physics*, v. 29, no. 3, pp. 311–312, March 1958**

Observations of the ferromagnetic resonance absorption of sub-microscopic particles may be interpreted to yield useful information about anisotropies. The alloy 2% Co–Cu heat-treated to precipitate cobalt containing about 10%

copper from the nonmagnetic solid solution was studied using ferromagnetic resonance techniques. In the early stages of growth the precipitate particles are shown to be essentially spherical in shape. Further growth of the precipitate particles (by subsequent heat-treatment) is accompanied by aspherical shape changes which modify the resonance spectra. The magnetocrystalline anisotropy of the cobalt precipitate in single crystals of this alloy was determined. This anisotropy is cubic with $M_1/M_s = -665$ oersted at room temperature. The cobalt-rich precipitate retains its cubic crystal structure to at least 4.2°K, apparently stabilized by the copper matrix. (*PA*, 1958, #8887)

1331. MAGNETIC MEASUREMENTS ON SOME PRECIPITATING SYSTEMS

Berkowitz, A. E. and Flanders, P. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 314–316, March 1958**

In the systems Au–Ni and β-brass–Fe, ferromagnetic precipitate particles develop in a nonmagnetic matrix. Single-crystal samples of these alloys were examined by measuring saturation magnetization, torque curves, rotational hysteresis, and remanence. The data on the Au–Ni system was analyzed to infer particle anisotropy distributions, orientation of the "easy" axes of the particles, and other features of the precipitate particle system. Electron micrographs of the precipitate particles are in general agreement with this analysis. The measurements on the β-brass-Fe system indicated that the precipitate particles were single crystals with the same crystal habit as the matrix, and were elongated in the ⟨111⟩ directions. The temperature dependence of the torque curves was identified with the temperature dependence of shape and magnetocrystalline anisotropy. (*PA*, 1958, #8889)

1332. PRECIPITATION AND MAGNETIC ANNEALING IN A COPPER–COBALT ALLOY

Becker, J. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 317–318, March 1958**

In an alloy containing 2% cobalt, balance copper, it is possible to quench a nonmagnetic solid solution from 1000°C and then produce a ferromagnetic precipitate in a nonmagnetic matrix by aging at several hundred degrees. The magnetic properties of this precipitate can be correlated with the size and shape of the precipitate particles. Considerable information about the precipitation process can be obtained in this way. In these experiments, saturation magnetization, torque, rotational hysteresis, remanence, coercive force for zero magnetization, and coercive force for zero remanence (which behaves in a surprising fashion) were observed during the course of aging. In particular, the effect of a field during aging in producing magnetic anisotropy (magnetic annealing) was studied and is shown to occur entirely during the growth of the particles, after the precipitation is complete. The precipitation process is viewed as one in which the particles as they grow are first superparamagnetic, then stable single domains, and finally multidomain. This point of view is consistent with all of the varied phenomena observed. (*PA*, 1958, #8890)

1333. MEASUREMENTS OF THE HALL EFFECT ON FERROMAGNETIC NICKEL LAYERS

Reimer, L.
***Zeitschrift für Physik*, v. 150, no. 3, pp. 277–286, 1958 (in German)**

Measurements of Hall effect R are described on nickel films as a function of magnetic field strength (0–12,000 oersted), temperature of glass substrate (20–400°C), and thickness (110-2000 Å), and also on compact material. The field dependence of R is found to be similar to that of magnetoresistance. The ferromagnetic effects are separated from the normal magnetic effects when the results are analyzed. (*PA*, 1958, #7903)

1334. THE DETERMINATION OF THE DISTRIBUTION OF THE MAGNETIZATION VECTORS IN EVAPORATED FILMS OF NICKEL AND IRON FROM THE MAGNETORESISTANCE EFFECT

Hellenthal, W.
***Zeitschrift für Physik*, v. 153, no. 3, pp. 359–371, 1958 (in German)**

For films deposited at high temperatures, in thicknesses less than about 300 Å, the magnetization vectors lie approximately in the plane of the film. In nickel film depositied on to unheated subtrates no such distribution was found: this can be explained in terms of stresses in the films. (*PA*, 1959, #5891)

1335. THIN FERROMAGNETIC FILMS. MAGNETIC PROPERTIES DEDUCED FROM THE CONDUCTIVITY OF THIN NICKEL FILMS
Colombani, A. and Goureaux, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 13, pp. 1979–1983, March 31, 1958 (in French)**

Results previously reported on the variation of the ferromagnetic Curie point with film thickness are discussed on the basis of theoretical work by Klein and Smith. (*PA*, 1958, #6047)

1336. ON THE THEORY OF THE DOMAIN STRUCTURE OF THIN FILMS OF MAGNETICALLY UNI-AXIAL MATERIALS
Málek, Z. and Kambersky, V.
***Czechoslovak Journal of Physics*, v. 8, no. 4, pp. 416–422, 1958**

The demagnetizing energy is calculated for a simple model of the domain structure, the axis of easy magnetization of the film being perpendicular to the surface. The width of the domain and, for the case of MnBi, the total energy of the domain structure are found as functions of the thickness of the film. (*PA*, 1959, #4796)

1337. ON THE TEMPERATURE DEPENDENCE OF THE COERCIVE FORCE IN THIN SPECIMENS OF NICKEL AND NICKEL–IRON ALLOYS
Kondorskii, E. and Rosenberg, M.
***Doklady Akademii Nauk SSSR*, v. 120, no. 4, pp. 753–756, 1958 (in Russian)**

The temperature dependence of the coercive force H_c of both work-hardened and annealed Fe–Ni alloys containing 85, 78 and 50% Ni was investigated in the temperature range −196 to 300°C on specimens whose thickness d varied from 0.35 to 0.005 mm. The effect of d on H_c in the work-hardened specimens was masked by a considerable increase of H_c due to internal stresses but a definite relationship between H_c and d of the annealed alloys was established, the value of H_c rising sharply below a certain critical value of d. The increase of H_c observed at $d = 0.005$ mm in materials characterized by comparatively low values of the anisotropy constant is attributed to the effect of gaseous impurities picked up by the metal during its heat treatment, and it is postulated that higher permeability and lower H_c can be attained in materials of this type by improved heat-treatment techniques. (*PA*, 1958, #7173)

1338. ON THE MAGNETIC PROPERTIES OF THIN ELECTROLYTICALLY DEPOSITED NICKEL FILMS
Ruske, W.
***Annalen der Physik*, Leipzig, Folge 7, v. 2, no. 5–6, pp. 274–286, 1958 (in German)**

A recording fluxmeter was used to obtain hysteresis loops for a large number of electrolytically deposited nickel films of thickness between 20 and 2×10^4 Å. The object of the work was to determine the effect of film thickness on magnetic properties when the influence of other factors such as structure, strain, etc., had been eliminated. (*PA*, 1959, #7164)

1339. STUDY OF PRECIPITATION-HARDENING EMPLOYING MAGNETIC MEASUREMENTS
Livingston, J. D. and Becker, J. J.
***Metallurgical Society of AIME, Transactions*, v. 212, no. 3, pp. 316–319, June 1958**

Precipitate particle size and various mechanical properties of copper cobalt alloy measured in early stages of precipitation hardening: in this range hardness and tensile properties increase with increasing interparticle spacing: effects of deformation on magnetic properties interpreted as resulting from change in shape of ferromagnetic precipitate particles during deformation. (*EI*, 1958)

1340. THIN FERROMAGNETIC FILMS. HALL EFFECT IN THIN FILMS OF NICKEL
Goureaux, G., Huet, P., and Colombani, A.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 247, no. 2, pp. 189–193, July 16, 1958 (in French)**

Gives results of measurements of the Hall effect in thin films of nickel of thickness 27–1350 Å and in fields of 10–35,000 oersted. The results indicate that in films of thickness 180–1350 Å, the axis perpendicular to the film

is one of easy magnetization and that the domains are oriented perpendicular to the film. In films of thickness less than 100Å, the axis perpendicular to the film is one of difficult magnetization. The region from 100–180 Å is one of transition. In the interval 180–1350 Å, the initial slope of the Hall voltage–induction curve is a linear function of the resistivity of the deposit. In fields of about 3000 oersted the Hall effect changes sign with films less than 25 Å in thickness. (*PA*, 1959, #2496)

1341. SPONTANEOUS MAGNETIZATION OF A THIN FILM MEASURED BY ELECTRON DIFFRACTION
Yamaguchi, S.
***Canadian Journal of Physics*, v. 36, no. 9, p. 1251, September 1958**

A diffraction pattern obtained for a gold film was superposed on that for a film containing nickel and nickel oxide. The two patterns were not concentric and from the relative displacement a value for the magnetization of the film was obtained. (*PA*, 1959, #1584)

1342. TEMPERATURE INDEPENDENT SPONTANEOUS MAGNETIZATION OF COBALT PRECIPITATES IN A COPPER MATRIX
Knappwost, A. and Illenberger, A.
***Naturwissenschaften*, v. 45, no. 10, p. 238, 1958 (in German)**

Magnetic experiments on small (8-20 Å) Co precipitates show that the spontaneous magnetization is independent of temperature up to room temperature, which is unexpected in view of Klein and Smith's results. (*PA*, 1958, #7171)

1343. THE DE HAAS-VAN ALPHEN EFFECT IN COPPER
Shoenberg, D.
***Nature*, v. 183, p. 171, January 17, 1959**

The effect is observed in a whisker made by the Brenner method with the [111] axis along the magnetic field. The period is 1.7×10^{-9} gauss^{-1} and agrees with the value for a free electron sphere of one electron per atom. Effective mass is 1.3 m. (*PA*, 1959, #5876)

1344. EFFECT OF CHEMISORBED HYDROGEN ON THE MAGNETIZATION OF NICKEL AT LOW TEMPERATURES
Dietz, R. E. and Selwood, P. W.
***Journal of Applied Physics*, v. 30, no. 4, (Supplement), pp. 101S–102S, April 1959**

The saturation magnetization of nickel particles in the range 10–100 Å has been determined by extrapolation from magnetizations measured at 4.2°K in fields up to 10^4 oersted. Measurements have been made prior to, and after, the admission of hydrogen to the nickel at room temperature.

(See also references: 1387, 1388, 1430, 1434, 1435, 1436, 1446, 1470, 1473, 1484, 1545, 1586)

B. General

1345. ON THE MAGNETIZATION OF SINGLE CRYSTALS OF NICKEL. A
Kaya, S.
***Science Reports of the Tôhoku University*, v. 17, pp. 639–663, 1928**

1346. ON THE MAGNETIZATION OF SINGLE CRYSTALS OF COBALT. B
Kaya, S.
***Science Reports of the Tôhoku University*, v. 17, pp. 1157–1177, 1928**

1347. STRAY MAGNETIC FIELDS FROM COBALT
Germer, L. H.
***The Physical Review*, v. 62, p. 295, 1942**

1348. FERROMAGNETISME DES ALLIAGES BINAIRES DE MANGANESE (THESIS)
Guillaud, C.
Strasbourg, 1943

1349. VARIATION THERMIQUE DU CHAMP COERCITIF DU NICKEL AGGLOMERE
Weil, L. and Marfoure, S.
***Journal de physique et le Radium*, v. 8, pp. 358–361, 1947**

1350. ELASTIC CONSTANTS AND INTERNAL LOSS OF SINGLE NICKEL CRYSTALS
Bozorth, M. and McSkimin, W.
***The Physical Review*, v. 75, p. 1954, 1949**

1351. ORDER-DISORDERED TRANSFORMATION AND MAGNETIC SUSCEPTIBILITY OF Mg–Cd ALLOYS
Miyata, N.
***Science Reports of the Yokohama National University*, no. 1, pp. 15-26, March 1952**

Results are given of susceptibility measurements over the whole composition range and at temperatures between room temperature and 350°C. At room temperature the alloys between pure Cd and 60% Mg (atomic) are diamagnetic, and those between 60% Mg and pure Mg paramagnetic. In the disordered state the susceptibilities are temperature independent and vary linearly with the atomic concentration of Mg. The susceptibilities are numerically larger in the ordered than in the disordered state. Comparison is made with results of electrical resistance measurements. (*PA*, 1955, #7185)

1352. PARAMAGNETIC SUSCEPTIBILITY OF AuCr ALLOYS
Giansoldati, A.
***Arkiv för Fysik*, v. 8, Paper 12, pp. 151–154, 1954**

Results of measurements on alloys with 2%–20% Cr (atomic) at temperatures between 300 and 800°K are given. Inverse susceptibility, temperature curves (corrected for Au diamagnetism) obey the Curie-Weiss law for the lower Cr concentrations, but for Cr concentrations above about 10% they show a gradual transition from one straight line to another at about 500 to 600°K. Effective p_B values are deduced for the different alloys for the different temperature ranges. (*PA*, 1955, #1056)

1353. MAGNETIC POWDER PATTERNS ON COBALT AND THE STRUCTURE OF THE ELEMENTARY DOMAINS
Andrä, W.
***Annalen der Physik*, Leipzig, v. 15, no. 2, pp. 135–140, 1954 (in German)**

Results are given of powder pattern experiments on polycrystalline cobalt specimens with and without application of magnetic fields perpendicular to the surface. Maze patterns with attached spikes were observed. Conclusions are drawn as to the shape and dimensions of the domains inside the metal. (*PA*, 1955, #3877)

1354. TEMPERATURE DEPENDENCE OF [THE] MAGNETIC ANISOTROPY OF Cd_3Mg
Miyata, N.
***Science Reports of the Yokohama National University*, I, no. 3, p. 19, March 1954**

Reports results of measurements of the two principal susceptibilities of a single crystal specimen between room temperature and 200°C. An order-disorder transformation was found to occur at 100°C. (*PA*, 1955, #7192)

1355. THE EFFECT OF HEAT-TREATMENT ON THE LONGITUDINAL MAGNETOSTRICTION IN WEAK MAGNETIC FIELDS
Matsumae, S.
***Kumamoto Journal of Science*, Series A, v. 1, no. 4, pp. 40–42, March 1954**

Reports results of measurements on electrolytic nickel in the field range of constant permeability. The magnetostriction is found to be considerably influenced by prior heat treatment which is thought to affect the internal strain of the specimen. (*PA*, 1955, #4790)

1356. COLLECTIVE ELECTRON FERROMAGNETISM AND THE PARAMAGNETISM OF COBALT ALLOYS
Watanabe, H.
***Science Reports of the Research Institutes of the Tôhoku University*, Series A, v. 6, no. 4, pp. 343–374, August 1954**

The paramagnetic susceptibilities above the Curie temperatures of some cobalt alloys are studied and interpreted on the collective electron theory of ferromagnetism developed previously by the author (1948) and Wohlfarth (1949, 1951). The effect of the polymorphic transformation on susceptibilities is also studied, and, as a result, some revisions for the phase diagrams are suggested. (*PA*, 1955, #1981)

1357. ON A NEW ANOMALY IN THE ALLOYS OF NICKEL AND COBALT. I. THE EFFECT OF HEAT TREATMENT IN MAGNETIC FIELD ON THEIR MAGNETIC PROPERTIES
Masumoto, S., Inoue, S., and Ukaji, I.
***Science Reports of the Research Institutes,* Tôhoku University, Series A, v. 6, no. 4, pp. 375–383, August 1954**

The effect of the magnetic field treatment on the magnetic properties of Ni–Co alloys was examined with 21 kinds of specimens in ring form. It has been found that the magnetic properties of some Ni–Co alloys in the γ-phase region are so remarkably affected by the magnetic treatment that the maximum permeability, 1050, of 60% Co alloy in an annealed state, becomes 16,600 after cooling in a field of 1 oersted. The magnetization and magnetic hysteresis curves of the alloys showing the remarkable effect are of Perminvar type when they are cooled in a weak field from 0.1 to 0.5 oersted, and become more rectangular in form with an increase of the field strength applied during cooling, showing that there are two kinds of domains, one of which can be reoriented in a weak field, the other in a stronger one. (*PA*, 1955, #2014)

1358. TEMPERATURE RELATION OF THE MAGNETOSTRICTION OF FERROMAGNETIC ALLOYS
Volkov, D. I. and Chechernikov, V. I.
***Zhurnal Eksperimentalnoi i Teoretischeskoi Fiziki*, v. 27, no. 2(8), pp. 208–214, 1954 (in Russian)**

The temperature relation of the magnetostriction of saturation of ferromagnetic alloys on a nickel base was investigated in order to establish whether Akulov's linear law relating the constants characterizing the even effect with the temperature (and the saturation magnetostriction at the absolute zero) remained valid for alloys, which seemed doubtful since contradicting results had been obtained by the only two investigatiors who examined alloys so far. The investigation was carried out on alloys of the systems Ni–Cu, Ni–Mn, Ni–Fe, in a narrow range near the Curie point, and with all the experimental refinements possible. These referred above all to the development of a new and improved type of strain gauges. Within the range investigated, the linear character of the relation was almost perfect and accurately confirmed the validity of Akulov's law. (*PA*, 1955, #4789)

1359. THE MAGNETIC ANISOTROPY OF COBALT
Sucksmith, W. and Thompson, J. E.
***Proceedings of the Royal Society of London,* Series A, v. 225, pp. 362–375, September 1954**

1360. MAGNETIC PROPERTIES OF SOME RARE EARTH METALS AND OXIDES. I
La Blanchetais, C. H.
***Journal des recherches du centre national de la recherche scientifique*, Paris, v. 6, no. 28, pp. 32–41, September 1954 (in French)**

This report describes the methods of preparation of very pure, iron-free specimens of Ce (electrolysis of $CeCl_3$) and Pr, and of a number of oxides and oxide mixtures of rare earths free from hydrates and carbonates. Also describes briefly the apparatus used in magnetic studies. (*PA*, 1955, #1995)

1361. MAGNETIZATION OF TIN AT THE SUPERCONDUCTING TRANSITION
Thompson, J. C. and Squire, C. F.
***The Physical Review*, v. 96, no. 2, pp. 287–291, October 1954**

Measurements have been made of the steady-state magnetization of a tin cylinder in the presence of an external magnetic field and with an externally supplied current at the transition to superconduction. In accord with earlier work in Germany, a longitudinal flux in excess of that caused by the external field is observed for certain combinations of external field and current. The dependence of the effect on the external parameters is given and it is shown that the metal is not in the pure superconducting state. No satisfactory theory for the effect has been found, but some numerical relationships have been computed. (*PA*, 1955, #391)

1362. DERIVATION OF MAGNETOSTRICTION AND ANISOTROPIC ENERGIES FOR HEXAGONAL, TETRAGONAL, AND ORTHORHOMBIC CRYSTALS
Mason, W. P.
***The Physical Review*, v. 96, no. 2, pp. 302–310, October 15, 1954**

In order to determine the measurements necessary to characterize the anisotropic energy and the saturation magnetostriction in hexagonal cobalt, a phenomenological derivation has been given for the equations which characterize the effects. Out to fourth-rank tensors, the results are the same as those for circular symmetry. It requires two constants to specify the anisotropic energy and four to specify the magnetostriction. When sixth-rank tensors are evaluated, a characteristic hexagonal symmetry appears. It requires four constants to characterize the anisotropic energy and nine to characterize the magnetostriction. These constants can be measured by using two oriented slabs. Four of the constants can be determined by measurements parallel to the saturation magnetization, four when the magnetostriction is perpendicular to the magnetization and one when they are 45 deg apart. In the appendix the first approximations for the magnetostrictive and anisotropy energies are derived for tetragonal and orthorhombic crystals. (*PA*, 1955, #392)

1363. MAGNETOSTRICTION AND CRYSTAL ANISOTROPY OF SINGLE CRYSTALS OF HEXAGONAL COBALT

Bozorth, R. M.

***The Physical Review*, v. 96, no. 2, pp. 311–316, October 15, 1954**

Magnetostriction at saturation has been measured in various crystallographic directions in a single crystal of cobalt. Results are described by Mason's formula with 4 constants, which are now evaluated. Magnetization causes contractions as large as 100×10^{-6}, and expansions up to 150×10^{-6} depending on crystallographic direction. A fractional decrease in volume, associated with domain orientation, is observed to be as large as 26×10^{-6}. Superposed on this contraction is a small isotropic increase in volume of 0.6×10^{-9} per oersted. Magnetic crystal anisotropy constants are determined and used in a calculation of the magnetostriction as dependent on the magnitude of the field applied to a disk with given demagnetizing factor. Calculation and observation agree, and show that the direction and magnitude of magnetization and of true field can be calculated in any applied field as long as it is considerably above the coercive force. (*PA*, 1955, #393)

1364. THE ΔE-EFFECT, YOUNG'S MODULUS, AND MAGNETIC PROPERTIES IN FERROMAGNETIC NICKEL–COPPER ALLOYS

Yamamoto, M.

***Science Reports of the Research Institutes of the Tôhoku University*, Series A, v. 6, no. 5, pp. 446–457, October 1954**

The results of the dynamic measurements of Young's modulus and its change with magnetization (the ΔE-effect) as well as of the ballistic measurements of the ferromagnetic characteristics made at ordinary temperatures on annealed ferromagnetic nickel-copper alloys are described. The ΔE-effect in alloys containing 5 to 20% copper shows a negative small minimum at low fields or at low magnetization. It is shown that the observed values of the saturation ΔE-effect are in a quantitatively fairly good agreement with values computed from a formula: $(\Delta E/E_0)_s = [0.7\,(\kappa_0 E_0 \lambda_s^2)/I_s^2]/[1 - 0.7\,(\kappa_0 E_0 \lambda_s^2)/I_s^2]$, where κ_0 is the initial suceptibility, I_s the saturation magnetization and λ_s the saturation magnetostriction. Young's moduli at unmagnetized state as well as at magnetically saturated state reveal minima at 15 to 20% copper. Some new information is also given of the magnetic properties. (*PA*, 1955, #1986)

1365. THE MAGNETIC PROPERTIES AND THEIR TEMPERATURE DEPENDENCE OF FERROMAGNETIC ALLOYS WITH AN ORDER–DISORDER TRANSFORMATION. II. Ni_3Mn

Taoka, T. and Ohtsuka, T.

***Journal of the Physical Society of Japan*, v. 9, no. 5, pp. 723–729, September–October 1954**

Measurements on the change of magnetic properties with the formation of the superlattice and their temperature dependency at a fixed state of order has been carried out on the ferromagnetic alloy Ni_3Mn which shows characteristic properties different from the same A_3B-type Ni_3Fe. Measurements were made by the apparatus described in Part I. Ni_3Mn is known to undergo an order-disorder transformation in the temperature range 600 to 300°C. Major results obtained are: (1) the ferromagnetic Curie point increases from below room temperature at the disordered state to over 490°C at the ordered state; (2) saturation magnetostriction is very small and the temperature dependence complicated; (3) large and long magnetic after-effects were found at the intermediate states of order. (*PA*, 1955, #2868)

1366. ON SOME MAGNETIC PROPERTIES OF THE ALLOY $MnAu_2$
Meyer, A. J. P. and Taglang, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 239, no. 16, pp. 961–963, October 18, 1954 (in French)**

σ–H and σ–T curves are given. In fields < 8000 oersted a constant susceptibility is found. Above 15,000 oersted the magnetization varies as $1/H^2$. No remanence was observed. The σ–T curves show a maximum at a temperature which decreases as the applied field increases. The observed magnetization corresponds to $3 \cdot 5$ μ_B per atom of Mn. (*PA*, 1955, #1988)

1367. NEGATIVE AND POSITIVE MAGNETO-CALORIC EFFECTS, AND THE MAGNETIC STATES OF THE COMPOUND $MnAu_2$
Meyer, A. J. P. and Taglang, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 239, no. 23, pp. 1611–1613, December 8, 1954 (in French)**

At a critical temperature T_c, depending on field strength, the magnetization passes through a maximum. Hence the magnetocaloric temperature change ΔT, proportional to $-(\partial I/\partial T)_H \Delta H$, changes sign at the same temperature. This effect is verified for temperatures between 14 and 130°C and fields between 6.6×10^3 and 28.1×10^3 oersted. Curves of ΔT against T, obtained by adiabatic demagnetization, lie above the T-axis for $T < T_c(H)$, below for $T > T_c$, and pass through a minimum at 90°C, the Curie temperature. (*PA*, 1955, #2871)

1368. LARGE MAGNETIC KERR ROTATION IN BiMn ALLOY
Roberts, B. W. and Bean, C. P.
***The Physical Review*, v. 96, no. 6, pp. 1494–1496, December 15, 1954**

Ferromagnetic domains in BiMn crystallites are found to be easily observed by utilizing plane-polarized light in reflection. A crystallite viewed parallel to the c_0 axis shows a characteristic "rick rack" or zigzag pattern of domains as a stable configuration in zero field. Magnetic domain patterns reminiscent of spiral surface growth are observed. The large magneto-optic rotation is thought to be due to the high resistivity of BiMn alloy. (*PA*, 1955, #1993)

1369. MAGNETO-THERMOELECTRIC POWERS OF NICKEL SINGLE CRYSTALS
Miyata, N. and Funatogawa, Z.
***Journal of the Physical Society of Japan*, v. 9, no. 6, pp. 967–973, November–December 1954**

The magneto-thermoelectric power (change of thermoelectric power due to magnetization of ferromagnetic substances), and its temperature dependency for nickel single crystals, are measured. The $(E_m)_{100}$ and $(E_m)_{111}$, which specify the characteristic property along the directions [100] and [111] respectively, are calculated using some reasonable approximations. The true magneto-thermoelectric power depends on the orientations of the crystal and is always positive, except in the neighborhood of the Curie point, where it is negative. It is due to additive magnetizations proportional to the external magnetic fields, and represents a maximum value near room temperature, tending to zero at 0°K and also at the Curie point. (*PA*, 1955, #2874)

1370. PARAMAGNETIC SUSCEPTIBILITY MEASUREMENTS ON PdAg ALLOYS
Kronqvist, E.
***Arkiv för Fysik*, v. 10, Paper 5, pp. 49–57, 1955**

The paramagnetic susceptibility of Pd and some Pd-rich PdAg alloys has been determined from room temperature up to about 1000°K. The experimental results have been compared with the collective electron theory for magnetism, developed principally by Stoner. Good agreement with this theory has been obtained in the interval of temperature studied. Further, it has been shown that cold-working does not appreciably change the paramagnetism of Pd and Pd-rich PdAg alloys. (*PA*, 1956, #3015)

1371. BAND MODEL FOR HALL EFFECT, MAGNETIZATION, AND RESISTIVITY OF MAGNETIC METALS
Pugh, E. M.
***The Physical Review*, v. 97, no. 3, pp. 647–654, February 1, 1955**

The ordinary Hall coefficients for Cu, Ni, Co and the binary alloys of these elements agree to within a factor of two with predictions based upon the usual band model in which the number of conduction electrons per atom is postulated to the number, $n_s = 0.6$, of $4s$ electrons required to explain the saturation magnetization in these

materials. The factor of two, however, created a dilemma, since both the magnetization data and the Hall data were accurately determined. The Hall results appeared to require that $n_s < 0.3$ whereas the magnetization data requires that $n_s > 0.54$. It will be shown that this dilemma disappears when the 4*s* band is considered divided into two parts in which the electrons with spins parallel to the spontaneous magnetization have much greater mobility than those with spins antiparallel. According to Mott, the antiparallel electrons have low mobility, because they can be scattered into the partially empty 3*d* band, whereas the parallel electrons cannot. It will be shown that the ordinary Hall data, the saturation magnetization data, and the resistivity data for these transition elements and their alloys, can be made understandable by employing a four-band model, consisting of two 4*s* bands and two bands from the 3*d* shell. (*PA*, 1955, #2873)

1372. MAGNETIC PROPERTIES OF MANGANESE-GERMANIUM ALLOYS

Quigg, R. J., Conrad, G. P., and Libsch, J. F.
***Journal of Metals*, v. 7, no. 2, p. 359, February 1955**

Magnetic values obtained on test bars knowing nominal composition of manganese-germanium alloys prepared by processing elemental powders and sintering them in purified helium atmosphere. (*EI*, 1955)

1373. THE TEMPERATURE DEPENDENCE OF MAGNETOSTRICTION IN A NICKEL CRYSTAL

Corner, W. D. and Hunt, G. H.
***Proceedings of the Physical Society*, London, Section A, v. 68, Part 3, pp. 133–144, March 1955**

From a single crystal of nickel two specimens have been prepared in the form of prolate spheroids whose major axes lie along the [100] and [111] crystallographic directions. By the use of a special capacitance bridge arrangement, the longitudinal magnetostriction of each specimen has been measured over the temperature range −180 to 360°C. The results obtained indicate that at low temperatures the magnetostriction below saturation varies with magnetization approximately in the manner given by the domain treatment suggested by Heisenberg, and that with increasing temperature there is a steady departure from the calculated values. The saturation magnetostriction was found to depend on temperature in a way which did not correspond to any known theory. (*PA*, 1955, #3883)

1374. A MAGNETIC INTERNAL FRICTION PEAK IN NICKEL UNDER ALTERNATING MAGNETIC FIELD

Mišek, K.
***Scientia Sinica*, v. 4, no. 1, pp. 107–118, March 1955**

The coupling between elastic and magnetic phenomena in ferromagnetic materials often gives rise to internal friction. In previous studies on magneto-elastic internal friction, the applied magnetic field was mostly static. In the present experiment, a nickel specimen was made to vibrate in torsion under an alternating magnetic field, and a pronounced internal friction peak was observed when internal friction was plotted as a function of the alternating magnetic field strength. This peak did not appear under similar conditions but using a static magnetic field. The position of the peak was shifted toward the side of higher magnetic field when the nickel specimen was either cold-worked or contained carbon; and it was shifted toward the side of lower magnetic field when the specimen was previously annealed at an elevated temperature. The height of the peak was considerably raised with an increase of vibrating frequency. A qualitative explanation of this peak is given on the basis of reversible and irreversible processes occurring at different stages of the magnetization curve of nickel. Factors affecting this peak are discussed. (*PA*, 1955, #9771)

1375. THE MAGNETIC SUSCEPTIBILITY OF METALLIC NEODYMIUM

Bates, L. F., Leach, S. J., Loasby, R. G., and Stevens, K. W. H.
Note in *Proceedings of the Physical Society*, London, Section B, v. 68, Part 3, pp. 181–182, March 1955

Report results on two Nd specimens (0.7% Fe) between 290 and 1000°K. The room temperature mass susceptibility was found to equal 38.6×10^{-6}, the susceptibility, temperature curve obeys the Curie-Weiss law up to 500°K ($\theta = -15$°K, $p_B = 3.72$), deviations from this law at higher temperatures being interpreted in terms of a temperature dependent electronic excitation process. (*PA*, 1955, #4793)

1376. BEITRAG ZUM FERROMAGNETISMUS VON LEGIERUNGEN DER UEBERGANGS-METALLE MIT ELEMENTEN DER B-GRUPPE
Castelliz, L.
***Zeitschrift für Metallkunde*, v. 46, no. 3, pp. 198–203, March 1955**

Contribution to ferromagnetism of alloys of transition metals with elements of B-group; saturation magnetization, and Curie temperature of binary and ternary B8-phases with germanium as B-metal, of NiCoSb and NiCoSn, as well as some fluorspar and Heussler phases. (*EI*, 1955)

1377. MAGNETIC INVESTIGATIONS ON TWO ALLOYS OF THE Au–Mn SYSTEM
Giansoldati, A.
Letter in *Journal de physique et le Radium*, v. 16, no. 4, pp. 342–343, April 1955 (in French)

Reports results of susceptibility measurements between room temperature and 1100°K for the alloys Au_3Mn and AuMn. For Au_3Mn a sudden change of susceptibility was observed at 920°K, accompanied by temperature hysteresis. For AuMn a very sharp susceptibility maximum was observed at 500°K, indicating this alloy to be antiferromagnetic. (*PA*, 1955, #7187)

1378. THE REDUCED MAGNETIZATION-TEMPERATURE CURVE OF FERROMAGNETIC ALLOYS
Kranz, J. and Bodewig, C.
***Zeitschrift für Physik*, v. 142, no. 4, pp. 396–400, 1955 (in German)**

The observed deviations of the reduced curves for Ni–Cu alloys from the curve for pure Ni are ascribed to statistical fluctuations in composition. For an alloy with mean Cu concentration $C = 0.25$ the observed curve is brought into coincidence with that for Ni by assuming a Gaussian distribution with $\sigma = [C(1 - C)/n]^{\frac{1}{2}} = 0.04$, leading to a value for the number of atoms n in a region of constant composition (erroneously called a domain) equal to only 120. (*PA*, 1956, #2232)

1379. MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON GERMANIUM BETWEEN ROOM TEMPERATURE AND LIQUID HYDROGEN TEMPERATURES
van Itterbeek, A., de Greve, L. and Duchateau, W.
***Applied Scientific Research*, Section B, v. 4, no. 4, pp. 300–308, 1955**

Susceptibility measurements have been done on germanium samples with different degrees of impurities. The susceptibilities from room temperature down to liquid hydrogen temperatures were measured. The results have been compared with those of Stevens and Crawford who also measured susceptibilities of germanium samples, but only down to liquid nitrogen temperatures. At liquid hydrogen temperatures a strong variation of the susceptibility was noticed, which is a consequence of the paramagnetic term, as predicted by Busch and Mooser from their measurements on α-tin. (*PA*, 1955, #5510)

1380. THE MINIMUM SIZE OF WEISS–HEISENBERG DOMAINS OF COBALT
Knappwost, A.
***Naturwissenschaften*, v. 42, no. 16, p. 459, 1955 (in German)**

From measurements of the susceptibility of a supersaturated Cu–Co alloy, containing 0.175%, Co, during the process of precipitation of pure Co in dispersed form, the minimum domain size is found to be 16 Å, assuming the applicability of the Langevin formula. (*PA*, 1956, #463)

1381. DE HAAS–VAN ALPHEN EFFECT—3. EXPERIMENTS AT FIELDS UP TO 32 kG
Dhillon, J. S. and Shoenberg, D.
***Philosophical Transactions of the Royal Society of London*, Series A, v. 248, no. 937, pp. 1–21, April 26, 1955**

Periodic field dependence of magnetic anisotropy (de Haas–van Alphen effect) studied for bismuth and zinc crystals by torque method between about 1.5 and 32 kG at 4.19°Kand about 1.5°K.(*EI*, 1955)

1382. FERROMAGNETIC DOMAIN PATTERNS ON SINGLE CRYSTALS AND BICRYSTALS OF NICKEL
Martius, U. M. and Gow, K. V.
***Canadian Journal of Physics*, v. 33, no. 5, pp. 225–234, May 1955**

Ferromagnetic domain patterns were studied on the (110), (112) and (001) planes of single crystals of nickel. The crystals were grown from seeds of predetermined orientation and no mechanical cutting was required prior to the observation of the domain patterns. The results are compared with data in the literature, existing discrepancies are pointed out and interpreted. The influence of grain boundaries on the domain patterns is shown in experiments with bicrystals. (*PA*, 1955, #5515)

1383. ZUR MAGNETISCHEN ANALYSE VON KUPFER–NICKEL–SINTERKOERPERN

Torkar, K. and Goetz, H.
***Zeitschrift für Metallkunde*, v. 46, no. 5, pp. 371–377, May 1955**

Magnetic analysis of copper nickel sintered products; development of magnetic balance for ferromagnetic materials for measuring saturation magnetization; balance makes it possible to measure dependence of magnetization on field strength; application to copper–nickel solid solutions. (*EI*, 1955)

1384. MAGNETIC SUSCEPTIBILITY OF HAFNIUM AND MANGANESE

Kriessman, C. J. and McGuire, T. R.
***The Physical Review*, v. 98, no. 4, pp. 936–937, May 15, 1955**

The magnetic susceptibility of hafnium, which has been measured from 4.2 to 1670°K, increases with increasing temperature above 77°K. At room temperature, the susceptibility is $(0.42 \pm 0.01) \times 10^{-6}$ emu/g. The susceptibility of manganese between 77°K and room temperature shows a maximum at 125°K. This can be identified with antiferromagnetism by a correlation with neutron diffraction data. In the temperature region below 77°K the susceptibility increases again quite rapidly. (*PA*, 1955, #6290)

1385. MAGNETIC MOMENTS OF COBALT–COPPER ALLOYS

Crangle, J.
***The Philosophical Magazine*, v. 46, no. 376, pp. 499–513, May 1955**

The rate of change of atomic moment with electron concentration for high temperature face-centered cubic form of solid solution of copper in cobalt is derived from measurements on variation of spontaneous magnetization of various alloys with temperature. (*EI*, 1955)

1386. TEMPERATURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF SODIUM AND POTASSIUM

Venkateswarlu, K. and Sriraman, S.
Letter in *Current Science*, v. 24, no. 6, pp. 191–192, June 1955

Results are reported of measurements between room temperature and 120°C, including the melting points. The room temperature values of the mass susceptibility were found to be 0.575 and 0.455×10^{-6} for Na and K respectively. With increasing temperature the susceptibility increases slightly up to the melting point and then decreases abruptly by a small amount. (*PA*, 1955, #9773)

1387. MAGNETIC SUSCEPTIBILITY OF α MANGANESE AT LOW TEMPERATURES

Arrott, A., Coles, B. R., and Goldman, J. E.
Letter in *The Physical Review*, v. 98, no. 6, pp. 1864–1865, June 15, 1955

Results are given of measurements on two samples, one from a cast ingot, the other a packed capsule of electrolytic flakes, between 1.8°K and room temperature. The room temperature values of the mass susceptibility are $8 \cdot 8$ and $10 \cdot 6 \times 10^{-6}$ respectively. Below 100°K the cast sample shows an increasing susceptibility with decreasing temperature, leading to weak ferromagnetism at He temperatures. This is ascribed to the presence of interstitial gaseous impurities and may be almost completely suppressed by degassing, after which the susceptibility remains almost constant over the range of temperatures covered. (*PA*, 1955, #8081)

1388. THE INFLUENCE OF TEMPERATURE ON MAGNETIC VISCOSITY

Phillips, J. H., Woolley, J. C., and Street, R.
***Proceedings of the Physical Society*, London, Section B, v. 68, Part 6, pp. 345–352, June 1955**

Measurements have been made to demonstrate the effect of temperature on irreversible magnetic viscosity in different types of precipitation alloys: Pt–Co, Ni_3Au and Alnico in an undeveloped state. In this type of alloy, the intensity of magnetization varies as a function of time according to the law $I = S_0 \ln t + \text{const.}$ On the activation

energy model of irreversible magnetic viscosity if ΔE is the change in activation energy produced by a small change in applied field ΔH, $\Delta E = q\Delta H$. For the Alnico and Ni_3Au specimens the two magnetic viscosity parameters S_0 and kT/q are approximately linearly related to temperature. For Pt–Co the viscosity parameters and the coercivity decrease rapidly with increasing temperature. The results are interpreted in terms of Néel's disperse field theory of magnetization with the additional assumption that strains set up between coherent precipitate and matrix are responsible for the production of the disperse fields. It is predicted from the observations of magnetic viscosity that in Pt–Co the disregistry between precipitate and matrix decreases on increasing the temperature. This has been verified by measurements of the differential thermal expansion between the material of precipitate and the matrix by X-ray methods. (*PA*, 1955, #7183)

1389. ANTIFERROMAGNETISM OF MANGANESE–COPPER AND MANGANESE–GOLD ALLOYS

Kussmann, A. and Raub, E.
***Naturwissenschaften*, v. 42, no. 14, p. 411, 1955 (in German)**

Susceptibility maxima were observed at about −125°C for Mn–Cu alloys with Mn concentrations between 30 and 65%, and at about 0°C for $MnAu_2$ in a field of strength 1.38×10^4 oersted and at higher temperatures in lower fields. (*PA*, 1956, #477)

1390. MAGNETIC TRANSFORMATION IN Mn Bi

Heikes, R. R.
***The Physical Review*, v. 99, no. 2, pp. 446–447, July 1955**

Spontaneous loss of magnetization of manganese bismuth at 633°K is interpreted as transition to new ferromagnetic phase with Curie temperature of about 470°K. (*EI*, 1955)

1391. MAGNETIC SUSCEPTIBILITY OF INDIUM ANTIMONIDE

Stevens, D. K. and Crawford, J. H., Jr.
***The Physical Review*, v. 99, no. 2, pp. 487–488, July 15, 1955**

The magnetic susceptibility of both *n*- and *p*-type InSb has been measured by the Faraday method from 65 to 650°K. The carrier contribution has been obtained by subtracting the lattice component in both the intrinsic range and the extrinsic range. These data indicate that the energy gap at 0°K is 0.262 ev and that the electron effective mass is $0.028m_\gamma$. The hole contribution to the susceptibility in the extrinsic range for the *p*-type specimen used was too small to permit a determination of the effective mass of holes. (*PA*, 1955, #8080)

1392. FERROMAGNETISM IN NOBLE METAL ALLOYS CONTAINING MANGANESE

Otter, F. A., Jr., Flanders, P. J., and Klokholm, E.
Letter in *The Physical Review*, v. 99, no. 2, pp. 599–600, July 15, 1955

Values are given of the Curie temperatures and saturation magnetizations of the alloys Au + 18·64%, Mn, Au + 13.01% Mn and Ag + 14.58% Mn. The first of these possesses a paramagnetic component of magnetization in high fields. Resistivity, temperature curves for these and some other related alloys are also shown. (*PA*, 1955, #8897)

1393. MAGNETIC TRANSFORMATION OF CERIUM AT HIGH TEMPERATURES. INFLUENCE OF MAGNESIUM IMPURITIES

Gaume-Mahn, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 3, pp. 286–288, July 18, 1955 (in French)**

Results are reported of susceptibility measurements for pure Ce between 290 and 1030°K. A fairly rapid decrease of the susceptibility takes place near 960°K on heating, with pronounced temperature hysteresis on cooling below this temperature. The transformation point is lowered by the addition of small amounts (1 to 2%) of Mg. (*PA*, 1955, #8912)

1394. MAGNETIC SUSCEPTIBILITIES OF MONOCRYSTALLINE AND LIQUID GALLIUM

Marchand, A.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 5, pp. 468–470, August 1, 1955 (in French)**

Results of measurements of the principal diamagnetic susceptibilities between 80 and 290°K are given. Liquid Ga was found to be slightly paramagnetic at 310° K. (*PA*, 1956, #488)

1395. MAGNETIC INTERNAL FRICTION PEAK IN NICKEL

Mísek, K.

***Czechoslovak Journal of Physics*, v. 5, no. 3, pp. 420–421, August 1955**

Internal friction peaks were observed during application of direct and alternating fields to specimens of nickel with and without carbon impurities. The effect is dependent on frequency, temperature and cold working. (*PA*, 1956, #1393)

1396. THE STRUCTURE AND MAGNETIC PROPERTIES OF THE ALLOY Mn_3AlC

Butters, R. G. and Myers, H. P.

***The Philosophical Magazine*, v. 46, pp. 895–902, August 1955**

An alloy of composition close to Mn_3AlC was prepared by induction melting. In the as-cast state the alloy was feebly magnetic at room temperature and the magnetic property was retained after homogenization at 1,000°C. This alloy was composed of a single phase possessing an ordered face-centered cubic structure with lattice parameter 3.869 Å. The ordered structure is similar to that found in the alloy Mn_3ZnC, the properties of which have been described elsewhere. The alloy Mn_3AlC, is strongly magnetic at low temperatures having a saturation moment at 0°K of 99.6 $ergs/g^{-1}oersted^{-1}$ equivalent to a Bohr magneton number 1.20 per Mn atom, the Curie temperature being 15°C. The paramagnetic susceptibility measured over the temperature range 65–800°C, was found to vary with temperature in a manner different from a normal ferromagnetic material, the $1/\chi - T$ graph possessing pronounced curvature concave to the temperature axis. (*PA*, 1955, #8913)

1397. ON THE GALVANOMAGNETIC EFFECTS IN *n*-TYPE INDIUM ANTIMONIDE

Kanai, Y.

Note in *Journal of the Physical Society of Japan*, v. 10, no. 8, pp. 718–719, August 1955

Results are given of measurements of the Hall constant and the magnetoresistance in magnetic fields up to 10^4 oersted for an InSb specimen with electron density 2.9×10^{17} cm^{-3} and carrier mobility $2 \times 10^4 cm^2V^{-1}sec^{-1}$. The Hall constant was found to be independent of field strength at −136°C, but the relative resistance change, both longitudinal and transverse, to be strongly dependent on it, reaching the value 0.2 at the highest fields applied and at temperatures −170° and −146°C respectively. The results are briefly discussed. (*PA*, 1955, #9763)

1398. ON AN EMPIRICAL FORMULA FOR THE FERROMAGNETIC ANISOTROPY CONSTANT IN CUBIC CRYSTALS

Yamamoto, M.

Note in *Journal of the Physical Society of Japan*, v. 10, no. 8, pp. 725–726, August 1955

An empirical relation $|K| = \frac{1}{4} I_0 H_s$, where I_0 is the saturation magnetization and H_s the field required to obtain about 99.8% of saturation for a polycrystalline specimen, gives good agreement with measured values for Ni–Co and Ni–Cu alloys. (*PA*, 1955, #9770)

1399. FERROMAGNETIC HALL COEFFICIENT OF NICKEL ALLOYS

Schindler, A. I. and Salkovitz, E. I.

***The Physical Review*, v. 99, no. 4, pp. 1251–1252, August 15, 1955**

Published Hall coefficient data for binary Ni alloys have been examined in light of the Karplus–Luttinger theory of the ferromagnetic Hall effect. This theory indicates that the extraordinary Hall coefficient is related to the square of the electrical resistivity, $R_1 = A\rho^2$. Neither the exponent nor the coefficient of ρ varies as additions of up to 30 atomic percent Cu are made to pure Ni, and as the temperature is varied from 20 to 290°K. On the other hand, small additions of either Al, Si or Sn to Ni cause a significant variation in A, but appear to leave the exponent of ρ unaltered. A tentative explanation is offered for the difference in behavior. (*PA*, 1955, #8905)

1400. PRESSURE DEPENDENCE OF DE HAAS–VAN ALPHEN PARAMETERS IN BISMUTH

Overton, W. C., Jr. and Berlincourt, T. G.

***The Physical Review*, v. 99, no. 4, pp. 1165–1169, August 15, 1955**

The Hall coefficient A of a bismuth single crystal has been measured at 4.2°K, in magnetic fields up to 12 kilogauss, and under liquid helium pressures up to 120 atm. The period (β/E_0) of the oscillations in reciprocal field, the phase and the monotonic part of the magnetic field dependence of A were found to depend on the pressure with small, but nevertheless easily measurable, pressure

coefficients. Only the single-period term observable in bismuth when the magnetic field is parallel to the trigonal axis was studied. (*PA*, 1955, #8918)

1401. THE EFFECT OF THE METHOD OF DEMAGNETIZATION OF THE SPECIMEN ON THE TEMPERATURE DEPENDENCE OF THE MAGNETIZATION OF NICKEL IN WEAK FIELDS

Drokin, A. I. and Il'yushenko, V. L.
***Zhurnal Experimentalnoi i Teoretischeskoi Fiziki*, v. 29, no. 3(9), pp. 339–344, 1955 (in Russian)**
(English translation in *Soviet Physics—JETP*, New York, v. 2, no. 2, pp. 191–196, March, 1956)

By two different methods, a study was made of the effect of the method of demagnetization of the specimen on the temperature variation of the intensity of magnetization of nickel in weak magnetic fields. (*PA*, 1956, #6788)

1402. GYROMAGNETIC RATIO OF NICKEL AT LOW MAGNETIC INTENSITIES

Scott, G. G.
***The Physical Review*, v. 99, no. 6, pp. 1824–1825, September 15, 1955**

It has recently been shown that the measured value for the gyromagnetic ratio of iron, as measured by an Einstein–DeHaas experiment, is field-dependent in the low-intensity region, and that the extrapolated zero-intensity value of this ratio checks the value which is theoretically expected from a consideration of recent ferromagnetic resonance experiments. This experiment has been repeated for a sample of pure nickel and a similar result has been obtained. The extrapolated zero intensity value for g' for nickel is 1.801. At a higher induced magnetic intensity, the effective value of g' changes to 1.830. (*PA*, 1956, #494)

1403. FERROMAGNETIC RESONANCE IN NICKEL AND IN SOME OF ITS ALLOYS

Standley, K. J. and Reich, K. H.
***Proceedings of the Physical Society*, London, Section B, v. 68, Part 10, pp. 713–722, October 1955**

From microwave resonance measurements, g values and line widths for nickel and for Ni–Cu, Ni–Al, Ni–Sb and Ni–Mn alloys with high nickel content have been determined. Measurements were made at a wavelength of 1.22 cm and usually in the temperature range 20–200°C. A constant temperature-independent g value of 2.19 ± 0.02 was found for all specimens except the Ni–Mn alloys; for these a decrease in g value with increase in manganese content occurred reaching 2.11 for the 13.5 atomic percent Mn alloy. Absolute absorption measurements were made and the line widths are expressed in terms of the damping constant $1/T_2$ introduced by Bloembergen (1950). For a given alloy the shape of the curve of $1/T_2$ against reduced temperature is similar to that found by Bloembergen for nickel but varies from alloy to alloy. A single curve of exponential form is found to represent the results when $1/T_2$ is plotted against saturation intensity of magnetization M, an increase in $1/T_2$ accompanying a decrease in M. A possible explanation is qualitatively presented. (*PA*, 1956, #1363)

1404. THE FLUCTUATING FIELD MODEL OF FERROMAGNETISM WITH PARTICULAR REFERENCE TO NICKEL

Stacey, F. D.
***Canadian Journal of Physics*, v. 33, no. 11, pp. 661–667, November 1955**

Following Néel's calculations of fluctuations in intermolecular field, a model is suggested in which there is a mutual repulsion of elementary magnets, so that spontaneous magnetization is affected by a process of ordering of the magnets on the lattice sites as well as the ordering in orientation. Specific heat considerations indicate that, if it occurs, the second disordering process is also complete at the Curie point. To explain the observed spontaneous magnetization of nickel it is necessary to assume coupled electron spins and appreciable next-nearest-neighbor exchange interactions. (*PA*, 1956, #461)

1405. CALCULATION OF MAGNETOSTRICTION CONSTANTS FOR NICKEL

Fletcher, G. C.
***Proceedings of the Physical Society*, London, Series A, v. 68, Part 11, pp. 1066–1071, November 1955**

Calculations are made of the magnetostriction constants λ_{100} and λ_{111} for nickel at 0°K, based on the collective electron model and the calculations of the author of the N(E) curve for the 3*d* electrons in that metal. The values of -187×10^{-6} and -44×10^{-6} obtained for λ_{100} and λ_{111} respectively are both rather larger than the lat-

est experimental figures which, however, are available only for 120°K. The method of calculation is very similar to that used by the author in previous work on ferromagnetic anisotropy and the possible reasons for discrepancy between theory and experiment are also similar. (*PA*, 1956, #2240)

1406. THE MAGNETIC SUSCEPTIBILITY OF METALLIC CERIUM

Bates, L. F., Leach, S. J., and Loasby, R. G.
***Proceedings of the Physical Society*, London, Series B, v. 68, Part 11, pp. 859–861, November 1955**

The magnetic susceptibility of pure metallic cerium has been measured over the temperature range 90° to 1057°K. At 293°K the susceptibility is 17.5 ± 0.2 emu/g and between 90° and 295°K the relation $\chi = 0.00588/(T + 42)$ is followed. The observed temperature variation of susceptibility can be explained on the basis of a change in thermal population of $^2F_{5/2}$ and $^2F_{7/2}$ levels separated by 1340 cm^{-1}, upon which is superimposed a small temperature-independent paramagnetism. (*PA*, 1956, #3018)

1407. RESIDUAL MAGNETIZATION AND MAGNETOSTRICTION OF NICKEL SINGLE CRYSTALS

Nakamura, Y.
***Journal of the Physical Society of Japan*, v. 10, no. 11, pp. 937–941, November 1955**

By the use of long cylindrical single crystals of pure nickel with various crystallographic orientations, magnetization and magnetostriction were measured at room temperature. It was found that the remanent magnetization I_r is given approximately by the following relation: $I_r/I_s = 1/\sqrt{3\beta_1}$, where I_s is the saturation magnetization and β_1 is the direction cosine of the rod axis with respect to the nearest [100] direction. On the basis of this relation the magnetostriction constants and also the crystal anisotropy constants were determined. Magnetostriction curves constructed theoretically from the obtained values of magnetostriction constants agree with the experimental curves. (*PA*, 1956, #1394)

1408. INFLUENCE OF MAGNETIC FIELD ON THE PRECIPITATION PROCESS OF FERROMAGNETIC PHASE IN Cu–Co ALLOY

Mitui, T. and Miyahara, S.
***Journal of the Physical Society of Japan*, v. 10, no. 11, p. 1023, November 1955**

The uniaxial anisotropy of an alloy containing 2% Co in which precipitation occurred after annealing in a magnetic field (1000–2000 oersted) is shown by torque measurements to have its origin in a shape effect rather than in the effect of directional order. (*PA*, 1956, #1369)

1409. MAGNETIC SUSCEPTIBILITY OF GERMANIUM

Stevens, D. K., Cleland, J. W., Crawford, J. H., Jr., and Schweinler, H. C.
***The Physical Review*, v. 100, no. 4, pp. 1084–1093, November 1955**

The magnetic susceptibility of a variety of Ge specimens has been measured as a function of temperature over the range from 70 to 300°K. The susceptibility of high-purity specimens shows an unexpected temperature dependence: a decreasing diamagnetism with increasing temperature. By subtracting the susceptibility of high-purity Ge at each temperature from that of impure material, the charge carrier susceptibility has been obtained for a number of *n*- and *p*-type specimens. The effective mass of electrons obtained from susceptibility measurements on *n*-type Ge is in agreement with values yielded by cyclotron resonance. Analysis of the range of transition from classical to Fermi–Dirac statistics suggests that the energy surfaces of the conduction band can be described by four rather than eight ellipsoids of revolution in k-space. In *p*-type Ge the agreement with cyclotron resonance results is not nearly so good in that a larger hole effective mass is required by the susceptibility data. Measurements have been made on one *n*-type specimen bombarded with fast neutrons. After exposures sufficient to produce essentially intrinsic behavior, there was no trace of the paramagnetic component expected from unpaired spins of trapped electrons. This result has been interpreted as indicating that the energy levels associated with bombardment-produced defects form overlapping, degenerate impurity bands for the exposure in question. (*PA*, 1956, #489)

1410. MAGNETIC SUSCEPTIBILITY OF SODIUM METAL

Bowers, R.
***The Physical Review*, v. 100, no. 4, pp. 1141–1144, November 1955**

The total susceptibility of sodium metal has been measured from room temperature down to 55°K using the Gouy technique. The mass susceptibility at room temperature was found to be $+(0.70 \pm 0.03) \times 10^{-5}$ c.g.s. units. This result is analyzed by using an estimate of the ion core susceptibility and calculations of the conduction-electron spin contribution. The analysis leads to a conduction-electron diamagnetism which is much smaller than the value obtained from the Landau–Peierls formula. No explanation is given of this disparity. The susceptibility decreases by 4.5% between room temperature and 55°K. No abnormal behavior was found in the susceptibility between 77 and 55°K where the Knight shift exhibits an anomaly. An account is given of experimental difficulties which were encountered in an attempt to measure the susceptibility at liquid helium temperatures. (*PA*, 1956, #490)

1411. MAGNETIC PROPERTIES OF ERBIUM METAL

Elliott, J. F., Legvold, S., and Spedding, F. H.
***The Physical Review*, v. 100, no. 6, pp. 1595–1596, December 15, 1955**

Measurements of the magnetic moment of erbium metal in the temperature range from 20.4 to 90°K are reported. The initial susceptibility shows a maximum at 78°K, and the metal appears to become ferromagnetic near 20°K. (*PA*, 1956, #1372)

1412. UEBER FERRO- UND ANTIFERRO-MAGNETISCHE EIGENSCHAFTEN IM SYSTEM GOLD-MANGAN

Kussmann, A. and Raub, E.
***Zeitschrift für Metallkunde*, v. 47, no. 1, pp. 9–15, January 1956**

Ferromagnetic and antiferromagnetic properties in gold manganese system; two zones of strong magnetization determined in system by means of thermomagnetic measurements; anomalous magnetic properties of Au_2Mn and AuMn phases; cause of this was proved to be intermediate phase Au_4Mn having tetragonal face-centered lattice and complex superstructure. (*EI*, 1956)

1413. THEORY OF THE MAGNETOSTRICTION OF Ni MONOCRYSTALS

Akulov, N. S.
***Doklady Akademii Nauk SSSR*, v. 106, no. 1, pp. 31–34, 1956 (in Russian)**

The author's law of magnetic anisotropy (1928), successfully applied to the calculation of the magnetostriction of crystals with six directions of spontaneous magnetization, assumes successive occurrence of longitudinal and transverse inversions. An analysis of the spin transitions to which these inversions are due, in the case of a field parallel to the directions of spontaneous magnetization to be calculated. (*PA*, 1956, #4503)

1414. VARIATION OF THE MAGNETIC ANISOTROPY ENERGY OF Ni AND OF Ni–Cu ALLOYS AS A FUNCTION OF THE TEMPERATURE

Sato, M. and Tino, Y.
***Journal de physique et le Radium*, v. 17, no. 1, pp. 5–8, January 1956 (in French)**

By consideration of the magnetic interactions between neighboring atoms, a simple theoretical explanation is given of the variation with temperature of the first anisotropy constant for nickel and nickel–copper alloys. The relation obtained is formally identical with the empirical relation given by Brukhatov and Kirensky, $K_1 = K_{10} \exp(-\alpha T^2)$. (*PA*, 1956, #4498)

1415. MAGNETIC SUSCEPTIBILITY OF LOW RESISTIVITY *N*-TYPE GERMANIUM

Hedgcock, F. T.
***Canadian Journal of Physics*, v. 34, no. 1, pp. 43–49, January 1956**

Some results for polycrystalline germanium as observed between room and liquid nitrogen temperatures are presented. The contribution to the susceptibility from both the free and bound charge carriers has been derived from the experimental results and appears to vary inversely with temperature. An effective mass for the charge carriers in *n*-type germanium is found to be 0.16 of the free electron mass. (*PA*, 1956, #1391)

1416. THE SATURATION MAGNETIZATION OF NICKEL UNDER HIGH HYDROSTATIC PRESSURE

von Klitzing, K. H. and Gielessen, J.
***Zeitschrift für Physik*, v. 146, no. 1, pp. 59–64, 1956 (in German)**

The pressure coefficient of the magnetization of nickel under hydrostatic pressures up to 5.3×10^3 atm and a field of strength 6.4×10^3 oersted was found to be less than 1.2×10^{-7} atm^{-1}, i.e., much less than the value 1.1×10^{-5} atm^{-1} obtained by Jones and Stacey. The pressures used by the latter are believed to be not purely hydrostatic. (*PA*, 1957, #540)

1417. THE INFLUENCE OF SPONTANEOUS, TRUE AND FERROMAGNETIC MAGNETIZATION ON ELECTRICAL RESISTANCE

Böhringer, E.

***Zeitschrift für Physik*, v. 146, no. 1, pp. 65–74, 1956 (in German)**

Reports results of experiments on nickel between 88 and 505°K. It is found that $R - R_s = A\,\delta R \cos^2\theta$, where θ = the angle between the current and the spontaneous magnetization vector in a domain, δR = the temperature dependent ferromagnetic resistance anomaly and R_s and A are constants. The resistance change was also measured at fields above those required for technical saturation, and was found to be proportional to the field strength and to depend on the temperature. (*PA*, 1957, #415)

1418. X-RAY EMISSION SPECTRA OF Mn AND Cu IN A HEUSLER ALLOY IN THE MAGNETIC TRANSITION RANGE OF TEMPERATURES

Vaĭnshteĭn, É. E. and Kotlyar, B. I.

***Doklady Akademii Nauk, SSSR*, v. 110, no. 1, pp. 44–47, 1956 (in Russian)**

The form and position of lines of the $K\beta$-group of Mn and Cu were studied in a Heusler alloy near the composition Cu_2AlMn, as well as the corresponding characteristics of the $K\alpha_{1,2}$ lines of the same elements over a wide range of temperatures. Details of the X-ray tube for these studies are given. With change from ferromagnetic to paramagnetic state there is a marked change in the form of the $K\beta_5$ lines; for Mn the lines shift towards the long-wave end of the spectrum while for Cu the opposite happens. Intensity measurements on these $K\beta_5$ lines are in qualitative agreement with Sokolov and Tsipis. The present authors consider that the changes in certain characteristics of Cu spectrum lines in this Heusler alloy during transition through the Curie point indicate that Cu, besides providing the basic lattice for carrying Mn atoms, also takes a large part in the ferromagnetism of the alloy. (*PA*, 1957, #5367)

1419. ANTIFERROMAGNETIC STRUCTURE OF α-MANGANESE AND A MAGNETIC STRUCTURE STUDY OF β-MANGANESE

Kasper, J. S. and Roberts, B. W.

***The Physical Review*, v. 101, no. 2, pp. 537–544, January 15, 1956**

Neutron diffraction data have been obtained at 4.2 and 298°K for both α-Mn and β-Mn. The pattern of moment alignment in the antiferromagnetic state of α-Mn is deduced. Dependent on interatomic distance, both parallel and antiparallel spin couplings are present. Also, for one kind of atom no moment alignment occurs. The magnitudes of the individual moments appear to exceed considerably one Bohr magneton. No coherent magnetic scattering is detectable for β-Mn at 4.2°K. The effect of atomic separation and of atomic arrangement on magnetic structure is discussed. (*PA*, 1956, #2239)

1420. TEMPERATURE VARIATION OF THE MAGNETOSTRICTION OF FERROMAGNETIC ALLOYS

Volkov, D. I., Chechernikov, V. I., and Tseitlin, V. B.

***Vestnik Moskovskogo Universiteta*, no. 2, pp. 21–28, 1956 (in Russian)**

The temperature dependence was investigated for alloys Ni–Cu, Ni–Mn, Ni–Co, 45% Ni–55% Fe at temperatures near the Curie point. The linear law for change of magnetostriction saturation with temperature, given by theory, accounts satisfactorily for the results observed. Ni–Co alloys exhibit allotropy and jumps of magnetostriction are observed at the temperature of modification as well as a considerable hysteresis of the $\lambda_s(T)$ curves. (*PA*, 1957, #6355)

1421. TEMPERATURE DEPENDENCE OF THE DIFFERENTIAL SUSCEPTIBILITY OF COBALT IN STRONG MAGNETIC FIELDS

Pál, L. and Tarnóczi, T.

***Acta Physica Academiae Scientiarum Hungaricae*, v. 6, no. 2, pp. 225–236, 1956**

A curve showing a characteristic double maximum was obtained for the temperature dependence of the differential susceptibility of cobalt in strong magnetic fields; all

sections of this curve could be interpreted on the basis of the theory of the rotation processes. The temperature of the minimum between the two maxima calculated from Sucksmith and Thompson's measurement on monocrystals is found to be in good agreement with the temperature of the experimentally determined minimum of the differential susceptibility of a polycrystalline sample. The effect of the $\alpha \rightleftarrows \beta$ phase transformation on the differential susceptibility is studied. (*PA*, 1957, #4532)

1422. SUPER-EXCHANGE AND THE MAGNETIC PROPERTIES OF PALLADIUM BETWEEN 80 AND 1600°K

Wucher, J.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 9, pp. 1143–1145, February 27, 1956 (in French)**

Results of measurements of the magnetic susceptibility of palladium from 757 to 1649°K are given. Previously published values, over smaller temperature ranges, are in good agreement with one another but the theoretical interpretation, particularly of the maximum at 80°K, is not satisfactory. A theory of super-exchange between nearest neighbors is now proposed. An equation for the susceptibility as a function of T is given, having only one adjustable parameter; this may be chosen to give a good representation of the observed values. One term of the whole expression has a maximum at 80°K and it is suggested that this gives an interpretation of the observed maximum at this temperature. (*PA*, 1956, #4484)

1423. FERROMAGNETIC DOMAINS ON MANGANESE-BISMUTH AT LOW TEMPERATURES

Andrä, W.

***Annalen der Physik*, Leipzig, v. 17, no. 2–3, pp. 78–83, 1956 (in German)**

Reports results of domain observations using the magneto-optic Kerr effect. Changes of the patterns with changing temperature are a result of the temperature variation of the magneto-crystalline anisotropy coefficient, which vanishes at 90°K, and of the saturation magnetization. (*PA*, 1956, #5216)

1424. THE MAGNETIC SUSCEPTIBILITIES OF COPPER, SILVER AND GOLD AND ERRORS IN THE GOUY METHOD

Henry, W. G. and Rogers, J. L.

***The Philosophical Magazine*, Eighth Series, v. 1, no. 3, pp. 223–236, March 1956**

A direct determination has been made of the absolute magnetic mass susceptibility of copper, silver and gold. The values at 23°C are: copper, $-0.0850_9 \pm 0.0002_7 \times 10^{-6}$; silver, $-0.1812_8 \pm 0.0005_4 \times 10^{-6}$; gold, $-0.1421_6 \pm 0.00048 \times 10^{-6}$, c.g.s. emu per gram. The probable errors of the relative values are 0.09%, 0.07% and 1.16% respectively. The correction for ferromagnetic impurities is discussed. From an experimentally determined magnetization curve of the ferromagnetic impurities in a silver specimen, it is shown that, although the error inherent in the long specimen method is greatly reduced by using a short specimen, an error may remain even when the smallest field acting on any part of the specimen is 6000 gauss. The method of calibrating the field by means of a current-carrying loop and of making allowance for the variation of the field strength in the plane normal to the axis of the specimen are described in detail. A pole piece design which is particularly suitable for the short specimen method is given. (*PA*, 1956, #5250)

1425. THE MAGNETIC SUSCEPTIBILITIES OF SOME DIAMAGNETIC ALLOYS: THE PRIMARY SOLID SOLUTIONS OF ZINC, GALLIUM, GERMANIUM AND ARSENIC IN COPPER

Henry, W. G. and Rogers, J. L.

***The Philosophical Magazine*, Eighth Series, v. 1, no. 3, pp. 237–252, March 1956**

The results of the measurements, by a modified Gouy method, of the rates of change of the diamagnetic susceptibility with concentration in the solid solution region of the four systems are presented. A method of alloy preparation is given which, although conducive to some lateral and vertical segregation, produces a sound melt. The magnetic properties of the system are discussed theoretically. An interpretation follows for which it is assumed that all the electrons outside the $3d^{10}$ shell occupy states in the band and that all but one contribute their normal atomic diamagnetism. Instead of a parabolic band with a positive slope, it is found necessary to use a band which has approximately the same negative slope as that calculated by Jones (1937) for pure copper. The constancy of the density of states curve at the top of the band for a one-dimensional alloy is demonstrated by a first-order perturbation treatment. The atomic magnetic

susceptibilities as calculated from the self-consistent fields without exchange are given for: Zn^{2+}, $Zn(4s)^1$, Ga^{3+}, $Ga(4s)^2$, Ge^{4+}, $Ge(4s)^2(4p)^1$, As^{5+}, $As(4s)^2(4p)^2$, Al^{3+}, $Al(3s)^2$, Si^{4+}, C^0 and with exchange for Si^{4+} and C^0. The results of a preliminary examination of twenty-nine copper, silver and gold based solid solutions are mentioned. They show the absence of the paramagnetism that would be expected from the existence of the singly occupied states predicted by Mott (1952) and Friedel (1952). (*PA*, 1956, #5251)

1426. TEMPERATURE HYSTERESIS OF THE GALVANOMAGNETIC EFFECT

Kirenskii, L. V. and Ivlev, V. F.
***Doklady Akademii Nauk SSSR*, v. 106, no. 3, pp. 419–421, 1956 (in Russian)**

The magnetic characteristics of a ferromagnetic are not single-valued functions of temperature for a given field but show dependence upon previous thermal history. Temperature dependence of magnetization in Ni and chrome–iron and temperature dependence of magnetostriction in Ni have been reported. The present paper describes a temperature hysteresis of electrical resistance with a ferromagnetic specimen in a steady magnetic field. The specimen was a Ni rod, $d = 0.5$ mm, $l = 20$ cm, included in a bridge circuit where it was compensated by a similar specimen. Fields of 12, 39 and 160 oersted were used and the specimen was taken automatically round a temperature cycle ranging from room temperature to the Curie point. Temperature and $\Delta R/R$ were recorded at right angles to give a magnetogram on a photographic plate. (*PA*, 1956, #6650)

1427. FERROMAGNETIC RESONANCE ABSORPTION IN A NICKEL SINGLE CRYSTAL AT LOW TEMPERATURES

Reich, K. H.
***The Physical Review*, v. 101, no. 6, pp. 1647–1648, March, 1956**

The g-value and line width of the ferromagnetic resonance in nickel is found to be the same at 4°K as at room temperature. A small effect due to inhomogeneous magnetization in the skin depth, predicted by Kittel and Herring, has been observed. Values for the anisotropy constants at 4.2°K are $K_1 = -8.3 \times 10^5$ ergs/cm^3, $K^2 = -1.4 \times 10^5$ ergs/cm^3. (*PA*, 1956, #3824)

1428. METAMAGNETISM AND MAGNETIC PROPERTIES OF $MnAu_2$

Néel, L.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 12, pp. 1549–1554, March 19, 1956 (in French)**

This report considers the effect of magnetocrystalline anisotropy of antiferromagnetic substances whose exchange forces are assumed to be much larger for each sublattice than between sublattices. The field dependence of the magnetization is determined for a range of parameter values, and experimental results for MCl_2 (M = Cu, Ni, Co, Fe) and $MnAu_2$ are interpreted. (*PA*, 1956, #5213)

1429. INTERPRETATION OF THE MAGNETIC PROPERTIES OF DYSPROSIUM AND ERBIUM

Néel, L.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 15, pp. 1824–1828, April 9, 1956 (in French)**

The properties of Dy and Er at low temperatures are interpreted as arising from a transition from a ferromagnetic to an antiferromagnetic state caused by the temperature variation of the magnetocrystalline anisotropy coefficient. (*PA*, 1956, #5214)

1430. INTERPRETATION OF DOMAIN PATTERNS RECENTLY FOUND IN BiMn AND SiFe ALLOYS

Goodenough, J. B.
***The Physical Review*, v. 102, no. 2, pp. 356–365, April 15, 1956**

Theory of energy associated with surface magnetic poles in ferromagnetic material and various magnetic domain configurations; variation of domains with thickness of material; interpretation of domains in BiMn and SiFe in terms of grain boundary nucleation and flux-reversal mechanism. (*EI*, 1956)

1431. MAGNETIC ANISOTROPY AND COLD WORKED TEXTURE OF TITANIUM

Reekie, J. and Yao, Y. L.
***Proceedings of the Physical Society*, London, Section B, v. 69, part 4, pp. 417–431, April 1956**

Magnetic susceptibility determinations have been made for commercially pure titanium metal following various mechanical and thermal treatments. Making use of the known texture of heavily rolled titanium, values have been deduced for the principal susceptibilities and magnetic anisotropy of the hexagonal metallic lattice. The values obtained are: $\chi_{\parallel} = 3.340 \times 10^{-6}$ and $\chi_{\perp} = 3.087 \times 10^{-6}$ emu/g at 25°C. These figures have been confirmed by preliminary measurements on an oriented single crystal of titanium. Knowing the magnetic anisotropy it is possible to estimate the texture in a specimen of the cold-worked or annealed metal from susceptibility measurements made in three orthogonal directions. This has been done in a number of cases, and the practical use of this aspect of the work is discussed. It is shown from magnetic measurements that heavily compressed titanium has a texture in which the basal planes of the hexagonal lattice are normal to the compression direction. Assuming that a compressed specimen approximates magnetically to single crystal behavior, the temperature variations of the principal susceptibilities have been determined from 25 to 300°C. The magnetic anisotropy is found to be temperature independent over this range, and the temperature coefficient of susceptibility, $d\chi/dT$, is 0.0011×10^{-6} emu/g deg. (*PA*, 1956, #5231)

1432. MAGNETIC PROPERTIES OF $MnAu_4$

Meyer, A. J. P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 242, no. 19, pp. 2315–2318, May 7, 1956 (in French)**

Results are given of magnetic investigations on the face-centered tetragonal compound γ' $MnAu_4$, which suffers a phase change to face-centered cubic γ $MnAu_4$ at 400°C. The γ' compound is ferromagnetic with Curie temperature 88°C, p_B value 4:15 and Curie–Weiss paramagnetism with specific Curie constant 3.50×10^{-3}. The γ phase may be retained to room temperature by quenching, and its magnetic properties were also studied. (*PA*, 1956, #6006)

1433. MAGNETIC POWDER PATTERNS ON COBALT AT HIGHER TEMPERATURES (PRELIMINARY COMMUNICATION)

Andra, W.
***Annales der Physik*, Leipzig, v. 17, no. 4–5, pp. 233–235, 1956 (in German)**

Results are reported of domain observations using colloidal suspensions which remain stable on heating up to 400°C. Temperature changes of the patterns are a result of the variation of the magnetocrystalline anisotropy coefficient, which vanishes at 250°C. (*PA*, 1956, #5217)

1434. GEFUEGE UND MAGNETISCHE EIGENSCHAFTEN VON DAUERMAGNETIEGIERUNGEN WAEHREND DER ISOTHERMEN AUSSCHEIDUNGSHAERTUNG

Biedermann, E. and Kneller, E.
***Zeitschrift für Metallkunde*, v. 47, no. 5, pp. 289–301, May 1956**

The following subjects are discussed: structure and magnetic properties of permanent magnet alloys during isothermal age hardening; particle growth, critical particle size and coercive force; determining particle size by X-ray and electron microscopic examination; course of coercive force during isothermal aging of Cu-Ni-Fe and Cu-Ni-Co alloys. (*EI*, 1956)

1435. MAGNETIC AFTER-EFFECT IN Ni_3Mn ALLOY

Taoka, T.
***Journal of the Physical Society of Japan*, v. 11, no. 5, pp. 537–547, May 1956**

The aftereffect (1) is large at the intermediate state of order of the alloy, (2) is most noticeable at the steepest part of the magnetization curve, (3) is comparatively temperature insensitive, and (4) is not affected by mechanical deformation. The experimental formula of the phenomenon is well expressed by an analytical form derived by Street and Woolley on the basis of the concept of a thermal activation process of single domain particles. It has been confirmed by electron microscopic study that the alloy is composed of a very large number of small particles of prolate ellipsoidal form embedded in a matrix. The dimension of these particles is of the order of magnitude occupied by only a single magnetic domain. (*PA*, 1956, #5222)

1436. MAGNETIC PROPERTIES OF Mg_2Sn

Korenblit, L. L. and Kolesnikov, A. P.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 26, no. 5, pp. 941–944, 1956 (in Russian)**

Earlier work by Boltaks on pressed powders of Mg_2Sn stoichiometric composition showed diamagnetic susceptibility increasing with temperature. Further excess of one or other constituent with respect to stoichiometric composition gave a paramagnetic susceptibility decreasing with temperature. It was considered that the diamagnetism is characteristic of the Mg_2Sn crystal lattice and that the paramagnetism is due to the paramagnetism of impurity ions. The present authors have repeated the measurements over a temperature range of +20 to +210°C with alloys of very high purity (not more than 0.01% Pb or Sb) and have found substantially the same results as Boltaks. They also measured the electrical conductivity and thermoelectric e.m.f. The Hall effect for one "impure" specimen was measured at room temperature. It is concluded that the results indicate that the paramagnetism of "impure" specimens is associated with the paramagnetism of free electron gas in the Mg_2Sn crystal. (*PA*, 1957, #1454)

1437. DOMAIN STRUCTURE AS AFFECTED BY THE UNIAXIAL FERROMAGNETIC ANISOTROPY INDUCED IN CUBIC SOLID SOLUTIONS

Yamamoto, M., Taniguchi, S., and Aoyagi, K.
***The Physical Review*, v. 102, no. 5, pp. 1295–1297, June 1, 1956**

The domain structure of a 40% cobalt–nickel single crystal has been found to be very small-scaled and complicated in the annealed state as compared with that of ordinary ferromagnetic substances but it becomes simpler and larger after quenching from above the Curie temperature, indicating that the domain structure of a cubic solid solution can be affected by the induced uniaxial anisotropy. It is shown that these findings, together with the results of considerations reported previously, lead to the conclusion that the perminvar-type magnetic properties are due to the stabilization of domain walls by the induced uniaxial anisotropy in face-centered cubic solid solutions and in body-centered cubic solid solutions with negative cubic anisotropy constants. (*PA*, 1956, #6011)

1438. MAGNETIC SUSCEPTIBILITY OF COPPER METAL AT LOW TEMPERATURES

Bowers, R.
***The Physical Review*, v. 102, no. 6, pp. 1486–1488, June 15, 1956**

The total magnetic susceptibility of high-purity copper has been measured between 300 and 1.45°K using the Gouy method. It is found that the mass susceptibility can be represented by $\chi = (-0.083 + 0.023/T) \times 10^{-6}$ c.g.s. unit. This temperature dependence is much smaller than that found by previous workers, whose data extends only down to 14°K. An anomaly in the susceptibility at low temperatures, previously reported was not found. The nuclear susceptibility of copper is responsible for about one-fifth of the temperature dependence found in the present work; the remainder can be explained by a paramagnetic impurity content which is plausible for the particular copper used. It is concluded that the susceptibility of pure copper is substantially independent of temperature in the measured range. (*PA*, 1956, #6003)

1439. ELECTRON AND NUCLEAR SPIN RESONANCE AND MAGNETIC SUSCEPTIBILITY EXPERIMENTS ON DILUTE ALLOYS OF Mn IN Cu

Owen, J., Browne, M., Knight, W. D., and Kittel, C.
***The Physical Review*, v. 102, no. 6, pp. 1501–1507, June 15, 1956**

Dilute alloys of Mn in Cu are expected to show marked effects of the exchange interaction between the $3d^5$ ion core electrons of the Mn atoms and the $4s$ conduction electrons of the crystal. The simple model leads to the prediction of indirect exchange ferromagnetism; electronic Knight shift of the electron spin resonance line-nuclear Knight shift of the copper nuclear resonance; electron spin relaxation by the coupling with the conduction electrons; and a contribution to the electrical resistivity by the Elliott–Schmitt mechanism. The observed width of the electron spin resonance line suggests that the *sd* exchange interaction may be of the order of 0.2 of the interaction in the free ion. The dilute alloys appear to be antiferromagnetic, but with a ferromagnetic interaction also present which is rather stronger than calculated on the indirect exchange model. An unexpected experimental result is that the nuclear Knight shift is unaffected by the presence of Mn, suggesting that the conduction electron

magnetization by the *sd* coupling is less than 1/50 of what might be expected. (*PA*, 1956, #6019)

1440. THE MAGNETIC PROPERTIES OF MnAs AND MnBi

Manuel, A. J.

***Proceedings of the Physical Society*, London, Section B, v. 69, Part 6, pp. 691–692, June 1956**

Observed transitions from ferromagnetic to antiferromagnetic characteristics with temperature are explained by suggesting that at low temperatures the substances are ferromagnetically ordered in 3 dimensions but on raising the temperature a weaker interaction between the basal planes is broken up leaving an assembly of 2 dimensional ferromagnetically ordered triangular networks of the basal planes. (*PA*, 1957, #536)

1441. PLASTIC BEHAVIOUR OF MAGNETIZED NICKEL CRYSTALS

Blank, H.

***Naturwissenschaften*, v. 43, no. 21, p. 494, 1956 (in German)**

This report describes results of creep experiments on nickel in the presence of a magnetic field, the strains induced by continuous or sudden changes of the field strength being measured. (*PA*, 1957, #6350)

1442. MAGNETIC PROPERTIES, ANTIFERROMAGNETISM AND FERROMAGNETISM OF $MnAu_2$

Meyer, A. J. P. and Taglang, P.

***Journal de physique et le Radium*, v. 17, no. 6, pp. 457–465, June 1956 (in French)**

Below 90°C and in fields less than about 10^4 oersted $MnAu_2$ has antiferromagnetic properties. By increasing the field beyond a critical value it becomes ferromagnetic, exhibiting spontaneous magnetization and a magnetocaloric effect. The critical field is a function of temperature. Above 90°C the substance is paramagnetic, the susceptibility obeying the Curie–Weiss law down to 300°C but showing pronounced deviations from this law at lower temperatures. The effect of the field is believed to be to uncouple the moments of the ions on two sublattices which are initially antiparallel and to orient them parallel to the field direction. (*PA*, 1957, #2409)

1443. THE CURVATURE OF THE BLOCH WALL AS AN ELEMENTARY PROCESS OF REVERSIBLE MAGNETIZATION CHANGES (INITIAL PERMEABILITY AND ΔE-EFFECT)

Kersten, M.

***Zeitschrift für angewandte Physik*, v. 8, no. 7, pp. 313–322, 1956 (in German)**

This report discusses the effects of reversible distortions of 90° domain boundaries on the temperature variation of the initial permeability and ΔE of nickel and Fe-Ni alloys. (*PA*, 1956, #7536)

1444. THE MAGNETIC SUSCEPTIBILITY OF THE ALKALI METALS

Appel, J.

***Zeitschrift für Naturforschung*, v. 11a, no. 7, pp. 613–615, July 1956 (in German)**

Reasons are given for the deviations of the "observed" electronic diamagnetic susceptibilities from the free electron values. (*PA*, 1957, #526)

1445. MAGNETIC DOMAINS IN MANGANESE–ANTIMONY

Perthel, R. and Andra, W.

***Annalen der Physik*, Leipzig, v. 19, no. 6–8, pp. 265–267, 1956 (in German)**

For Mn_2Sb dagger-shaped domains were observed parallel and star-shaped ones perpendicular to the tetragonal axis. For MnSb the observed complicated patterns, showing sharply bent domain boundaries, are ascribed to strain effects. (*PA*, 1957, #9258)

1446. ELECTRON MICROSCOPICAL INVESTIGATION OF MAGNETIC POWDER PATTERNS

Schwartze, W.

***Annalen der Physik*, Leipzig, v. 19, no. 6–8, pp. 322–328, 1956 (in German)**

The resolving power of the powder pattern method and the density variation of the powder particles near a domain boundary are discussed. Electron microphotographs of patterns on cobalt are shown. (*PA*, 1957, #9259)

1447. STRUCTURAL TRANSITION AND ANTI-FERROMAGNETISM IN THE ALLOY AuMn
Morris, D. P. and Preston, R. P.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 8, pp. 849–851, August 1956**

X-ray investigations showed AuMn to have a CsCl-type structure above about 125°C and to transform to an ordered body-centered tetragonal structure ($c/a = 0.968$) below this temperature. The susceptibility has a maximum at about 110°C and a further minimum at 70°C. (*PA*, 1957, #2411)

1448. FURTHER MEASUREMENTS ON THE MAGNETIC SUSCEPTIBILITY OF GERMANIUM DOWN TO LIQUID HELIUM TEMPERATURES
van Itterbeek, A. and Duchateau, W.
***Physica*, v. 22, no. 8, pp. 649–656, August 1956**

Measurements were made on seven samples of germanium obtained from single crystals of very pure germanium or of germanium containing small amounts of Sb (10^{14}, 10^{15}, 10^{17}). The measurements were carried out between room temperature and liquid helium temperatures. For the pure samples an increase was found of the diamagnetic susceptibility of about 5% between room and liquid hydrogen temperatures. In the liquid helium region the susceptibility was nearly constant. For the impure samples the increase of the diamagnetic susceptibility between room temperature and the liquid hydrogen temperature region is about 11% and 18%. For the sample with the greatest concentration of Sb, a minimum is found in the susceptibility vs. temperature between liquid hydrogen and liquid helium temperatures. A paramagnetic term appears at the lowest temperatures. In order to check the precision of the method, measurements were also carried out on a sample of piezoelectric quartz. A susceptibility was found which was constant within 0.2% between room temperature and liquid helium temperatures. (*PA*, 1956, #8282)

1449. THE INTERPRETATION OF THE TEMPERATURE VARIATION OF THE INITIAL PERMEABILITY OF Mn_2Sb, COBALT, IRON AND NICKEL
Kersten, M.
***Zeitschrift für angewandte Physik*, v. 8, no. 8, pp. 382–386, 1956 (in German)**

The temperature variation of the domain size is considered. (*PA*, 1956, #7537)

1450. ON THE MAGNETIC PROPERTIES OF METALLIC EUROPIUM (PRELIMINARY STUDY)
la Blanchetais, C. H. and Trombe, F.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 8, pp. 707–709, August 20, 1956 (in French)**

Measurements of the magnetic susceptibility of metallic Eu^{++} show that the ferromagnetic Curie point is approximately 90°K. The difference between this value and that for Gd^{+++} (289°K), which has the same electronic configuration, is attributed to the different interaction forces a result of the different crystal structures of the two elements. (*PA*, 1957, #2404)

1451. CHANGE OF MAGNETIC SUSCEPTIBILITY OF TRANSITION METALS AND ALLOYS AT THEIR MELTING POINT
Nakagawa, Y.
***Journal of the Physical Society of Japan*, v. 11, no. 8, pp. 855–863, August 1956**

The magnetic susceptibility of Mn, Fe, Co, Ni and their alloys has been measured through their melting points up to 1600°C. In general, the susceptibility of transition metals shows a decrease or an increase on melting, depending on whether the interatomic interactions favor parallel alignment of atomic magnetic moments or not, indicating that the interactions are always weaker in liquid than in solid. Although some Fe alloys of face-centered cubic lattice form exceptions to the above simple rule, they are also explained on the basis of the Bethe–Slater exchange interaction curve together with the volume increase on melting. It is to be noted that a remarkable supercooling of liquid, often exceeding one hundred degrees, has been observed during the course of these susceptibility measurements. (*PA*, 1956, #8281)

1452. EFFECT OF HYDROSTATIC PRESSURE ON MAGNETIC PROPERTIES OF MONO-CRYSTALLINE Bi AT LOW TEMPERATURES
Verkin, B. I., Dmitrenko, I. M., and Lazarev, B. G.
***Zhurnal Experimentalnoi i Teoreticheskoi Fiziki*, v. 31, no. 3(9), pp. 538–540, 1956 (in German)**

A pressure of about 1500 atmospheres was applied by the ice-bomb technique to a Bi crystal in a beryllium-bronze container; the de Haas–van Alphen effect was observed by the torque method. The pressure reduced the amplitude of the oscillations several times but altered the period [$\Delta(1/H)$] by only a few percent (increase for field nearly parallel to, and decrease for field nearly perpendicular to trigonal axis). The pressure also caused an appreciable increase in the anisotropy of the steady susceptibility. (*PA*, 1957, #2412)

1453. OBSERVATION OF MAGNETIC DOMAINS IN ELECTRON SHADOW PHOTOGRAPHS

Blackman, M. and Grünbaum, E.
***Nature*, v. 178, pp. 584–585, September 19, 1956**

A 46 kev electron beam is passed close to the surface of an unmagnetized Co crystal. The leakage field originating from the oppositely magnetized domains deflects the electrons, and a shadow photograph shows a series of cusps, the dimensions of which lead to domain spacings between 40 and 240μ. (*PA*, 1957, #2432)

1454. THE INFLUENCE OF PLASTIC DEFORMATION ON THE BARKHAUSEN EFFECT

Wortruba, K.
***Czechoslovak Journal of Physics*, v. 6, no. 5, pp. 468–472, October 1956 (in Russian)**

Intensity of the Barkhausen effect is investigated on plastically deformed mumetal as well as on nickel, and compared with the course of "Hc" on the same specimens. In mumetal the intensity of the Barkhausen effect increases monotonically with plastic elongation; with nickel it first rapidly decreases, passes through a minimum and then again gradually increases. On the basis of Tebble's theory of the origin of the Barkhausen effect, this behavior is qualitatively explained by a change in width of the domain through internal stress produced by plastic deformation. (*PA*, 1957, #4551)

1455. SATURATION MAGNETIZATION IN COPPER–NICKEL ALLOYS

Ahern, S. A. and Sucksmith, W.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 10, pp. 1050–1052, October 1956**

Measurements of the ferromagnetic Curie point and the saturation moment of Cu–Ni alloys containing up to 34.3% Cu are reported. The chemical analysis of the alloys is stated to 0.1%, and the saturation moments are claimed to be accurate to 2%. The results are discussed briefly in relation to earlier measurements and to their theoretical interpretation. (*PA*, 1957, #3452)

1456. ON THE MAGNETIC PROPERTIES OF THE SYSTEM MnSb–CrSb

Hirone, T., Maeda, S., Tsubokawa, I. and Tsuya, N.
***Journal of the Physical Society of Japan*, v. 11, no. 10, pp. 1083–1087, October 1956**

The change of magnetic properties due to the replacement of manganese by chromium in manganese antimonide (MnSb), which is of the NiAs structure, was investigated. It was found that, with the increase of the concentration of chromium, the magnetic behavior of these compounds $(Mn_{1-x}Cr_x)Sb$ changes as follows: (1) at $x = 0$ (MnSb), the temperature–magnetization curve shows the typical behavior of a ferromagnetic substance, (2) in the range of $0.1 \leq x \leq 0.7$, it deviates remarkably from the Weiss curve in proportion with the chromium content, and the temperature dependence of the reciprocal susceptibility above the Curie point is of a ferrimagnetic type, (3) in the range $0.8 \leq x \leq 0.9$ a transition from ferrimagnetic to antiferromagnetic was observed, and finally,(4) at $x = 1$ (CrSb) a typical antiferromagnetism could be seen. A short discussion of such transitions is given. (*PA*, 1957, #3437)

1457. THE DYNAMIC MAGNETOSTRICTION OF NICKEL–COBALT ALLOYS

Clark, C. A.
***British Journal of Applied Physics*, v. 7, no. 10, pp. 355–360, October 1956**

The magnetostrictive properties of binary nickel–cobalt alloys in the range of 0–23% cobalt are discussed with particular reference to the use of these materials for transducers. Measurements, at various polarizing fields, of the electromechanical coupling coefficient, reversible permeability and Young's modulus are described. Various criteria which govern the choice of magnetic materials for ultrasonic transducers are discussed and it is shown that two alloys, containing respectively about 4.4 and 18.4% cobalt, give good performance as transducer materials. (*PA*, 1957, #530)

1458. NEUTRON DIFFRACTION STUDY OF THE STRUCTURES AND MAGNETIC PROPERTIES OF MANGANESE BISMUTHIDE
Roberts, B. W.
***The Physical Review*, v. 104, no. 3, pp. 607–616, November 1, 1956**

The intermetallic compound, BiMn, has been studied by neutron diffraction at temperatures from 4.2°K to 733°K (460°C). In the temperature range 340–360° to 445°C a disordered arrangement of Mn atoms on regular and interstitial lattice sites fits the data well if the Mn atoms are assumed to be in the paramagnetic state. This model conflicts with the suggestion made by Guillaud of an antiferromagnetic state in this temperature range. The temperature hysteresis associated with both magnetization and the large cell distortions are qualitatively explained by the disordering and recovery at the transformation temperatures. The effective moment per Mn atom below the transformation agrees with the magnetic measurements of Heikes within experimental error. Measurements of spin direction made at temperatures below 84°K show that only partial rotation occurs in zero magnetic field. (*PA*, 1957, #2410)

1459. MAGNETIC SUSCEPTIBILITY OF RUBIDIUM AND THE ELECTRICAL RESISTANCE ANOMALY
Hedgcock, F. T.
***Canadian Journal of Physics*, v. 34, no. 11, pp. 1164–1167, November 1956**

Previous investigations of the resistivity–temperature curve of rubidium showed there to be an anomaly at 180°K. It has since been shown that there is no crystallographic change here and the present work suggests that the anomaly is not due to an electronic transition of the type originally suggested. The conclusion is drawn that the anomaly may be attributable to small amounts of oxygen. (*PA*, 1957, #2410)

1460. SYMMETRY OF GALVANOMAGNETIC EFFECTS IN ANTIMONY
Juretschke, H. J.
***Acta Crystallographica*, v. 8, part 11, pp. 716–722, November 1955**

The phenomenological theory of galvanomagnetic effects in a medium of point-group symmetry 3m, isomorphic to antimony, has been developed for the case that these effects can be described in terms of an expansion in powers of the magnetic field. Schemes of coefficients of these powers up to and including the fourth power are constructed explicitly. Various experimental arrangements for a determination of all independent constants are discussed, and the voltages to be expected in each case are worked out in detail. A final section lists the relations between the galvanomagnetic coefficients of the conductivity and resistivity tensors. (*PA*, 1956, #2999)

1461. EXPERIMENTAL INVESTIGATION OF MOLECULAR FIELD TYPE INTERACTIONS. SOLID SOLUTIONS OF A FERROMAGNETIC OR ANTIFERROMAGNETIC METAL IN PALLADIUM
Cohen, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 21, pp. 1613–1616, November 19, 1956 (in French)**

Results are reported of susceptibility measurements between room temperature and 800°C on Pd–Ni alloys (Ni content up to 17% and Pd–Cr alloys (Cr content up to 17.5%) and deduces the values of the paramagnetic Curie temperatures and the Curie constants. (*PA*, 1957, #2406)

1462. MAGNETIC AFTER-EFFECT DUE TO FLUCTUATIONS IN THE NEIGHBORHOOD OF THE CURIE POINT
Pescetti, D. and Barbier, J. C.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 22, pp. 1740–1743, November 26, 1956 (in French)**

Results are given of measurements of the quantity S_v up to about 320°K for an alloy 70% Ni, 27% Cu, 3% Be; S_v increases with temperature, reaches a maximum at about 260°K and then decreases to vanish at the Curie point. Results are also given for the coercive force and the reversible and irreversible susceptibilities. (*PA*, 1957, #5453)

1463. STUDY OF THE TERNARY ALLOYS PALLADIUM–NICKEL–COPPER
Cohen, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 23, pp. 1845–1847, December 5, 1956 (in French)**

Results are reported of susceptibility measurements between 0 and 800°C on alloys with 6.9% Ni and up to 18.7% Cu, and deduces the values of the Curie constant and the paramagnetic Curie temperature; both decrease linearly with Cu concentration. (*PA*, 1957, #5455)

1464. MAGNETIZATION AND MAGNETO-RESISTANCE OF SOME DILUTE ALLOYS OF Mn IN Cu
Schmitt, R. W. and Jacobs, I. S.
***Canadian Journal of Physics*, v. 34, no. 12A, pp. 1285–1289, December 1956**

Results of magnetoresistance and magnetization measurements at low temperatures on alloys of 0.2–1.8% (atomic) of Mn in Cu are given. The results indicate the onset of a cooperative magnetic effect in these alloys, and are discussed in relation to possible domain structures. (*PA*, 1958, #233)

1465. GYROMAGNETIC RATIO OF COBALT
Scott, G. G.
***The Physical Review*, v. 104, no. 6, pp. 1497–1498, December 15, 1956**

Magnetomechanical measurements were made on two cobalt rods in an attempt to find changes in the g' factor at low magnetic intensities. No such effect was found, g' being independent of the induced magnetic intensity down to the lowest values which could be measured. The results also indicate that cobalt samples of high purity would be required in order to obtain an accurate value of g' for this metal. (*PA*, 1957, #3453)

1466. MAGNETIC SUSCEPTIBILITY OF DILUTE Cu ALLOYS AT LOW TEMPERATURES
Hedgcock, F. T.
***The Physical Review*, v. 104, no. 6, pp. 1564–1567, December 15, 1956**

The temperature dependence of the magnetic susceptibility of a number of dilute copper-tin and copper-iron alloys has been measured between room temperature and 4.2°K. The results indicate an anomalous paramagnetism in the neighborhood of the temperature of the observed resistance minimum in these alloys. Proposed models for the resistance minimum and impurity scattering are reviewed in the light of this new magnetic information. (*PA*, 1957, #3434)

1467. MAGNETIC STRUCTURES IN COPPER–MANGANESE ALLOYS
Meneghetti, D. and Sidhu, S. S.
***The Physical Review*, v. 105, no. 1, pp. 130–135, January 1, 1957**

A neutron diffraction study of a series of substitutional solid solutions up to 85 atomic % manganese in copper has shown that at about 13 atomic % manganese, a broad intensity maximum appears in the region of (100) reflection of the face-centered cubic pattern of copper. A correlation of this maximum with the magnetic attraction of the specimens indicates that it is at least in part due to short-range magnetic order. Its intensity decreases at compositions greater than 50 atomic percent manganese. Above 69 atomic percent manganese an antiferromagnetic structure is observed and is interpreted as due to an antiferromagnetic coupling between manganese atoms as the manganese concentration becomes predominant. (*PA*, 1957, #3457

1468. STUDY OF HYDROGENATED PALLADIUM–NICKEL AND PALLADIUM–COBALT ALLOYS
Cohen, J. and Wucher, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris*, v. 244, no. 1, pp. 49–52, January 2, 1957 (in French)**

Results are given of susceptibility measurements at room temperature on Pd–Ni (10% Ni) and Pd–Co (2.5% Co) containing varying amounts of hydrogen. The susceptibility decreases linearly with H content and vanishes when $H/(Pd + Ni, Co) \cong 0.6$ but the Curie temperature is independent of the H content. (*PA*, 1957, #5456)

1469. MAGNETO-THERMAL EFFECTS IN NICKEL AND COBALT
Tebble, R. S. and Teale, R. W.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 1, pp. 51–64, January 1957**

Comprehensive measurements on the reversible and total magneto-thermal effect, the reversible susceptibility and the magnetization curves of annealed nickel and cobalt have been made. It is shown that, for reversible changes in magnetization, there is no significant change in the value of the "rotational" coefficient b'' for nickel in high fields, and that reversible changes in intrinsic mag-

netization and rotations of the magnetization vectors must predominate. For cobalt, with a higher coercivity, these effects also predominate even in relatively low fields. There is no evidence of the reduction in the numerical value of b'' in high fields, which has been deduced from the results of earlier work, and it is suggested that if any additional effects are present in high fields they must be irreversible. There is good agreement with the results of Tebble, Wood and Florentin and of Bates and his co-workers. (*PA*, 1957, #3438)

1470. MAGNETO-RESISTANCE IN METALS

MacDonald, D. K. C.

***The Philosophical Magazine*, Eighth Series, v. 2, no. 13, pp. 97–104, January 1957**

Novel results were found on magneto-resistance of sodium and rubidium: measurements made both on plate-like specimens which show very strong anisotropy in magnetic field, and on cylinder of diameter large compared with mean free path, l, of electrons: anomalous behavior appears to depend on attainment of large values of ratio l/r, where r is orbital radius of free electron in magnetic field. (*EI*, 1958)

1471. MAGNETIZATION CURVES OF TUBULAR NICKEL SPECIMENS UNDER TORSION AND PRESSURE

Strnat, K.

***Zeitschrift für Naturforschung*, v. 12a, no. 1, pp. 76–79, January 1957 (in German)**

Hysteresis loops are given for nickel tubes under torsion, both longitudinal and circumferential components of the magnetization being considered. Similar loops are given for a hard nickel tube under longitudinal pressure. (*PA*, 1957, #9760)

1472. MAGNETIC SUSCEPTIBILITY OF DILUTE ALLOYS OF NICKEL IN COPPER BETWEEN 2.5°K AND 295°K

Coles, B. R., Arrott, A., and Goldman, J. E.

***The Physical Review*, v. 105, no. 3, pp. 814–818, February 1, 1957**

The magnetic susceptibilities of pure Cu and dilute Cu–Ni alloys containing 0.59, 1.16, and 2.48 atomic % Ni have been measured by a Gouy method at temperatures between 295 and 2.5°K. At room temperature all the alloys were found to be diamagnetic, the numerical value of the susceptibility decreasing with increasing nickel content, as found by earlier workers. The paramagnetic contributions found at low temperatures were, however, considerably smaller than those previously reported, although the 2.48% alloy was paramagnetic at temperatures below 16°K. The resultant susceptibility of each alloy is given with reasonable accuracy by an expression of the form $aT + b + (c/T)$, and the significance of each of these terms is discussed. A theoretical model, in which the number of nickel atoms possessing resultant magnetic moments is temperature-dependent and which fitted the earlier high-temperature data reasonably well, has been found inadequate for the new low-temperature results. (*PA*, 1957, #3447)

1473. NEW MAGNETIC ANISOTROPY

Meiklejohn, W. H. and Bean, C. P.

***The Physical Review*, v. 105, no. 3, pp. 904–913, February 1, 1957**

A new type of magnetic anisotropy has been discovered which is best described as an exchange anisotropy. This anisotropy is the result of an interaction between an antiferromagnetic material and a ferromagnetic material. The material that exhibits this exchange anisotropy is a compact of fine particles of cobalt with a cobaltous oxide shell. The effect occurs only below the Néel temperature of the antiferromagnetic material, which is essentially room temperature for the cobaltous oxide. An exchange torque is inferred to exist between the metal and oxide which has a maximum value at 77°K of ~ 2 dyne-cm/cm^2 of interface. (*PA*, 1957, #4525)

1474. INTERBAND MAGNETO-OPTIC EFFECTS IN SEMICONDUCTORS

Burstein, E. and Picus, G. S.

***The Physical Review*, v. 105, no. 3, pp. 1123–1125, February 1, 1957**

Previous studies on InSb have been extended to higher photon energies. For magnetic fields as low as 15,000 oersted the intrinsic absorption spectrum exhibits several prominent peaks attributed to vertical optical transitions between magnetic sub-bands of the light-hole valence band. Similarities and differences between the I.M.O. (interband magneto-optic effect) and cyclotron resonance experiments are discussed. (*PA*, 1957, #5316)

1475. THE ELECTRONIC STRUCTURE OF NICKEL AND ITS ALLOYS

Krinchik, G. S.

***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 36–40, 1957 (in Russian)**

On the assumption that Ni has 0.47 3*d*-holes/atom and 0.13 4*s*-electrons/atom, the magnetic properties of Ni and Ni-based alloys can be satisfactorily explained theoretically. The assumption can be further tested by measurement of the spectroscopic splitting factor (g) and paramagnetic susceptibility of Ni_3Mn. A further proof of the same assumption by the optical method of Roberts is acknowledged in a note added in proof. (*PA*, 1958, #4410)

1476. ELECTRONIC STRUCTURE OF NICKEL AND ITS ALLOYS

Krinchik, G. S.

***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*) v. 4, no. 1, pp. 26–29, 1957**

Making a more exact model of ferromagnetism of *s*-electrons of nickel permits experimental data to be explained for saturation magnetization, paramagnetic susceptibility, and factor of spectroscopic resolution of various nickel alloys: it is possible to verify correctness of original aims of theory by measurement of factor of spectroscopic resolution and paramagnetic susceptibility in alloy Ni_3Mn. (*EI*, 1957)

1477. ON THE TEMPERATURE VARIATION OF THE SPONTANEOUS MAGNETIZATION IN ALLOYS IN THE NEIGHBORHOOD OF THE CURIE POINT

Belov, K. and Paches, Ya.

***Fizika Metallov i Metallovedenie*, v. 4, no. 1, pp. 48–53, 1957 (in Russian)**

The temperature variation of the spontaneous magnetization was determined in three independent ways for pure Ni and six Ni-based alloys. From analysis of the results the authors conclude that the Curie temperature (T_c) is most accurately calculated from thermodynamic data. Methods of calculating T_c which involve measurement of electrical resistivity, galvanomagnetic effect, etc. are less accurate. (*PA*, 1958, #4150)

1478. TEMPERATURE VARIATION OF SPONTANEOUS MAGNETIZATION IN ALLOYS NEAR THE CURIE POINT

Belov, K. and Paches, Ya.

***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), v. 4, no. 1, pp. 35–39, 1957**

Curves of temperature vs. spontaneous magnetization for nickel and several nickel alloys, obtained from curves of "galvanomagnetic effect vs. square of magnetization," by "isomagnetic lines" method, and by method of "thermodynamic coefficients"; it was established that so-called "tails" in magnetization curves are particularly large in alloys. (*EI*, 1957)

1479. MEASUREMENTS ON THE MAGNETIC SUSCEPTIBILITY OF WHITE TIN AND COPPER DOWN TO LIQUID HELIUM TEMPERATURES

van Itterbeek, A. and Duchateau, W.

***Physica*, v. 23, no. 2, pp. 169–172, February 1957**

For copper a constant value is found for the susceptibility between room temperature and 20°K. At low temperatures the susceptibility increases strongly, which is due to the small amount of nickel and iron (0.0003%) present in the sample. For the polycrystalline tin, which is paramagnetic, a decrease of 16% is found for the susceptibility between room temperature and 2°K. For a single crystal of tin a decrease of 10% only was found. (*PA*, 1957, #8717)

1480. DOMAIN PATTERNS ON COBALT CRYSTALS

Hall, E. O.

***Proceedings of the Physical Society*, London, Section B, v. 70, Part 2, pp. 254–256, February 1957**

An examination of the powder patterns formed on planes other than the basal prism faces of cobalt, shows that the type of pattern formed on the basal plane is not characteristic of that plane only but appears in a modified form on other planes, finally broadening out to become the known prism face pattern. A theoretical explanation of the results is given in terms of the energies per unit volume of the different domain structures. (*PA*, 1957, #5467)

1481. ON THE ANISOTROPY OF THE EVEN (TRANSVERSE) PHOTOMAGNETIC EFFECT IN GERMANIUM MONOCRYSTALS
Kikoin, I. K. and Bykovskiĭ, Yu. A.
***Doklady Akademii Nauk SSSR*, v. 116, no. 3, pp. 381–384, 1957 (in Russian)**

The even photomagnetic (photomagnetoelectric) effect (so termed because there is no change of sign on reversal of magnetic field) in a (111) plane showed marked variations on rotation about the [111] axis suggesting three-fold symmetry, while [110] rotation of a (110) cut specimen suggested two-fold symmetry. No explanation of this behavior is possible in terms of the simple theory of the effect. (*PA*, 1958, #2331)

1482. NEW TYPE OF MAGNETIC TRANSITION IN Mn_3ZnC
Brockhouse, B. N. and Myers, H. P.
***Canadian Journal of Physics*, v. 35, no. 3, pp. 313–323, March 1957**

Alloys with the approximate composition Mn_3ZnC are known to be ferromagnetic but the saturation magnetization shows a maximum in the region of 231°K. X-ray and neutron diffraction measurements are reported which demonstrate that at 231°K there is a second-order transition below which ordering of the manganese ions occurs, resulting in a tetragonal distortion of the normally cubic lattice and a complex magnetic structure. One possible magnetic structure is discussed. Above the transition the alloy is apparently a normal ferromagnetic substance. (*PA*, 1957, #8019)

1483. THE MAGNETIC SUSCEPTIBILITY OF α AND β BRASS
Childs, B. G. and Penfold, J.
***The Philosophical Magazine*, Eighth Series, v. 2, pp. 389–403, March 1957**

The magnetic susceptibility has been measured at 77 and 300°K of a series of copper–zinc alloys, ranging in composition from 0-47.6 atomic % zinc, and of one silver-cadmium alloy containing 30.5 atomic % cadmium. For the copper–zinc system the absolute susceptibility ranges from -0.085×10^{-6} emu/g for pure copper to -0.191×10^{-6} emu/g for 47.6% zinc. No significant difference was found between the values for a given alloy at the two temperatures of measurement. The significance of the results is discussed in relation to a theory recently proposed by Henry and Rogers. (*PA*, 1957, #4547)

1484. CALCULATIONS OF THE VOLTAGE FOR THE KIKOIN–NOSKOV PHOTOMAGNETIC EFFECT AND THE DEMBER EFFECT IN STRONG MAGNETIC FIELDS
Moizhes, B. Ya.
***Zhurnal Tekhnicheskoi Fiziki*, v. 27, no. 3, pp. 495–501, 1957 (in Russian)**

The Kikoin–Noskov effect is the voltage appearing across a semiconducting slab when a magnetic field is applied perpendicular to the direction of incident illumination (usually known as the photomagnetoelectric or P.M.E. effect). Calculations are presented for the cases of strong and weak illumination and for thick and thin slabs, all for strong magnetic fields. The Dember, or photodiffusion, effect (the potential difference arising in the direction of illumination due to different rates of diffusion of holes and electrons) is also calculated for the same conditions. (*PA*, 1957, #9178)

1485. MAGNETIC PROPERTIES OF $MnAu_3$
Meyer, A. J. P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 244, no. 15, pp. 2028–2031, April 8, 1957 (in French)**

Reports results of measurements of the susceptibility between 90°K and room temperature, and in fields up to 2.7×10^4 oersted. A susceptibility maximum is observed at 145°K. (*PA*, 1957, #7222)

1486. MAGNETOSTRICTION AND MAGNETIC ANISOTROPY OF MnBi
Williams, H. J., Sherwood, R. C., and Boothby, O. L.
***Journal of Applied Physics*, v. 28, no. 4, pp. 445–447, April 1957**

The magnetostriction of oriented polycrystalline MnBi was found to be higher than any published value for a metal. A value of -250×10^{-6} was measured parallel to a field of 22,000 oersted oriented perpendicular to the c axis of the aligned hexagonal crystallites. This field magnetized the specimen to only slightly more than half of saturation. A tentative value of -800×10^{-4} for the mag-

netostriction at saturation was obtained by plotting the magnetostriction as a function of $(B-H)^2$ and extrapolating to saturation. Magnetic anisotropy constants of $K_1 = 9.1 \times 10^6$ ergs per cm^2 and $K_2 = 2.6 \times 10^6$ ergs per cm^3 were obtained by fitting a calculated curve to the experimental magnetization curve. (*PA*, 1957, #6358)

1487. THE ELECTRIC AND MAGNETIC PROPERTIES OF THE INTERMETALLIC COMPOUND, CdSb

Pilat, I. M.

***Fizika Metallov i Metallovedenie*, v. 4, no. 2, pp. 232–238, 1957 (in Russian)**

The electrical resistivity, thermoelectric power, Hall constant, thermal conductivity and magnetic susceptibility were measured as functions of temperature for a variety of specimens of CdSb including: stoichiometric and various small departures therefrom, and also various dopings with Al, Te, Pb, Sn, and In. Results are given in tables and graphs. In discussion it is argued that the variation of some of the measured parameters can be related to variations in the binding forces in the crystals. (*PA*, 1958, #4007)

1488. MAGNETIC PROPERTIES OF ALLOYS HAVING COMPOSITIONS Mn_{60} Al_x Zn_{20-x} C_{20} AND MN_{60} GA_x Zn_{20-x} C_{20}

Howe, L. and Myers, H. P.

***The Philosophical Magazine*, Eighth Series, v. 2, no. 16, pp. 554–560, April 1957**

In these alloys Bohr magneton number per manganese atom for ferromagnetic state differs by 0.32, being greater in zinc alloy: it was thought that this difference could be accounted for by difference in valencies between Al and Zn: while it is clear that magnetic properties are very dependent upon electron concentration of corner atoms in cell, this dependence is not due to simple valency mechanism proposed. (*EI*, 1958)

1489. SOLID SOLUTIONS BETWEEN FERROMAGNETIC AND ANTIFERROMAGNETIC COMPOUNDS WITH NiAs STRUCTURE

Lotgering, F. K. and Gorter, E. W.

***Journal of Physics and Chemistry of Solids*, v. 3, no. 3–4, pp. 238–249, 1957**

Several solid solution series with NiAs structure were prepared, viz, $CrTe_{1-x}Se_x$, $Mn_{1-x}Cr_xSb$ and $CrTe_{1-x}Sb_x$: saturation magnetizations were measured between 20°K and Curie temperatures, and susceptibilities between Curie temperatures and 850–1100°K; magnetic properties found can be accounted for by assuming that dominant exchange interaction is not direct M-M interaction. (*EI*, 1958)

1490. MAGNETIC STRUCTURE OF Mn_2Sb

Wilkinson, M. K., Gingrich, N. S., and Shull, C. G.

***Journal of Physics and Chemistry of Solids*, v. 2, no. 4, pp. 289–300, 1957**

Neutron diffraction studies on single crystals and powdered samples of Mn_2Sb were made to determine magnetic structure of compound: ferrimagnetic structure predicted by C. Guillaud was confirmed except for exact values of individual atomic moments of manganese atoms; experimental values satisfactorily explain scattering from powdered samples at temperatures from 78 to about 800°K. (*EI*, 1957)

1491. LOW TEMPERATURE ELECTRICAL AND MAGNETIC BEHAVIOR OF DILUTE ALLOYS OF Mn IN Cu

Schmitt, R. W. and Jacobs, I. S.

***Journal of Physics and Chemistry of Solids*, v. 3, no. 3–4, pp. 324–327, 1957**

Measurements of magnetization, resistivity and magnetoresistivity of dilute alloys of manganese in copper: at very low temperatures magnetization is hysteretic and remanence is observed in all except most dilute alloys: magnetoresistance also exhibits reproducible hysteretic behavior in cases where there is hysteresis in magnetization: magnetoresistance is proportional to square of magnetization. (30 ref). (*EI*, 1957)

1492. MAGNETIC PROPERTIES OF PURE AND *N*-TYPE GERMANIUM AT LIQUID HELIUM TEMPERATURES

Hedgcock, F. T.

***Journal of Electronics*, v. 2, no. 6, pp. 513–528, May 1957**

The magnetic susceptibility of samples of *n*-type germanium of various charge carrier densities has been measured between 4.2°K and room temperature. An

anomalous low temperature paramagnetism has been observed in high purity germanium. Specimens with large charge carrier concentrations, which may be classed as "degenerate" samples, afford an experimental situation in which the onset of charge–carrier degeneracy can be followed by lowering the temperature alone. For a particular impurity concentration range, in the non-degenerate samples, the observed susceptibility results can be explained by assuming the usual activation process in extrinsic semiconductors. Below this concentration, it seems necessary to suggest the existence of conduction in an impurity band. Using these results an estimate of the effective electron mass in the impurity band can be made. (*PA*, 1957, #8715)

1493. THE THEORY OF THE MAGNETOSTRICTION OF NICKEL SINGLE CRYSTALS
Braun, U. F. (W. F. Brown), Jr.
***Doklady Akademii Nauk SSSR*, v. 112, no. 5, p. 827, 1957 (in Russian)**

In recent experiments Akulov finds for change of elongation in Ni crystals during magnetization along [111] his own curves gave better agreement with experiment than those calculated by Gans and Harlem (*Annalen Physik*, Leipzig, v. 15, p. 516, 1932; v. 16, p. 162, 1933) based on Heisenberg's work (*Zeitschrift für Physik*, v. 69, p. 287, 1931). The author draws attention to his own paper (*The Physical Review*, v. 52, p. 325, 1937) in which it is shown that such divergence is the result of error in Gans and Harlem's calculations. Curves calculated correcently on the basis of Heisenberg theory coincide satisfactorily with experimental data. (*PA*, 1957, #6356)

1494. APROPOS OF THE NOTE BY W. F. BROWN, "THE THEORY OF MAGNETOSTRICTION OF NICKEL SINGLE CRYSTALS"
Akulov, N. S.
***Doklady Akademii Nauk SSSR*, v. 112, no. 5, pp. 828–830, 1957 (in Russian)**

The error in Gans and Harlem pointed out by Brown is of no significance in Akulov's theory and calculations, and the objection against the formal method, used by Heisenberg, remains even with Brown's corrections. Akulov concludes that coincidence of his own results with those of experiment is difficult to account for by experimental error. (*PA*, 1957, #6357)

1495. MAGNETIC PROPERTIES OF NEODYMIUM SINGLE CRYSTALS
Behrendt, D. R., Legvold, S., and Spedding, F. H.
***The Physical Review*, v. 106, no. 4, pp. 723–725, May 15, 1957**

Magnetic measurements have been made on single crystals of neodymium which were grown by the Bridgman technique. At 20.4°K and above, the susceptibility obtained with the field perpendicular to the c_0-axis of the hexagonal crystal is greater than that obtained with the field parallel to the c_0-axis. In this same temperature range no anisotropy is observed in the basal plane. At 4.2°K antiferromagnetic ordering is indicated by the data and magnetic anisotropy in the basal plane is observed. (*PA*, 1957, #6345)

1496. THE MAGNETIZATION OF COBALT–MANGANESE AND COBALT–CHROMIUM ALLOYS
Crangle, J.
***The Philosophical Magazine*, Eighth Series, v. 2, pp. 659–668, May 1957**

Magnetization measurements on the hexagonal and the face-centered cubic phases in several ferromagnetic Co-rich alloys in these systems have been made. By the use of suitable extrapolation procedures, the magnetic moments of both phases in each system at the absolute zero have been estimated. In the Co–Mn alloys there is a significant difference in the dependence of moment on composition between the two phases. This is not the case in the Co–Cr alloys, where the rate of change of moment with composition of both phases is the same. (*PA*, 1957, #8721)

1497. THE MAGNETIC SUSCEPTIBILITY OF YTTERBIUM FROM 1.3°K TO 300°K
Lock, J. M.
***Proceedings of the Physical Society*, London, Section B, v. 70, part 5, pp. 476–480, May 1957**

The susceptibility of ytterbium metal has been measured at room temperature and between 1.3 and 80°K. Its magnitude seems to indicate that the atoms are mostly in the ^1S-state and the 4*f*-shell completely filled, only about 1 atom in 260 being in the $^2F_{7/12}$-state with 13 electrons in the 4*f*-shell. The paramagnetic saturation effect at the lowest temperatures seems to confirm this. The material

has been tested for superconductivity down to 1.24°K in fields as low as 10 oersted, with a negative result. (*PA*, 1957, #6346)

1498. MAGNETIC PROPERTIES OF Cu–Mn ALLOYS

Yosida, K.

***The Physical Review*, v. 106, no. 5, pp. 893–898, June 1, 1957**

The polarization of conduction electrons due to *s–d* interaction in CuMn alloys is investigated. The uniform polarization due to the first-order perturbed energy corresponding to the Fröhlich–Nabarro and Zener mechanism is shown to be completely modified by the first-order perturbation of the wave-functions and the polarization is concentrated in the neighborhood of the Mn ions. At the same time it is shown that the Fröhlich–Nabarro interaction is included in the Ruderman–Kittel result as one component. The electronic *g*-value of Mn ions and the Knight shift of the Cu nuclei are also discussed from this point of view. (*PA*, 1957, #7220)

1499. MAGNETIC SATURATION IN ALLOYS OF NEODYMIUM AT LOW TEMPERATURES

Lock, J. M.

***The Philosophical Magazine*, Eighth Series, v. 2, pp. 726–732, June 1957**

The magnetization of alloys of neodymium with lanthanum has been measured from room temperature down to 1.5°K. Above about 15°K the susceptibility is field-independent and obeys a Curie–Weiss law modified by a small temperature-independent paramagnetic terms, $\chi = C/(T - \theta) + K$. The Curie constant C gives effective atomic moments for all alloys in approximate agreement with the theoretical value for the Nd^{3+} ion, $3.62\mu_B$ per atom. At lower temperatures the alloys show striking saturation effects, and it is suggested that this can be accounted for in terms of a model in which the magnetic interactions between neodymium atoms are antiferromagnetic for nearest neighbors but ferromagnetic for more distant neighbors. (*PA*, 1957, #8720)

1500. HALL EFFECT AND SUSCEPTIBILITY OF GOLD

Alekseevskii, N. E. and Gaidukov, Yu. P.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 6, pp. 1589–1591, 1957 (in Russian)**

Previous work by the same authors revealed a minimum in the resistance/temperature dependence at ~4°K which disappeared in the presence of a magnetic field greater than a critical value, about 8.5 k oersted. The variation of Hall voltage with magnetic field has been measured (at 7 temperatures from 0.07 to 295°K), a change of slope being observed in each case at ~ 8.5 k oersted. The susceptibility, remaining diamagnetic in the range 1.45–295°K, also increased abruptly at the same field. (*PA*, 1958, #1777)

1501. THE MAGNETIC SUSCEPTIBILITIES OF LANTHANUM, CERIUM, PRASEODYMIUM NEODYMIUM AND SAMARIUM, FROM 1.5°K TO 300°K

Lock, J. M.

***Proceedings of the Physical Society*, London, Section B, v. 70, Part 6, pp. 566–576, June 1957**

The magnetic susceptibilities of these rare-earth metals have been measured over the temperature range 1.5°K to 300°K. Low temperature anomalies correlating with recent specific heat measurements have been found in cerium, neodymium and samarium at temperatures of 12.5°K, 7.5°K and 14.8°K respectively, and it is believed that these metals become anti-ferromagnetic below these temperatures. At higher temperatures the susceptibilities of cerium and praseodymium obey the Curie–Weiss law, with effective atomic moments of 2.51 and 3.56 Bohr magnetons respectively. Neodymium obeys a law of the form $\chi = C/(T - \theta) + K$, where the Curie constant C indicates an effective atomic moment of 3.3 Bohr magnetons (μ_B). These moments are in fair agreement with the values expected for the trivalent ions of the elements, assuming Russell–Saunders coupling of the orbital and spin moments of the 4*f* electrons. (*PA*, 1957, #7225)

1502. SPECIFIC HEATS AND MAGNETIC SUSCEPTIBILITIES OF ALLOYS OF CERIUM WITH LANTHANUM AT LOW TEMPERATURES

Roberts, L. M. and Lock, J. M.

***The Philosophical Magazine*, Eighth Series, v. 2, no. 18, pp. 311–319, June 1957**

Specific heat measurements between 1.5 and 20°K, and magnetic susceptibility measurements between 1.5 and 290°K were made on four alloys containing respectively

78.9, 37.6, 27.0 and 5.03% by weight of cerium in lanthanum; comparison is made with similar previous measurements on pure cerium; explanation of anomalous magnetic behavior of alloys. (*EI*, 1957)

1503. THE EFFECT OF DISLOCATIONS ON THE INITIAL PERMEABILITY OF NICKEL IN THE RECRYSTALLIZED AND IN THE PLASTICALLY DEFORMED STATE
Kersten, M.
***Annalen der Physik*, Leipzig, v. 20, no. 1–6, pp. 337–344, 1957 (in German)**

The variation with temperature of the initial permeability of recrystallized Ni between −180° and 200°C is explained by considering the cylindrical distortion of Bloch walls between dislocations. The model can also be applied to plastically deformed and incompletely recrystallized Ni over a smaller temperature range, the upper temperature limit decreasing to about room temperature with increasing deformation. (*PA*, 1959, #4803)

1504. EFFECT OF OMNIDIRECTIONAL COMPRESSION ON MAGNETIC PROPERTIES OF ZINC MONOCRYSTALS AT LOW TEMPERATURES
Dmitrenko, I. M., Verkin, B. I., and Lazarev, B. G.
***Zhurnal Experimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 1(7), pp. 287–289, 1957 (in Russian)**

1505. SPONTANEOUS MAGNETIZATION IN THE Mn–Ga–C ALLOYS
Myers, H. P.
***Canadian Journal of Physics*, v. 35, no. 7, pp. 819–822, July 1957**

Measurements of spontaneous magnetization, Curie temperature, and lattice parameter have been made on a series of alloys containing 20% (atomic) C and in which the Ga content varied from 10–18%. The results are compared with similar observations on Mn–Al–C and Mn–Zn–Al–C alloys. (*PA*, 1957, #9272)

1506. COMMENTS ON THE MANUEL MODEL FOR MnBi
Heikes, R. R. and Roberts, B. W.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 7, p. 711, July 1957**

Shows that the model proposed by Manuel for the interpretation of the magnetic properties of MnBi and MnAs leads to a value for the Curie constant that is 10 times larger than that observed. The model is also inconsistent with neutron diffraction observations. (*PA*, 1957, #8015)

1507. FERROMAGNETIC DOMAINS
Bates, L. F.
***Endeavour*, v. 16, no. 63, pp. 151–160, July 1957**

Techniques for studying physical processes involved when ferromagnetic metal is magnetized; experiments with cobalt and with silicon iron crystals; effects of imperfections; new patterns of special significance; electron microscope studies; photographs of patterns (24 ref). (*EI*, 1957)

1508. PLATINUM ALLOY PERMANENT MAGNETS
***Platinum Metals Review*, v. 1, no. 3, pp. 84–86, July 1957**

High energy and coercive force values of cobalt platinum which can provide more powerful permanent magnet than any other material known; material is used for permanent motor employed in Hamilton electric wrist watch; equilibrium diagram for cobalt platinum system; ordering transformation. (*EI*, 1957)

1509. THE ANTIFERROMAGNETISM OF MANGANESE COPPER ALLOYS
Bacon, G. E., Dunmur, I. W., Smith, J. H., and Street, R.
***Proceedings of the Royal Society of London*, Series A, v. 241, pp. 223–238, August 7, 1957**

Manganese-rich γ-phase alloys of manganese + copper have been investigated by neutron and X-ray diffraction techniques, and the temperature variations of magnetic susceptibility and electrical resistivity have been measured. The disappearance of long-range antiferromagnetic ordering has been correlated with the face-centered-tetragonal–face-centered-cubic martensitic transformation of these alloys. The Néel temperatures and the magnetic moments of the manganese ions, for alloys of various compositions, have been determined. The Néel temperature increases approximately linearly with increasing manganese content and extrapolates to 660°K at 100% Mn; the value of $1.4 \pm 0.1 \mu_B$ has been obtained for the ionic moment of the manganese ions in pure γ-Mn. Experiments

on plastically strained specimens show that compressive stress results in alignment of the c axes of the crystallites along the [100]-type direction most nearly parallel to the stress axis. The ionic moments are aligned along the c axis and the susceptibility of plastically strained specimens is anisotropic. An analysis is given of the results of measurements of the anisotropy of susceptibility from which may be calculated $\chi_{\parallel}$ and $\chi_{\perp}$, the susceptibilities of a single antiferromagnetic domain measured respectively parallel and perpendicular to the direction of antiferromagnetism. The results of the investigations are discussed in terms of an electron band model of an antiferromagnetic metal. (*PA*, 1957, #9267)

1510. THE USE OF "MAGNETIC INKS" IN DOMAIN STRUCTURE INVESTIGATION

Blackman, M.

***Research*, v. 10, no. 8, pp. 329–330, August 1957**

Commercially available dilute magnetic inks were used to investigate domain patterns on electropolished hexagonal and prism faces of cobalt crystals. (*PA*, 1958, #5126)

1511. ON THE TEMPERATURE DEPENDENCE OF THE PARAMAGNETC SUSCEPTIBILITY OF FERROMAGNETIC ALLOYS

Volkov, D. I. and Chechernikov, V. I.

***Fizika Metallov i Metallovedenie*, v. 5, no. 1, pp. 168–169, 1957 (in Russian)**

The paramagnetic susceptibility (χ) was measured at various temperatures (T) from the ferromagnetic Curie point (θ_f) to $\sim$ 1200°C for a series of Ni alloys and a wide range of composition of each. For all these alloys $\chi = \chi_k + \chi_T$ where χ_T = const./$(T - \theta_p)$ and θ_p = paramagnetic Curie temperature; χ_k is independent of T but depends on the concentration (v) of the ferromagnetic element in the alloy. Thus a plot of T against $1/(\chi - \chi_k)$ gives a straight line for each alloy. At $T \cong \theta_f$ there is a transition region where the magnetization (σ) is represented by $H = \alpha\sigma + \beta\sigma^3 + \gamma\sigma^3$ (900 oersted $< H <$ 10,000 oersted), α, β, γ all being functions of T and v. Results agree with the s–d exchange model of a ferromagnetic. (*PA*, 1958, #4138)

1512. THE DE HAAS–VAN ALPHEN EFFECT OF ZINC

Fukuroi, T. and Saito, Y.

***Science Reports of the Research Institutes of the Tôhoku University*, Series A, v. 9, no. 4, pp. 273–292, August 1957**

The de Haas–van Alphen effect of pure zinc crystal was investigated at temperatures ranging from 63 to 1.3°K by means of a torsion magnetometer. In the magnetic field less than 16 k oersted and at the temperatures 4.2°K and above, a remarkable periodic variation of magnetic susceptibility was found with the intensity of magnetic field and it is here referred to as the long-period effect. While in the field higher than 19 k oersted and at temperatures from 4.2 to 1.3°K, it was observed that a shorter-period and smaller-amplitude effect, which is accompanied by some complicated beat structures, is superposed on the high-field extension of the long-period effect just cited. From the analysis of the long-period effect the de Haas–van Alphen parameters were obtained: $E_{0l} = 5.5 \times 10^{-14}$ erg, $M_{1l}/m_0 = 5.4 \times 10^{-3}$, $m_{3l}/m_0 = 2.7 \times 10^{-1}$. $T_{Dl} =$ 400°K, $n_l = 1.2 \times 10^{-6}$ atom^{-1}; and from the analysis of the short-period effect; $E_{0s} = 7.9 \times 10^{-14}$ erg, $m_{1s}/m_0 = 1.6 \times 10^{-1}$, $m_{3s}/m_0 = 8.3 \times 10^{-2}$, $T_{Ds} = 570$°K, $n_s = 3 \times 10^{-5}$ atom^{-1}. (*PA*, 1957, #9761)

1513. MAGNETIZATION, MAGNETOSTRICTION AND RELAXATION PHENOMENA DURING ISOTHERMAL MAGNETIC ANNEALING AT HIGH TEMPERATURES IN Ni–Co ALLOYS

Masumoto, H., Saito, H., and Takahashi, M.

***Science Reports of the Research Institutes of the Tôhoku University*, Series A, v. 9, no. 4, pp. 293–308, August 1957**

An apparatus for the precise measurement of magnetostriction and magnetization at high temperatures was constructed, and these magnetic properties in thermally demagnetized Ni–Co alloys have been measured at high temperatures. It was found that these properties showed a remarkable relaxation phenomenon. Their time changes at constant temperature were continuously traced under the external fields of various strengths from the instant of the application of the field onward. The amount of the time change in the magnetostriction becomes large when the strength of field during annealing is large and the annealing duration is long. The effect begins to appear at about 300°C and is most remarkable at about 350°C and then gradually decreases, vanishing finally at the Curie

point. With progress of annealing, the negative magnetostriction becomes smaller and even turns positive in the case of alloys containing large amounts of cobalt, while the initially positive striction becomes larger. It may be considered that these relaxations are caused by a microcreep phenomenon in a broad sense of the word, that is, by displacements of impurities or lattice defects due to the magnetostriction at high temperatures. (*PA*, 1957, #9759)

1514. DE HAAS–VAN ALPHEN OSCILLATIONS IN THE THERMAL AND ELECTRICAL MAGNETORESISTANCE OF TIN

Alers, P. B.

***The Physical Review*, v. 107, no. 4, pp. 959–960, August 15, 1957**

Oscillatory behavior of the de Haas–van Alphen type was found in both the electrical and thermal magnetoresistance of a tin single crystal at liquid helium temperatures. Measurements were made in magnetic fields ranging from 22 to 25 kilogauss. The tetragonal axis of the crystal was parallel to the field and perpendicular to the rod axis. The thermal and electrical oscillations were in phase and yielded values for β^*/E_o of 5.7×10^{-7} gauss^{-1}, respectively. This is in substantial agreement with the value (5.9×10^{-7} gauss^{-1}) deduced by Shoenberg from diamagnetic susceptibility measurements. (*PA*, 1958, #238)

1515. PROPERTIES OF PALLADIUM–RHODIUM ALLOYS

Hoare, F. E. and Preston, J.

***Nature*, v. 180, p. 334, August 17, 1957**

Earlier results have been confirmed, showing that the magnetic susceptibility goes through a sharp maximum at 5% Rh concentration. The electronic specific heat term has now been measured below 4°K; this also shows a maximum at 5% Rh, but very much less pronounced. It is difficult to account for this difference on the usual model. (*PA*, 1957, #9664)

1516. A PROPOSAL FOR DETERMINING THE FERMI SURFACE BY MAGNETO-ACOUSTIC RESONANCE

Pippard, A. B.

***The Philosophical Magazine*, Eighth Series, v. 2, pp. 1147–1148, September 1957**

Bömmel has observed that the attenuation of ultrasonic waves in a pure tin crystal at 4°K varies in an oscillatory manner with the strength of a magnetic field applied transversely. This is attributed to a new type of cyclotron resonance which concerns the spatial extension of electron orbits in the direction of wave propagation. A study of single crystals in all orientations should give detailed information about the Fermi surface. (*PA*, 1957, #9769)

1517. AN INVESTIGATION INTO THE EFFECT OF MAGNETIC DOMAINS IN COBALT ON AN ELECTRON BEAM

Blackman, M. and Grünbaum, E.

***Proceedings of the Royal Society of London*, Series A, v. 241, pp. 508–521, September 10, 1957**

The effect on an electron beam of the leakage field due to the magnetic domains in an unmagnetized crystal of hexagonal cobalt was investigated. A conventional electron-diffraction camera was used, the primary beam being limited by a small movable aperture and the deflections observed on a photographic plate. Both the hexagonal and prism faces were examined. Magnetic effects were found: (a) on the primary beam, (b) on the diffraction pattern, (c) on the shadow edge of the diffraction pattern, and (d) on the shadow photograph of the crystal produced by diffuse scattering from the edge of the aperture. These effects are analyzed in terms of the fields produced by the magnetic domains; measurements are made of the size of the domains and of the magnitude of the leakage field at the surface and its variations with the distance from the surface. (*PA*, 1958, #651)

1518. REMARKS ON ZENER'S CLASSICAL THEORY OF THE TEMPERATURE DEPENDENCE OF MAGNETIC ANISOTROPY ENERGY

Brenner, R.

***The Physical Review*, v. 107, no. 6, pp. 1539–1541, September 15, 1957**

The temperature dependence of the first anisotropy constant for nickel is calculated by averaging the local anisotropy energy over a Langevin function. Reasonably good agreement with the experimental curve is obtained for $T/\theta > 0.3$. An estimate is made of the variation of the local anisotropy constant with changes in volume. (*PA*, 1958, #5105)

1519. EVIDENCE FOR SUBGRAINS IN MnBi CRYSTALS FROM BITTER PATTERNS

Ellis, W. C., Williams, H. J., and Sherwood, R. C.
***Journal of Applied Physics*, v. 28, no. 10, pp. 1215–1216, October 1957**

Bitter patterns on a surface containing the *c* axis in a single crystal of MnBi show that each magnetic domain consists of subdomains because of slight differences of orientation of the *c* axis in each subgrain. Laue reflections confirm that the spread of orientation of a given plane is about 2 deg. (*PA*, 1958, #229)

1520. ON THE DOMAIN STRUCTURE OF A Mn—BISMUTH ALLOY OF HIGH COERCIVITY

Shur, Ya. S., Shtol'ts, E. V., Kandaurova, G. S., and Bulatova, L. V.
***Fizika Metallov i Metallovedenie*, v. 5, no. 2, pp. 234–240, 1957 (in Russian)**

By means of powder figures it was shown that magnetization of Mn–Bi proceeded in two ways: (1) weak magnetizing fields allowed the formation of zones of reversed magnetization and gave coercivities (H_c) of up to 1000 oersted; (2) strong applied fields prevented the growth of reversed zones and gave H_c of several thousand oersted. It is believed that the same phenomena occur in other high-coercivity alloys but are not so easily observed as in Mn–Bi which is highly magnetically anisotropic. (*PA*, 1958, #4151)

1521. DOMAIN STRUCTURE IN HIGH COERCIVITY MANGANESE–BISMUTH ALLOYS

Shur, Ya. S., Shtol'ts, E. V., Kandaurova, G. S., and Bulatova, L. V.
***Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*) v. 5, no. 2, pp. 40–45, 1957**

Study made by powder figure method of domain structure in MnBi alloy, and its change under influence of magnetic field; it was found that process of reversal of magnetization was greatly dependent on initial state of magnetization; visual observation made for first time of reversal of magnetization in individual crystallites, by single rotation process. (*EI*, 1957)

1522. MAGNETIC SUSCEPTIBILITY OF GERMANIUM

Bowers, R.
***The Physical Review*, v. 108, no. 3, pp. 683–689, November 1957**

The magnetic susceptibility of highly doped Ge was measured between 300 and 1.3°K. The contribution of the carriers to the susceptibility was derived from the data. Most of the measurements concerned electrons occupying unbound states in the conduction band. The observed conduction-electron susceptibility was compared with theoretical estimates based on the effective-mass values given by cyclotron-resonance experiments. The results support a 4-ellipsoid model of *n*-Ge. No appreciable change in the effective masses was observed between room temperature and 1.3°K. No evidence was found for any substantial change in the curvature of the conduction band for energies up to 0.08 ev above the band minimum. This finding contradicts certain conclusions of Stevens, et al. An explanation for the disagreement is proposed. Measurements were made of the spin susceptibility of quasi-bound states of electrons and holes in Ge at a carrier density near $6 \times 10^{16}/cm^3$. In each case, the spin susceptibility was found to be almost independent of temperature. It is concluded that there is strong exchange coupling between neighboring impurity centers at this concentration. The susceptibility of high-purity Ge was measured, and found to be independent of temperature below 60°K. (*PA*, 1958, #3244)

1523. RESISTIVITY AND MAGNETORESISTANCE OF Au_2Mn

Smith, J. H. and Street, R.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 11, pp. 1089–1092, November 1957**

This material has the property that a characteristic threshold field, depending on temperature, must be exceeded before ferromagnetism is developed. Measurements are reported at fields up to 2.1×10^4 oersted and between 20 and 500°K. The temperature variation of resistance is like that of nickel. Below the Néel point (360°K) the magnetoresistance is anisotropic; its variation with temperature is similar to that of the magnetocaloric effect. The results are discussed on a band model. (*PA*, 1958, #2311)

1524. THE SATURATION MAGNETOSTRICTION OF NICKEL SINGLE CRYSTALS
Birss, R. R.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 11, pp. 1093–1096, November 1957**

Re-analyzes the data of Masiyama (1928) and compares the results with those obtained from the measurements of Bozorth and Hamming. (*PA*, 1958, #2415)

1525. STUDY OF THE MAGNETIC LEAKAGE FIELD IN COBALT BY MEANS OF A DIVERGENT ELECTRON BEAM
Blackman, M. and Grünbaum, E.
***Nature*, v. 180, pp. 1189–1190, November 30, 1957**

A continuation of previous work. The divergent beam scans an extended region parallel to an edge of a cobalt crystal. Trochoidal curves are obtained close to the prism and hexagonal faces, and these change their character reversibly during temperature cycling to above the isotropy temperature where the leakage field is small. (*PA*, 1958, #1129)

1526. MAGNETIC PROPERTIES OF UMn_2
Lin, S. T. and Kaufmann, A. R.
***The Physical Review*, v. 108, no. 5, pp. 1171–1174, December 1, 1957**

The magnetic properties of UMn_2 were investigated for the temperature range from 360 down to 4.2°K. Below room temperature the magnetization curves are slightly bent toward the field axis and below 230°K the sample showed a small remanence. The susceptibility against temperature curve shows a λ-type anomaly at 260°K and a steep increase at about 4°K. The hysteresis loops are not symmetrical with respect to the origin, and the degree of asymmetry depends upon either the temperature or whether the sample was cooled in magnetic field or without field. From some evidence, UMn_2 is classified as an antiferromagnetic material with a small parasitic ferromagnetism which may arise from uncompensated sublattice moments or uncompensated domain wall magnetization. (*PA*, 1958, #1772)

1527. THEORIE DE BLOCHWANDWOELBUNG MIT STREUFELDENFLUSS FUER KUBISCHE KRISTALLE MIT NEGATIVER KRISTALLANISOTROPIEKONSTANTEN
Dietze, H. D.
***Technische Mitteilungen Krupp*, v. 5, no. 7, pp. 169–177, December 1957**

Theory of Bloch wall curvature under influence of stray fields in cubic crystals with negative crystal anisotropy constants; effect of stray field on domain wall bulging is calculated for nickel; as in case of iron, stray field influences temperature dependence of initial susceptibility. (*EI*, 1958)

1528. TEMPERATURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF α-SILVER–ZINC ALLOYS
Meyer, L. and Weiner, D.
***The Physical Review*, v. 108, no. 6, pp. 1426–1427, December 15, 1957**

The magnetic susceptibility of α-silver-zinc alloys was measured from 5–35% Zn between room temperature and helium temperatures. All samples became slightly more diamagnetic with decreasing temperature, and any temperature-dependent paramagnetic contribution to the susceptibility due to bound electron states must be less than 0.1% of the room-temperature value of the susceptibility. (*PA*, 1958, #7165)

1529. PARAMAGNETIC PROPERTIES OF DILUTE PALLADIUM–COBALT ALLOYS CONTAINING HYDROGEN
Burger, J. P. and Wucher, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 25, pp. 2230–2233, December 16, 1957 (in French)**

Reports results of measurements up to 1000°K of the susceptibility of pure Pd–Co alloys containing 1, 2 and 4% Co; deviations from a Curie–Weiss law were observed. The three alloys containing hydrogen contents up to H/Pd about 0.7 were also investigated, and here the law was found to hold between 100 and 300°K. (*PA*, 1958, #1776)

1530. THE MAGNETIC SUSCEPTIBILITY AND EFFECTIVE MASS OF THE CURRENT CARRIERS IN SILICON AND GERMANIUM
Geist, D.
Naturwissenchaften, v. 45, no. 2, pp. 33-34, 1958 (in German)

The effective mass is here calculated from the carrier density and from that part of the magnetic susceptibility which can be ascribed to the free current carriers. This small fraction of the total susceptibility is derived by measurements on samples having a range of impurity concentrations. The method enables the effective masses to be calculated at definite temperatures and it is found that the values in general increase with temperature. (*PA*, 1958, #4980)

1531. FERROMAGNETISM OF A ZIRCONIUM–ZINC COMPOUND
Matthias, B. T. and Bozorth, R. M.
The Physical Review, v. 109, no. 2, pp. 604–605, January 15, 1958

The compound with approximate composition $ZrZn_2$ was found to be ferromagnetic below 35°K with a saturation moment at the absolute zero of about 0.13 Bohr magnetons per molecule. The possible implications of this observation are briefly discussed. (*PA*, 1958, #2406)

1532. THE MAGNETIC PROPERTIES OF A SERIES OF NICKEL–COPPER ALLOYS
Meyer, A. J. P. and Wolff, C.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 246, no. 4, pp. 576–579, January 27, 1958 (in French)

Reports results of determinations of the Curie temperatures θ and saturization moments σ_0, as well as of the reduced magnetization curves for alloys with up to 35% Cu; θ varies linearly to extrapolate to 0 at 57% Cu and σ_0 at 52% Cu. The temperature variation of σ is as $T^{5/2}$; the law of corresponding states is not obeyed. (*PA*, 1958, #4137)

1533. MAGNETOSTRICTION CONSTANTS OF NICKEL–COPPER AND NICKEL–COBALT ALLOYS
Yamamoto, M. and Nakamichi, T.
Journal of the Physical Society of Japan, v. 13, no. 2, pp. 228–229, February 1958

Values of λ_{100} and λ_{111} have been obtained at room temperature in single crystal specimens by the strain gauge technique. For Ni–Cu, the constants are always negative but the absolute values decrease steadily and vanish at 35% Cu. In Ni–Co, λ_{111} is always negative and exhibits a shallow minimum at 30% Co, while λ_{100} increases almost linearly, is zero at 20% Co and $+116 \times 10^{-6}$ at 55% Co. (*PA*, 1959, #4786)

1534. METHOD FOR MEASURING MAGNETOSTRICTION CORRECTED FOR INITIAL DOMAIN DISTRIBUTION AND ITS APPLICATION TO NICKEL AND IRON
Stauss, H. E.
Journal of Applied Physics, v. 29, no. 2, pp. 182–184, February 1958

Technique uses cubic specimen placed between two iron rods of same cross section; combination is put along common axis of two like solenoids connected in series; strain is measured with resistance strain gage, once parallel to magnetic field, and second time normal to field; application to grade A nickel and armco iron. (*EI*, 1958)

1535. MAGNETIC RESONANCE OF $MnAu_2$
Asch, G. and Meyer, A. J. P.
Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 246, no. 8, pp. 1180–1182, February 24, 1958 (in French)

Reports results of measurements between 17 and 140°C, in fields up to 2×10^4 oersted and at frequencies 9.30 and 36.63 kMc. An absorption maximum which shifts to higher fields as the temperature rises to 90°C was observed at the higher frequency; at higher temperatures the maximum position is steady at 1.27×10^4 oersted. The results are explained in terms of field-dependent magnetic transitions. (*PA*, 1958, #4132)

1536. MAGNETIC PROPERTIES OF DYSPROSIUM SINGLE CRYSTALS
Behrendt, D. R., Legvold, S., and Spedding, F. H.
The Physical Review, v. 109, no. 2, pp. 1544–1547, March 1, 1958

Single crystals of metallic dysprosium were grown by the Bridgman method and their magnetic properties deter-

mined in different crystallographic directions of the hexagonal close-packed structure. Below the Néel point of 178.5°K the individual magnetic moments are aligned perpendicular to the c_0 axis. The moments are aligned in an antiferromagnetic manner from 178.5°K down to 85°K and in a ferromagnetic manner below 85°K. Measurements with the field parallel and perpendicular to the c_0 axis reveal magnetic anisotropy at all temperatures. Below 110°K magnetic anisotropy is also observed in the basal plane. The direction of easy magnetization is along an α_0 axis. In the c_0 direction the crystals are extremely "hard" magnetically, the magnetization curves being linear as in the case of a paramagnetic material. The saturation moments follow the T^2 law. (*PA*, 1958, #2395)

1537. MAGNETIC PROPERTIES OF HOLMIUM AND THULIUM METALS

Rhodes, B. L., Legvold, S., and Spedding, F. H.
***The Physical Review*, v. 109, no. 5, pp. 1547–1550, March 1, 1958**

The magnetic moments of holmium and thulium metals were measured in applied fields of 3000–18,000 oersted, over the temperature range of 4.2–300°K. Holmium, paramagnetic above 133°K, appears to be antiferromagnetic between 20 and 133°K, and ferromagnetic below 20°K. Thulium was found to be paramagnetic above 51°K and possibly antiferromagnetic below 51°K. (*PA*, 1958, #2396)

1538. ANTIFERROMAGNETISM IN THE BODY-CENTERED CUBIC Mn–Cr SOLID SOLUTION

Kasper, J. S. and Waterstrat, R. M.
***The Physical Review*, v. 109, no. 5, pp. 1551–1552, March 1, 1958**

Neutron diffraction evidence for antiferromagnetism in an equiatomic solid solution of Mn and Cr, with the body-centered cubic structure, is presented. At 298°K the average moment per atom is $(0.85 \pm 0.04)\mu_B$. (*PA*, 1958, #2407

1539. TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY

Carr, W. J., Jr.
***Journal of Applied Physics*, v. 29, no. 3, pp. 436–437, March 1958**

The temperature dependence of the crystalline anisotropy constants of iron, cobalt, and nickel is discussed. It is shown that Zener's result for iron (i.e., the first anisotropy constant varies as the tenth power of the magnetization) also may be derived from molecular field theory. In cobalt a satisfactory agreement with experiment is obtained by using Zener's results together with the postulate that the intrinsic anisotropy varies with thermal expansion in the manner recently calculated by the author. For nickel also the temperature dependence of K_1 seems to require, in addition to the tenth power of the magnetization, a multiplicative factor that is linear in the temperature. No explanation has been found for this latter term. (*PA*, 1958, #8873)

1540. TEMPERATURE DEPENDENCE OF THE ABSORPTION OF ULTRASOUND IN A NICKEL SINGLE CRYSTAL FROM 77° TO 650°K

West, F. G.
***Journal of Applied Physics*, v. 29, no. 3, pp. 480–482, March 1958**

The temperature dependence of the difference between the demagnetized and saturation ultrasonic absorptions was measured between 77 and 650°K. From 77 to above 400°K, at 10 Mc, this difference is found to be inversely proportional to the first-order magnetocrystalline anisotropy constant K_1 to approximately the first power. This result shows the inadequacy of present theories of absorption based on microeddy current losses accompanying domain wall motion and domain rotation. Further evidence is presented which seems to definitely exclude the rotation mechanism for this frequency range in nickel. (*PA*, 1959, #2168)

1541. UNUSUAL MAGNETIC BEHAVIOR OF DISORDERED Ni_3Mn

Kouvel, J. S., Graham, C. D., Jr., and Becker, J. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 518–519, March 1958**

Measurements were made of the magnetization of disordered Ni_3Mn alloy for various fields between 945 and 7550 oersted and at many temperatures between 1.5 and 300°K. The magnetization vs. temperature curve for any given field is found to have a pronounced maximum at about 25°K and a long concave-upward section extending

from about 140°K to temperatures above 300°K. By means of a new method of analysis, the Curie point is deduced to be 132°K. An abnormally large induced magnetization, greatest at about 50°K, is also found. All the experimental results are consistent with the occurrence of a ferrimagnetic–ferromagnetic transition at low temperatures. (*PA*, 1958, #8910)

1542. MAGNETIC PROPERTIES OF DILUTE MAGNETIC ALLOYS AND OF THE RARE EARTH METALS

Pratt, G. W., Jr.
***Journal of Applied Physics*, v. 29, no. 3, pp. 520–521, March 1958**

Dilute alloys of paramagnetic atoms in Cu or the noble metals were found to exhibit ferromagnetism as well as antiferromagnetism. This is of particular interest because the origin of the magnetic behavior cannot lie in the customary Heisenberg exchange interaction between nearest neighbors because of the large separation between the paramagnetic atoms in dilute alloys. A similar situation exists in the rare earths where nearest neighbor *4f–4f* direct exchange is negligible. The spin coupling can be explained by taking account of the direct exchange interaction between the paramagnetic atoms and the conduction electrons and by super-exchange. To describe the super-exchange coupling it is necessary to know the energy levels of the paramagnetic atom in the solid. The results of a Hartree–Fock analysis of this problem are briefly discussed. A generalization of a previous molecular field treatment is also given. (*PA*, 1959, #434)

1543. GROWTH OF MnBi CRYSTALS AND EVIDENCE FOR SUBGRAINS FROM DOMAIN PATTERNS

Ellis, W. C., Williams, H. J., and Sherwood, R. C.
***Journal of Applied Physics*, v. 29, no. 3, pp. 534–536, March 1958**

MnBi crystals were prepared by crystallization in a temperature gradient from a liquid solution of bismuth saturated with manganese. Informative domain patterns were developed on surfaces of a crystal by the normal Kerr magneto-optic effect and by the Bitter technique. Block patterns, obtained in some instances, were interpreted as evidence for subgrain structure. (*PA*, 1958, #8928)

1544. MAGNETIC MOMENTS AND APPARENT MOLECULAR FIELDS IN SOME RARE EARTH METALS AND COMPOUNDS

Henry, W. E.
***Journal of Applied Physics*, v. 29, no. 3, pp. 524–525, March 1958**

A study has been made of the absolute magnetization of some rare earth metals (gadolinium and cerium) and some compounds (ytterbium oxide, neodymium oxide, erbium oxide and yttrium iron garnet) as a function of magnetic fields up to 60,000 gauss and temperature down to 1.3°K. The saturization magnetization of ferromagnetic gadolinium is 7.05 ± 0.10 Bohr magneton per atom of gadolinium and its molecular field is 1.3 megagauss. The average magnetization of cerium is only 0.17 Bohr magneton per atom of cerium even at 1.3°K and 60,000 gauss. It is ferrimagnetic with an estimated antiferromagnetic molecular field of one-half megagauss. Ytterbium sesquioxide has an antiferromagnetic molecular field of about 35,000 gauss and becomes antiferromagnetic at about 3°K in zero field. Yttrium iron garnet (YIG) has been studied and the saturation magnetization has been determined at 100°K and in the helium range. The saturation magnetization is 0.83 at 1.3°K as compared with 1.25 Bohr magnetons per atom of iron in gamma iron (III) oxide studied previously. A ballistic method was used for measuring the magnetic moment and the calibration was made using metallic iron.

1545. PRECIPITATION AND MAGNETIC ANNEALING IN A COPPER–COBALT ALLOY

Becker, J. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 317–318, March 1958**

In an alloy containing 2% cobalt, balance copper, it is possible to quench a nonmagnetic solid solution from 1000°C and then produce a ferromagnetic precipitate in a nonmagnetic matrix by aging at several hundred degrees. The magnetic properties of this precipitate can be correlated with the size and shape of the precipitate particles. Considerable information about the precipitation process can be obtained in this way. In these experiments, saturation magnetization, torque, rotational hysteresis, remanence, coercive force for zero magnetization, and coercive force for zero remanence (which behaves in a surprising fashion) have been observed during the course of aging. In particular, the effect of a field during aging in producing magnetic anisotropy ("magnetic

annealing") has been studied and is shown to occur entirely during the growth of the particles, after the precipitation is complete.

The precipitation process is viewed as one in which the particles as they grow are first superparamagnetic, then stable single domains, and finally multidomain. This point of view is consistent with all of the varied phenomena observed.

1546. RECRYSTALLIZATION OF MnBi INDUCED BY A MAGNETIC FIELD

Boothby, O. I., Wenny, D. H., and Thomas, E. E.
***Journal of Applied Physics*, v. 29, no. 3, p. 353, March 1958**

Polycrystalline MnBi has been found to recrystallize when subjected to a strong magnetic field at temperatures between ~270°C and the Curie point, ~350°C. A fiber texture develops in which the crystals are oriented with the easy direction of magnetization (the *c* axis) parallel to the applied field. This effect has not been observed before to our knowledge. The polycrystalline MnBi was prepared by chill-casting an alloy of the stoichiometric composition and then heat-treating the casting at 300°C for 24 hr. Cast plates 0.5 in. thick containing about 90% MnBi were prepared in this way. The initial heat treatment was made without a field to provide material with a random crystal orientation. The randomly oriented material was then heat treated in a field of 8000 oersted to induce recrystallization and develop the fiber texture. Crystal orientations were determined by X-ray diffraction patterns taken from polished surfaces. Photomicrographs in which the magnetic domain patterns were made visible by means of the Kerr magneto-optic effect showed that recrystallization was involved in the development of the fiber texture. Possible mechanisms to explain the recrystallization and its utilization to orient the particles in fine powder magnets are considered.

1547. THE GYROMAGNETIC RATIO OF VERY PURE NICKEL

Meyer, A. J. P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 248, no. 10, pp. 1517–1519, March 10, 1954 (in French)**

The g' value of 99.998% pure N_1 was found to be 1.845 ± 0.007 (cf. $g = 2.193 \pm 0.02$). (*PA*, 1958, #4134)

1548. ON THE EXISTENCE OF A MOST PROBABLE MAGNETIZATION JUMP

Ivlev, V. F. and Rudyak, V. M.
***Doklady Akademii Nauk SSSR*, v. 120, no. 3, pp. 495–496, 1958 (in Russian)**

There is still some uncertainty as to the size distribution of jumps in the Barkhausen effect. Most estimates are of the order of 10^{-6} c.g.s/m. The authors have studied the effect in a piece of electrolytic nickel 0.5 mm in diameter and 35 mm long with an apparatus sensitive to 10^{-7} c.g.s/m. Graphs of the size distribution of Barkhausen jumps are given for annealed and unannealed specimens of the nickel, the most probable values being 1.7 and 1.5 c.g.s/m. respectively. (*PA*, 1958, #7195)

1549. TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY

Carr, W. J., Jr.
***The Physical Review*, v. 109, no. 6, pp. 1971–1976, March 15, 1958**

The temperature dependence of the crystalline anisotropy constants of iron, cobalt, and nickel is discussed. It is shown that Zener's result for iron (i.e., the first anisotropy constant varies as the tenth power of the magnetization) also may be derived from molecular field theory. In cobalt a satisfactory agreement with experiment is obtained by using Zener's results together with the postulate that the intrinsic anisotropy varies with thermal expansion in the manner recently calculated by the author. For nickel the temperature dependence of K_1 seems to require, in addition to the tenth power of the magnetization, a multiplicative factor that is linear in the temperature. No explanation has been found for this latter term. (*PA*, 1958, #2393)

1550. MAGNETIC AFTER-EFFECT DUE TO QUENCHED-IN VACANCIES IN NICKEL

Nakamura, Y. and Takamura, J.
***Journal of the Physical Society of Japan*, v. 13, p. 316, March 1958**

Following a quench from about 1000°C the intensity of magnetization recovered about 80% of its initial value in one day but further recovery took place only slowly, the change being complete in about 10 days. Similar changes in volume occurred. (*PA*, 1959, #4787)

1551. REDUCTION OF MAGNETIC SUSCEPTIBILITY IN BERYLLIUM–COPPER
Bernstein, H.
***Transactions of the Metallurgical Society of the AIME*, v. 212, no. 2, pp. 225–226, April 1958**

Investigation carried out to establish effect of small amounts of iron on susceptibility of copper (2% Be) alloy and to determine if effect could be minimized; alloy is magnetically stable after short time exposures up to 900°F; to precipitate ferromagnetic iron phase, temperatures on order of 1000°F were required. (*EI*, 1958)

1552. THE MAGNETIC SUSCEPTIBILITY AND ELECTRICAL RESISTIVITY OF SOME TRANSITION METAL SILICIDES
Robins, D. A.
***The Philosophical Magazine*, Eighth Series, v. 3, pp. 313–327, April 1958**

Sintered samples have been prepared of a number of silicides formed by the group IVa, Va and VIa transition metals and silicon. Magnetic susceptibility measurements were made at room temperature and 500°C and the electrical resistivity and temperature coefficient of resistivity determined for the range 20 to 120°C. The results are discussed in relation to the type of bonding present in these compounds and it is shown that the transition-metal silicides are essentially metallic in character. (*PA*, 1958, #3228)

1553. THE INFLUENCE OF HYDROSTATIC PRESSURE ON THE MAGNETIZATION OF Au_2Mn
von Klitzing, K. H. and Gielessen, J.
***Zeitschrift für Physik*, v. 150, no. 4, pp. 409–414, 1958 (in German)**

The magnetization below saturation increases markedly (by a factor 2½ at 10^4 oersted and 4.5×10^3 atm) while the threshold field decreases. The results are discussed in terms of the pressure dependence of the molecular field and the crystalline anisotropy. (*PA*, 1958, #7191)

1554. THE MAGNETIC PROPERTIES OF RARE EARTH METALS AT VERY LOW TEMPERATURES
Leipfinger, H.
***Zeitschrift für Physik*, v. 150, no. 4, pp. 415–435, 1958 (in German)**

Reports results of susceptibility measurements of metallic Ce, Pr, Nd, Sm, Tb, Dy, Ho, Tm and Yb as well as some of their salts down to 1.5°K. In some cases differences with earlier results are observed and these are ascribed to impurities or the physical state of the specimens; powdered Dy does not exhibit ferromagnetism. (*PA*, 1958, #7169)

1555. ELECTRICAL AND MAGNETIC PROPERTIES OF THE ZnSb–CdSb SYSTEM
Pilat, I. M., Chizh, L. D. and Voityshen, S. Yu.
***Zhurnal Tekhnicheskoi Fiziki*, v. 28, no. 4, pp. 786–788, 1958 (in Russian)**

Variation of electrical conductivity σ, activation energy ΔE, thermo-emf α, carrier mobility μ, Hall effect and magnetic susceptibility χ of the ZnSb–CdSb alloys was investigated in the composition range from 4 CdSb + ZnSb to CdSb + 4 ZnSb. All the investigated alloys displayed semiconducting properties. The character of the property vs. composition curves indicates that CdSb and ZnSb form a series of solid solutions. Since all the studied properties reach their minimum (σ, χ) or maximum (ΔE, μ, α) values at the composition ZnSb + CdSb, the existence of an intermetallic compound $CdZnSb_2$ is postulated. (*PA*, 1958, #7962)

1556. CALCULATED AND OBSERVED EFFECTS OF TEXTURE ON THE MAGNETIC PROPERTIES AND YOUNG'S MODULUS OF NICKEL SHEET
Jones, E. R. W., Clark, C. A., and Fell, E. A.
***British Journal of Applied Physics*, v. 9, no. 5, pp. 178–184, May 1958**

Relative values of Young's modulus, magnetostrictive coupling coefficient and initial and maximum permeabilities are calculated for various textures in nickel, an approximate model being used for magnetic properties. Experimental values are given for high purity polycrystalline nickel sheet produced by powder metallurgy and annealed in purified hydrogen. Comparison between theory and experiment indicates good agreement for Young's modulus and fair agreement for magnetic properties. The textures were determined by X-ray photographic

techniques and it was shown that strip possessing a cube recrystallized texture gave lower properties than recrystallized strip having a random grain orientation. It was also found, in agreement with previous work on copper, that the perfection of the cube texture was mainly governed by the temperature of anneal. (*PA*, 1958, #4135)

1557. MAGNETIC EFFECTS ON THE ELECTRON DIFFRACTION PATTERNS FROM A COBALT CRYSTAL

Blackman, M. and Grünbaum, E.
***Proceedings of the Physical Society*, London, v. 71, Part 5, pp. 758–760, May 1958**

Electron diffraction patterns taken on the prism face of a cobalt crystal showed a distortion due to the magnetic leakage field of domains. The normal diffraction spots were replaced by a series of arcs. When the primary beam was moved parallel to the edge of the crystal, the distorted pattern changed with a period characteristic of the domain spacing. On heating the crystal, the magnitude of the distortion decreased, and became negligible at about 250°C. (*PA*, 1958, #4535)

1558. REPRODUCIBLE THERMOMAGNETIC REMANENCE IN NICKEL OXIDE AND THE ALLOYS Pd_3Mn_2 AND CrSb

Perakis, N., Wucher, J., Parravano, G., and Wendling, R.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 21, pp. 3037–3040, May 28, 1958 (in French)**

The effect has been observed in the antiferromagnetic substances by cooling them in a magnetic field. It depends on the magnitude of the field and on the temperature, and vanishes by heating to the Néel point. (*PA*, 1958, #7176)

1559. MAGNETIC PROPERTIES OF *N*-TYPE SILICON

Sonder, E. and Stevens, D. K.
***The Physical Review*, v. 110, no. 5, pp. 1027–1034, June 1, 1958**

The magnetic susceptibility of *n*-type silicon samples with a wide range of donor concentrations (3×10^{16} to 3×10^{19} atoms/cm^3) was measured as a function of temperature from 3 to 300°K. By utilizing conduction-electron concentrations obtained from Hall coefficient measurements on comparison specimens over the range from 50 to 400°K, the contributions to the susceptibility arising from the conduction electrons and electrons trapped on donor atoms are analyzed. In the upper range of temperature the diamagnetic contribution of conduction electrons is dominant and is consistent with the model of six energy minima in the conduction band. However, comparison of the squared reciprocal mass ratio with that obtained from cyclotron-resonance experiments reveals that the former is appreciably smaller than the latter (~ 8 as compared to ~ 13). As the temperature is lowered, the conduction-electron contribution becomes successively less as electrons are frozen out on donor atoms. The trapping of electrons by donors at low temperatures leads to a Curie-law paramagnetism in the specimens of higher purity, whereas in the more impure samples, deviations from Curie's law occur which are attributed to interactions between closely spaced donor centers. (*PA*, 1958, #5119)

1560. MAGNETIC SUSCEPTIBILITY OF ALKALI ELEMENTS. I. SODIUM AND POTASSIUM

Venkateswarlu, K. and Sriraman, S.
***Zeitschrift für Naturforschung*, v. 13a, no. 6, pp. 451–455, June 1958**

A vacuum Curie balance was specially designed for the study of magnetic susceptibilities at higher temperatures. With this apparatus the magnetic study of sodium and potassium was made at different temperatures ranging from 32 to 250°C. Special attention was paid to the preparation of the specimen. Corrections for all possible errors were made. The results point out that the susceptibilities of the metals increase with temperature both below and above their melting points. The temperature coefficients of the susceptibility of valence electrons of the two metals are in general agreement with Stoner's theory. (*PA*, 1958, #7166)

1561. MAGNETIC SUSCEPTIBILITY OF ALKALI ELEMENTS. II. LIQUID ALLOYS OF SODIUM AND POTASSIUM

Venkateswarlu, K. and Sriraman, S.
***Zeitschrift für Naturforschung*, v. 13a, no. 6, pp. 455–458, June 1958**

Alloys of sodium and potassium were prepared in vacuum in a specially blown pyrex glass apparatus. Several bulbs containing these alloys of different compositions were studied at temperatures ranging from 30 to 250°C. The compositions of these alloys were determined by gravimetric method. The results show that for the alloys of all compositions the additivity law is obeyed both at room temperature and at higher temperatures. No evidence for the formation of the compound Na_2K could be detected from the magnetic study. (*PA*, 1958, #7167)

1562. MAGNETIC PROPERTIES OF THE Gd–La AND Gd–Y ALLOYS

Thoburn, W. C., Legvold S., and Spedding, F. H.
***The Physical Review*, v. 110, no. 6, pp. 1298–1301, June 15, 1958**

For alloys of high Gd content, paramagnetic to ferromagnetic transitions are observed with decreasing temperature. As the Gd content is decreased, ferromagnetic ordering is replaced by antiferromagnetic ordering. In the Gd–La alloys, a crystal structure change affects the magnetic properties. (*PA*, 1958, #6042)

1563. REVERSIBLE SUSCEPTIBILITY UNDER STRESS

Morkowski, J.
***Acta Physica Polonica*, v. 17, no. 6, pp. 435–453, 1958**

Measured in polycrystalline Ni by the alternating field method, for magnetic field values up to about 68 oersted. During the measurements the specimen was subject to compression and tension, the values of which varied from about -14 to $+21$ kg/mm^2. The results obtained show that application of tension lowers the value of reversible susceptibility in weak fields and increases it at more intense fields as compared with the unstressed specimen. At small compressive stresses, down to about -3 kg/mm^2, the picture is the reverse; at larger values of compressive stress, however, the reversible susceptibility is smaller for all values of magnetic field intensity than in the unstressed specimen. The results obtained are interpreted theoretically on the basis of statistical considerations. (*PA*, 1959, #5889)

1564. THE VARIATION WITH TEMPERATURE OF THE MAGNETIC LEAKAGE FIELD IN COBALT

Blackman, M. and Grünbaum, E.
***Proceedings of the Royal Society of London*, Series A, v. 245, no. 1242, pp. 408–416, 1958**

The variation with temperature of the magnetic leakage field of an unmagnetized crystal of hexagonal cobalt was investigated by means of an electron beam. Both the prism and hexagonal faces were examined in the temperature range from 20 to 380°C by a new method using a divergent electron beam. In addition, the prism face was studied from 20–170°C. It was found that the strength of the magnetic leakage field decreased steadily with increasing temperature. It became negligible at about 260°C and this condition persisted up to 380°C. It was also found that the basic domain spacings did not change during heating or cooling of the crystal. (*PA*, 1958, #5117)

1565. MAGNETIC PROPERTIES OF METALS AT LOW TEMPERATURES. IV. EFFECT OF HOMOGENEOUS COMPRESSION ON THE DE HAAS–VAN ALPHEN EFFECT IN ZINC CRYSTALS

Dmitrenko, I. M., Verkin, B. I., and Lazarev, B. G.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 2(8), pp. 328–329, 1958 (in Russian)**

A method and apparatus were developed for investigation of the influence of homogeneous compression on the anisotropy of the magnetic properties of crystals at low temperatures. The angular dependence of the oscillation periods of the magnetic susceptibility of free zinc crystals due to the two smallest groups of mobile charges was established. The effect of homogeneous compression at a pressure of $p = 1700$ kg/cm^2 on the period and amplitude of the oscillations due to the smallest groups of mobile charges. A large (40–48%) increase of the periods of these oscillations was found for all values of the angle θ between the field vector and the direction of the chief crystal axis. Homogeneous compression of the crystal is found to cause a strong decrease of the oscillation amplitude and a change in the temperature dependence of the oscillation amplitude. The experimental data are compared with the semi-phenomenological theory of the influence of deformations on oscillation effects in metals at low temperatures. (*PA*, 1959, #2508)

1566. NOTE ON THE MAGNETIC SUSCEPTIBILITY OF DILUTE Cu–Mn ALLOYS
Dekker, A. J.
***Physica*, v. 24, no. 8, pp. 697–706, August 1958**

The following features of the susceptibility of these alloys are discussed: (a) the concentration dependence of the effective Curie temperature in the high temperature region; (b) the occurrence of a "gradual" antiferromagnetic transition at low temperatures; (c) the concentration dependence of the position and shape of the antiferromagnetic transition. (*PA*, 1959, #445)

1567. MAGNETIC SUSCEPTIBILITY OF COPPER–NICKEL AND SILVER–PALLADIUM ALLOYS AT LOW TEMPERATURES
Pugh, E. W. and Ryan, F. M.
***The Physical Review*, v. 111, no. 4, pp. 1038–1042, August 15, 1958**

The magnetic susceptibilities of copper–nickel alloys with up to 39 atomic per cent nickel and silver–palladium alloys with up to 10 atomic per cent palladium were measured by the Gouy method at temperatures between 295 and 2.1°K. Measurements are reported on samples with an impurity content of less than 10 parts per million and on samples with greater impurity content. The susceptibility is nearly temperature-independent for all the silver–palladium alloys and for the copper–nickel alloys with up to 27% nickel. Higher nickel concentrations give rise to a $1/T$ susceptibility term which is too large to be accounted for by impurity content. The simple band model of Mott adequately describes the susceptibility of the silver–palladium alloys but fails to predict the large temperature-independent paramagnetic contribution of nickel in copper. Exchange energies calculated by the Stoner collective electron method for the copper–nickel alloys, using specific heat and susceptibility data, are somewhat unsatisfactory and suggest the presence of another mechanism. (*PA*, 1959, #3642)

1568. MAGNETISCHE EIGENSCHAFTEN UND ORDNUNGSSTRUKTUR VON Ni–Mn–LEGIERUNGEN
Hahn, R. and Kneller, E.
***Zeitschrift für Metallkunde*, v. 29, no. 8, 9, pp. 426–441, August 1958; pp. 480–488, September 1958**

Magnetic properties and order–disorder structure of Ni–Mn alloys: partially ordered alloys (above 25 at.–% Mn) are quasiparamagnetic; effect of plastic deformation on magnetic and electrical properties of single crystals (22.7–32.9 at.–% Mn); explanation in terms of dislocation theory (70 ref.) (*EI*, 1958)

1569. PROCESSING AND PROPERTIES OF COBALT–PLATINUM PERMANENT-MAGNET ALLOYS
Martin, D. L.
***Transactions of the Metallurgical Society of the AIME*, v. 212, no. 4, pp. 478–485, August 1958**

Preparation of CoPt alloys and their fabrication; great influence of composition and heat treatment on magnetic properties of alloys in range 40 to 60 at.–% noted; peak properties of 4700 coercive force and 9,000,000 gauss-oersted energy product were obtained by controlled cooling and aging; these high values combined with ductility and machinability give alloys useful characteristics. (*EI*, 1958)

1570. THE MAGNETIC SUSCEPTIBILITIES OF ALLOYS OF CERIUM WITH THORIUM
Bates, L. F. and Newmann, M. M.
***Proceedings of the Physical Society*, London, v. 72, Part 3, pp. 345–352, September 1958**

The paramagnetic susceptibilities of 90, 71, 60, 42, 20, 10 and 5 atomic per cent cerium in thorium alloys were measured over the temperature range 90 to 700°K. The temperature dependence of the resistivity of 90, 60, 40, 20 and 5 atomic per cent cerium–thorium alloys was investigated over the range 90 to 293°K. The thermal expansion of the 60% alloy was measured over this temperature range. All the alloys exhibit a sharp decrease in susceptibility at low temperatures. This has been attributed to the excitation of some of the $4f$ electrons of the cerium atoms into the conduction band at these temperatures, and the resistivity and expansion results support this hypothesis. Above room temperature the susceptibilities of all the alloys obey a Curie–Weiss law, $\chi = C/(T - \theta)$, over at least part of the temperature range. The effective magnetic moments per cerium atom, calculated from the Curie constants C increased with decreasing cerium content. A model is proposed in which coupling between the

cerium f electron and the conduction electrons causes polarization of the latter in the neighborhood of the cerium atoms. The apparent increase in p_{eff} is attributed to this induced moment. (*PA*, 1959, #455)

1571. THE γ PHASE IN URANIUM ALLOYS

Loasby, R. G.

***Proceedings of the Physical Society*, London, v. 72, Part 3, pp. 425–428, September 1958**

Electrical resistivity and magnetic susceptibility properties of two alloys based on γ-uranium are described and interpreted in terms of a theoretical structure derived from X-ray work by Pfeil. The implication of the earlier work, that uranium in the γ form is characterized by only four electrons per atom (as opposed to six for the α and β forms), is supported by the present results. (*PA*, 1959, #858)

1572. RELATION OF MAGNETIC DISORDERING TO THE THERMODYNAMICS OF SOLID METALLIC SOLUTIONS

Oriani, R. A.

***Journal of Chemical Physics*, v. 29, no. 3, p. 679, September 1958**

It is argued that at 1110°K the face-centered solid solutions of iron–nickel at concentrations from 0 to 56 atomic % Ni have an excess entropy close to zero, which means that the magnetic moments of the iron and nickel atoms are not changed by the solution process. This behavior is contrasted with that of Au–Ni alloy. (*PA*, 1959, #1586)

1573. MAGNETIC PROPERTIES OF TERBIUM METAL

Thoburn, W. C., Legvold, S., and Spedding, F. H.

***The Physical Review*, v. 112, no. 1, pp. 56–58, October 1, 1958**

Results of magnetic measurements on metallic terbium over the temperature range from 4 to 375°K and in fields hanging from 50 to 18,000 oersted are reported. The metal is found to have a paramagnetic Curie point of 237°K. Tests with fields of from 50 to 800 oersted indicate an order-to-disorder transition at approximately 230°K which is evidently a Néel point. It appears that terbium has a weakly bound antiferromagnetic ordering for temperatures between 218 and 230°K, this ordering being gradually changed to ferromagnetic in fields exceeding 200 oersted. Below 218°K the metal is ferromagnetic. The magneton numbers obtained from the paramagnetic susceptibility measurements and from the extrapolated ferromagnetic saturation moment are in good agreement with values calculated for the free ion. (*PA*, 1959, #3634)

1574. MAGNETIZATION CURVES OF SUPERCONDUCTIVE TIN ALLOYS

Lynton, E. A. and Serin, B.

***The Physical Review*, v. 112, no. 1, pp. 70–72, October 1, 1958**

A previous investigation of flux trapping has been supplemented by obtaining the magnetization curves of very fine impure tin wires in a transverse external field. For annealed specimens (containing In, Bi, or Cd) in which the impurity is completely dissolved and homogeneously distributed, it was found that some flux is frozen-in in decreasing magnetic field when the external field equals half the critical value. However, this flux leaks out monotonically as the field is further reduced, and none remains in zero field. In pure specimens virtually no flux trapping occurs. However, in a specimen containing more Cd than was completely soluble, considerable flux remains frozen-in even in zero field. These results confirm the previous inference that suitably prepared and annealed homogeneous alloy specimens are incapable of freezing-in appreciable amounts of magnetic flux. It is further concluded that this is due to the fact that the flux which is initially trapped when the specimens begin to become superconducting readily leaks or migrates out, probably because of the tendency of lines of force to contract as suggested by Faber and Pippard. (*PA*, 1959, #4792)

1575. SUPERCONDUCTIVITY AND FERROMAGNETISM IN ISOMORPHOUS COMPOUNDS

Matthias, B. T., Corenzwit, E., and Zachariasen, W. H.

***The Physical Review*, v. 112, no. 1, p. 89, October 1, 1958**

Isomorphous germanides of some of the rare-earth metals are observed to become either ferromagnetic or superconducting. It is concluded that there is a close relationship between the two phenomena. (*PA*, 1959, #3507)

1576. MAGNETIC REQUIREMENTS ON FERROMAGNETIC NICKEL AMALGAM
Henning, W.
***Zeitschrift für Naturforschung*, v. 13a, no. 10, pp. 897–898, October 1958 (in German)**

Samples of nickel amalgam were heat-treated at 265°C for different times and then cooled in liquid air. They were found to be ferromagnetic, and their magnetization and coercive force were measured. (*PA*, 1959, #5881)

1577. THE INFLUENCE OF TEMPERATURE ON THE DISTRIBUTION OF FERROMAGNETIC DOMAINS FROM THE STANDPOINT OF THE COERCIVE FORCE
Rothenstein, B. and Hrianca, J.
***Naturwissenschaften*, v. 45, no. 21, pp. 507–508, 1958 (in German)**

Measurements of the internal friction of nickel as a function of applied field have been made at temperatures between 16 and 200°C. The domain distributions indicated by the results are compared with a Maxwell distribution. (*PA*, 1959, #2514)

1578. THE DEMAGNETIZING ENERGY AND DOMAIN STRUCTURE OF A UNIAXIAL SINGLE CRYSTAL
Fox, M. and Tebble, R. S.
***Proceedings of the Physical Society*, London, v. 72, Part 5, pp. 765–770, November 1958**

The conditions under which a reduction in the demagnetizing energy in a uniaxial crystal can be brought about by rotation of the magnetization vectors (μ^* effect) is examined and an expression for the energy reduction is obtained for materials with high anisotropy ($K > 2\pi I^{02}$). The closure domain structure of cobalt was examined by Bitter pattern technique on the curved surface of a disk, and the results give the conditions under which domains of reverse magnetization are preferred. Suggestions for future development are made. (*PA*, 1959, #2489)

1579. MAGNETIC SUSCEPTIBILITY OF SOME URANIUM ALLOYS. RESISTANCE PROPERTIES OF SOME URANIUM ALLOYS
Bates, L. F. and Loasby, R. G.
***Proceedings of the Physical Society*, London, v. 72, Part 5, pp. 757–564, November 1958**

The magnetic susceptibilities and electrical properties of a series of quenched alloys of uranium with zirconium, niobium and molybdenum, metals which have four, five and six outer electrons respectively, were measured over the temperature range 90 to 300°K. The general features of the three systems are the same, with anomalies at about 0.5 and 2.0 atomic percent of the solute. The first anomaly is of unknown origin, and the second suggests that alloys containing up to about 2 atomic percent of the solute may be obtained in the α-form by quenching them from the γ-phase field, and that within this composition range the behavior is consistent with the full Brillouin zone structure that has been proposed for α-uranium. (*PA*, 1959, #1431)

1580. EFFECT OF UNIFORM COMPRESSION ON THE OSCILLATION OF THE MAGNETIC SUSCEPTIBILITY OF BISMUTH AT LOW TEMPERATURES
Brandt, N. B. and Ventssel', V. A.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 5(11), pp. 1083–1087, 1958 (in Russian)**

The influence of uniform pressure of about 1000 atm on the oscillation of the magnetic susceptibility of bismuth in a magnetic field up to 13 k oersted (de Haas–van Alphen effect) was investigated at 4.2–1.6°K. The character of variation of the effective mass tensor, Fermi boundary energy E_0, Dingle factor and electron concentration were estimated with the Landau formula. Assumptions regarding the nature of the electron energy spectrum in bismuth are made. (*PA*, 1959, #2507)

1581. ON THE INTERACTION BETWEEN EXTERNAL AND INTERNAL ELECTRONS IN FERROMAGNETIC TRANSITION ELEMENTS
Izyumov, Yu. A.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 5(11), pp. 1148–1154, 1958 (in Russian)**

The interaction between 4*s*- and 3*d*-electrons in transition metals is investigated. It is shown that the dynamical part of the interaction manifests itself in the interaction beween elementary excitations of the Fermi and Bose type. At low temperatures, elastic collision processes

between these excitations dominate; at high temperatures, transition processes begin to play an important role. The magnetization as a function of the temperature and field strength is calculated. (*PA*, 1959, #2487)

1582. ON THE PROPERTIES OF THE RARE-EARTH METALS

de Gennes, P. G.

***Comptes rendus hebomadaires des séances de l'académie des sciences*, v. 247, no. 21, pp. 1836–1838, November 24, 1958 (in French)**

Assuming the ions are coupled only by the spins of the conduction electrons, the paramagnetic Curie point is shown to vary as $(g-1)^2J(J+1)$. This result is confirmed by experiment for the series Gd to Tm. The frequent occurrence of metamagnetism and the anomalies in resistivity and specific heat are also briefly explained. (*PA*, 1959, #3631)

1583. COMPLETELY NONMAGNETIC ALLOY FOR INSTRUMENTATION IN MAGNETIC FIELDS

Pugh, E. W.

***Review of Scientific Instruments*, v. 29, no. 12, pp. 1118–1119, December 1958**

A high-purity copper–nickel alloy is described which has zero magnetic moment at room temperature and less than a tenth the moment of pure copper at all temperatures down to 2°K. The alloy was used with considerable advantage in sample holders for magnetic force measurements, and other uses are anticipated. A method of preparing the alloy is discussed which requires limited metallurgical equipment. (*PA*, 1959, #5868)

1584. MAGNETOSTRICTION OF LOW-DENSITY COBALT RONDEL

Stauss, H. E.

***Journal of Applied Physics*, v. 29, no. 12, pp. 1690–1691, December 1958**

A dimensional change that simulates magnetostriction can be expected when a porous or spongy ferromagnetic body is placed in a magnetic field. Such an effect was observed. Polycrystalline cobalt with a density less than 50% of normal developed a strain of -139×10^{-6}, whereas cobalt of normal density developed a strain of -28×10^{-6}. This finding appears to open the way for the development of materials with enhanced values of strain in a magnetic field. (*PA*, 1959, #4785)

1585. FERROMAGNETIC SUPERCONDUCTORS

Matthias, B. T., Suhl, H., and Corenzwit, E.

***Physical Review Letters*, v. 1, no. 12, pp. 449–450, December 15, 1958**

It is pointed out that superconductivity and ferromagnetism might occur together in suitable solid solutions of the superconductor $CeRu_2$ and the ferromagnetics $PrRu_2$ or $GdRu_2$. In the first system $(Ce,Pr)Ru_2$, the overlap in properties would occur below 1°K and has yet to be observed. In the second system $(Ce,Gd)Ru_2$, the ferromagnetic Curie point and superconducting T_c would appear to coincide at a ratio Ce:Gd of 94 : 6 and a temperature of 3.6°K. Both transitions have been observed experimentally in a specimen with 8% $GdRu_2$; as the temperature is lowered in this case, the ferromagnetic transition precedes the superconducting, in which phase it is then believed that the sample never leaves the intermediate state. (*PA*, 1959, #3512)

1586. THE CHANGE OF SPONTANEOUS MAGNETIZATION WITH HYDROSTATIC PRESSURE

Gugan, D.

***Proceedings of the Physical Society*, London, v. 72, Part 6, pp. 1013–1026, December 1958**

Measurements were made of the effect of pressure on the spontaneous magnetization of nickel, cobalt, and a series of nickel alloys. The measurements were made using a thin-disk permeameter designed to produce high magnetic fields for only a very small power consumption. The results are in good agreement with the results of other hydrostatic pressure experiments and with the results of experiments on the thermodynamically related "forced" volume magnetostriction. An adequate verification of the important thermodynamic relation $(\partial V/\partial H)_{p,T} = -(\partial M/\partial P)_{H,T}$ was obtained for the nickel-iron alloy system. The results do not agree with the anomalous results reported by Stacey who used Bridgman's thin-disk technique of generating high pressures. Under some conditions nickel shows an anomalously large, linear decrease of spontaneous magnetization with pressure; possible reasons for this are discussed. (*PA*, 1959, #2492)

1587. THE SATURATION MAGNETOSTRICTION OF NICKEL CRYSTALS AT LOW TEMPERATURES
Corner, W. D. and Hutchinson, F.
***Proceedings of the Physical Society*, London, v. 72, Part 6, pp. 1049–1052, December 1958**

The saturation magnetostriction λ of two single crystals of nickel were measured over the temperature range 20 to 500°K by a capacitance bridge method. The (γ, T) curves allow a reasonable extrapolation to absolute zero to be made, giving $\lambda_{111} = -28 \times 10^{-6}$, $\lambda_{100} = -57 \times 10^{-6}$, values which are of the same order as those calculated by Fletcher, $\lambda_{111} = -44 \times 10^{-6}$, $\lambda_{100} = -187 \times 10^{-6}$. An explanation is given for the discrepancy between the results obtained by Corner and Hunt (1955) and the present values. (*PA*, 1959, #2494)

1588. THE MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS
Bowers, R.
***Journal of Physics and Chemistry of Solids*, v. 8, pp. 206–211, January 1959**

Work done during the past two years on the magnetic susceptibility of charge carriers in semiconductors is reviewed briefly. The principal topics covered are related to the work on *n*-type Ge and InSb; experiments on *n*-type Si are also discussed. (*PA*, 1959, #5874)

1589. A BITTER FIGURE EXAMINATION OF SOME POLYCRYSTALLINE NICKEL–COBALT ALLOYS
Bates, L. F. and Isaac, E. D.
***Proceedings of the Physical Society*, London, v. 73, Part 1, pp. 14–16, January 1959**

A Bitter figure examination of polycrystalline Ni–Co alloys of compositions 21, 29, 46 and 59% Co, respectively, showed domain wall movements to occur in the last three alloys, the field limits being in reasonable agreement with the results of a study of the heat changes accompanying magnetization processes in the alloys. (*PA*, 1959, #2493)

1590. LOW-TEMPERATURE ELECTRICAL AND MAGNETIC BEHAVIOR OF DILUTE ALLOYS: Mn IN Cu AND Co IN Cu
Jacobs, I. S. and Schmitt, R. W.
***The Physical Review*, v. 113, no. 2, pp. 459–463, January 15, 1959**

Measurements are reported of the remanent magnetization in a 1.8 atom per cent Mn in Cu alloy at 4.2°K and of the low-temperature resistance, magnetoresistance, and magnetization of solid solution alloys of 0.5, 1.0, and 2.0 atom per cent Co in Cu. The isothermal remanence of the Cu(Mn) alloy saturates at about 3×10^{-2} (μ_B/Mn atom) after application of a field of about 14 k oersted, and does not increase after application of pulsed fields up to 140 k oersted. It is equal to the saturation thermoremanence obtained after cooling in fields $\geqq 1.5$ k oersted. Both remanences reverse in relatively low fields of about 2 k oersted. The magnetoresistance and magnetization of the Cu(Co) alloys obey the relation, $\Delta\rho = -b\sigma^2$, found previously for Cu(Mn) alloys, with b temperature-independent in contrast to that for Cu(Mn). The low-temperature resistivity of the Cu(Co) alloys increases with decreasing temperature and no maximum occurs down to 1.6°K. The magnetization of the Cu(Co) alloys shows neither remanence nor hysteresis but is nonlinear with field and with concentration. Comparison of results on these systems with existing theories delineates the areas of agreement and of disagreement. (*PA*, 1959, #4780)

1591. MAGNETIC RESONANCE OF POLYCRYSTALLINE COBALT AT 35.3 kMc/s AS A FUNCTION OF TEMPERATURE
Asch, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, v. 248, no. 6, pp. 781–784, February 9, 1959 (in French)**

The resonance field was measured between 190 and 670°K and reaches a maximum at 530°K, the isotropy point. The g value derived, 2.18 ± 0.03 was compared with that derived from g'. The temperature variation of the line width was also measured and reaches a minimum at 530°K. (*PA*, 1959, #4806)

1592. THE MAGNETIC SUSCEPTIBILITY OF SILVER–MANGANESE SOLID SOLUTIONS BETWEEN 100°K AND 500°K
Morris, D. P. and Williams, I.
***Proceedings of the Physical Society*, London, v. 73, Part 3, pp. 422–432, March 1959**

The magnetic susceptibility of Ag–Mn solid solutions containing between 4.44 and 38.1 at. % Mn has been

measured between 100 and 500°K. Alloys containing less than 20 at. % Mn obey a Curie-Weiss law and the ρ_{eff} values derived for the Mn atoms are discussed and compared with other published values for this system. Over the range 7–20 at. % the (ρ_{eff}, Mn concentration) curve is linear, indicating a $3d^{6}4s_{2}$ configuration for the Mn atoms at infinite dilution. Other published values for more dilute alloys are however not in good agreement with a linear extrapolation. Examination of published data shows that a similar discrepancy between dilute and more concentrated alloys exists in Cu–Mn solid solutions. No explanation of such an effect can yet be advanced, but the sensitivity of the p_{eff} values to the diamagnetic correction in very dilute alloys is pointed out, as well as a difference between electronic configurations deduced from susceptibility and from electron spin resonance measurements. Beyond 20 at. % Mn the Ag-Mn alloys no longer obey a Curie–Weiss law and the possibility of short-range magnetic order in them is discussed. Some comparisons are drawn between the solid solutions of Mn in Cu, Ag and Au. (*PA*, 1959, #7152)

1593. SEARCH FOR NEW HEUSLER ALLOYS

Morris, D. P., Preston, R. R., and Williams, I.
***Proceedings of the Physical Society*, London, v. 73, Part 3, pp. 520–523, March 1959**

Preliminary results are reported of X-ray and magnetic measurements for alloys corresponding to compositions Ag_2MnAl, Ag_2MnIn, Au_2MnAl, Au_2MnIn and Au_2MnZn. The silver compounds are not ferromagnetic down to liquid air temperature; Ag_2MnIn has a hexagonal crystal structure and Ag_2MnAl shows two phases after heat treatment. The gold alloys have a CsCl structure at room temperature. Au_2MnAl and Au_2MnIn are ferromagnetic with Curie temperatures at approximately -40°C and -130°C respectively. Au_2MnIn in addition suffers a cubic–tetragonal transformation at -37°C. Au_2MnZn preserves its cubic structure and paramagnetic properties down to liquid air temperatures. (*PA*, 1959, #8312)

1594. REMARKS ON MAGNETICALLY DILUTE SYSTEMS

Sato, H., Arrott, A., and Kikuchi, R.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 94S–96S, April 1959**

A re-examination of the magnetic properties of magnetically dilute systems is made. Special references are made to iron in gold and chromium and to manganese in copper.

1595. SATURATION MAGNETIZATION AND FERROMAGNETIC INTERACTION IN TERBIUM METAL

Henry, W. E.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 99S–100S, April 1959**

The magnetic moment of terbium metal is measured at 295, 100, 4.2, and 1.25°K in applied fields up to 70,000 gauss. A sample motion ballistic technique is used to measure the magnetic moments.

1596. STRUCTURAL AND MAGNETIC PROPERTIES OF Mn–Co–C ALLOYS

Holtzman, A. H. and Conrad, G. P., II
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 103S–104S, April 1959**

$Mn_xCo_{(80-x)}C_{20}$ alloys were studied for magnetic properties, crystal structure, and metallographic appearance.

1597. EFFECT OF COMPOSITION AND PROCESSING ON THE ACTIVITY OF SOME MAGNETOSTRICTIVE MATERIALS

Davis, C. M., Jr. and Ferebee, S. F.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 113S–115S, April 1959**

The dynamic magnetostrictive properties of a number of magnetic materials were determined as a function of composition and processing. The materials investigated include nickel, 2V-Permendur, a cobalt–nickel alloy, several nickel– and aluminum–iron alloys, and a group of nickel–cobalt ferrites.

1598. MERCURY PROCESS FOR MnBi PRODUCTION

Goldman, A. and Post, G. I.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 204S–205S, April 1959**

Magnetic properties are determined for the strongly ferromagnetic residue of MnBi, left after mercury distillation.

1599. EXPERIMENTAL DETERMINATION OF THE HYPERFINE COUPLING IN FERROMAGNETIC METALS AND ALLOYS
Kurti, N.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 215S–219S, April 1959**

Experimental methods based on specific heat measurements and on the observation of anisotropic γ emission are described. The results for cobalt, cobalt–nickel and cobalt–iron alloys are presented and discussed. Hyperfine coupling in metallic terbium is compared with that in Tb^{3+} in terbium ethyl sulfate.

1600. TEST OF SPIN-WAVE THEORY WITH PRECISION MAGNETIZATION MEASUREMENTS
Foner, S., and Thompson, E. D.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 229S–230S, April 1959**

Precision measurements of magnetic moments in single crystal nickel specimens are made from 4.2 to 290°K in a uniform magnetizing field applied along principal crystallographic directions. Comparisons are made with predictions of spin-wave theory; possible causes of discrepancies are summarized. Estimates of exchange constant are given.

1601. MAGNETIC CONTRIBUTIONS TO THE ELASTIC CONSTANTS OF NICKEL AND AN Fe–30% Ni ALLOY AT HIGH MAGNETIC FIELDS
Alers, G. A., Neighbours, J. R., and Sato, H.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 231S–232S, April 1959**

The possibility that the fundamental interatomic magnetic interaction makes an observable contribution to the elastic constants of a ferromagnetic metal was investigated. Central interaction effects were clearly observed, and easily interpreted for Ni, although large volume magnetostriction in the Fe–Ni alloy made analysis difficult.

1602. NEUTRON DIFFRACTION INVESTIGATION OF A POSSIBLE FERRO–ANTIFERRO-MAGNETIC TRANSITION IN $Mn_{0.2}Cr_{0.8}Sb$
Pickart, S. J. and Nathans, R.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 280S–281S, April 1959**

Neutron powder patterns, indicating an antiferromagnetic–ferromagnetic phase change, show a spin structure similar to that of CrSb within the antiferromagnetic region. Below the ferromagnetic Curie point weak superstructure lines appear. Additional measurements on the compound MnSb are reported. Results are discussed in relation to the types of exchange interactions present in these materials.

1603. EXCHANGE ANISOTROPY IN DISORDERED Ni_3Mn
Kouvel, J. S. and Graham, C. D., Jr.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement), pp. 312S–313S, April 1959**

Magnetic hysteresis loop and torque measurements were made on a disordered polycrystalline Ni_3Mn specimen which had been cooled to liquid helium temperatures in a magnetic field. Results indicate that the co-existence of ferromagnetism and antiferromagnetism at low temperatures gives rise to exchange anisotropy interactions of the type conceived by Meiklejohn and Bean for the ferromagnetic Co–antiferromagnetic CoC system. Important differences between the two systems are suggested, however, by the experimental results.

1604. INTERNAL FERROMAGNETIC RESONANCE IN NICKEL
Anderson, J. C. and Donovan, B.
***Proceedings of the Physical Society*, London, v. 73, Part 4, pp. 593–599, April 1959**

The internal resonance, revealed by measurements of the complex permeability, was investigated in nickel over the temperature range 5–100°C. The resonant frequency is found to be a decreasing function of temperature and, over the range studied, the variation is roughly from 450 to 300 Mc in the case of a polycrystalline disk, and from 270 to 40 Mc in the case of a colloidal suspension of nickel particles. This behavior is consistent with the view that the resonance is due to the internal magnetic field associated with the anisotropy energy and a quantitative interpretation is attempted using the available experimental values for the anisotropy constants. (*PA*, 1959, #5902)

1605. MEASUREMENTS ON THE MAGNETIC SUSCEPTIBILITIES OF Ag–Mn AND Cu–Mn ALLOYS

van Itterbeek, A., Pollentier, R., and Peelaers, W.
***Applied Scientific Research*, B, v. 7, no. 5, pp. 329–337, 1959**

Measurements were carried out with different concentrations of manganese between room temperature and liquid hydrogen temperatures. A paramagnetic behavior was found. The dependence was examined of the susceptibilities on the field strength; no field dependence could be detected except in some of the Ag–Mn alloys, but this effect originated from small ferromagnetic impurities which were determined by means of the method of Honda. The concentration of the manganese was determined magnetically and compared with determinations based on the electrical resistance. (*PA*, 1959, #8282)

VII. MAGNETIC PROPERTIES OF NON-FERROUS METAL COMPOUNDS

A. Films, Thin Layers, Particles, Whiskers and Wires

1606. MAGNETIC PROPERTIES OF COLLOIDAL NICKELOUS OXIDE

Richardson, J. T. and Milligan, W. O.
***The Physical Review*, v. 102, no. 5, pp. 1289–1294, June 1, 1956**

Magnetic susceptibility measurements by the Faraday method have been made in the temperature range 4–550°K for a series of iron-free nickelous oxide samples prepared by the heat-treatment of hydrous nickelous hydroxide in a current of nitrogen at temperatures of 250–1300°C, the crystal size as given by electron diffraction methods varying from 80–2000 Å. Samples (crystal size ~ 2000 Å) prepared at 1200–1300°C exhibit susceptibilities typical of an antiferromagnetic material, the observed Néel point of 523°K agreeing with the results of earlier investigators. In samples (crystal size ~ 100–200 Å) prepared at 300–500°C the susceptibility agrees with that for the larger crystals above the Néel point, but exhibit maxima at lower temperatures. The temperatures, T_c, at which the maxima appear, decrease regularly and the amplitudes of the maxima increase regularly, with decreasing crystal size. In the range studied, linear plots [$10^{-4}T_c = 1.090f\text{-}1.037$] are obtained for T_c as a function of f, the ratio of the average number of next nearest magnetic neighbors per nickel atom to the number of next nearest magnetic neighbors in an infinite crystal, as computed from the observed crystal sizes. Neutron diffraction patterns demonstrate that the magnetic structure is antiferromagnetic at temperatures both above and below T_c, and hence the maxima do not correspond to shifted Néel points. The magnetic susceptibility curves for the colloidal crystals of nickelous oxide resemble those obtained by others for certain iron and chromium sulphides. In iron sulphide, FeS_x, the susceptibility increase to the maximum is attributed by Néel and others to a ferrimagnetic structure, analogous to certain ferrites. In view of the "active" oxygen (Bunsen test) contents of the nickelous oxide samples which vary from 0.36 to 0.00 percent as the crystal size increases from 80 to 2000 Å, it is possible to attribute the ferrimagnetic behavior to the ordering of a sublattice of defects, as Néel does for FeS_x. However, the subsequent decrease in susceptibility at temperatures below T_c cannot be readily explained for either FeS_x or NiO. In view of the linear relationship between T_c and f, it is concluded that the unusual magnetic properties of colloidal nickelous oxide is attributable to the small size of the crystals and the accompanying enhanced specific surface and the decreased number of next nearest magnetic neighbors which results in an altered magnetic environment. Nickelous oxide prepared at 250°C contains a small amount of undecomposed nickelous hydroxide detectable by electron diffraction methods. The magnetic susceptibility of pure nickelous hydroxide follows a Curie–Weiss law $\chi_m = 1.07/(T - 36)$ from about 300 to 90°K. Below 90°K, the susceptibility increases more slowly to a value of $\sim 2000 \times 10^{-6}$ emu at 4°K, and some field dependence was observed, suggesting the desirability of additional studies concerning possible ferromagnetism. (*PA*, 1956, #6010)

1607. MAGNETIC SUSCEPTIBILITY OF αMnS
Banewicz, J. J. and Lindsay, R.
***The Physical Review*, v. 104, no. 2, pp. 318–320, October 15, 1956**

The magnetic susceptibility of a powder sample of αMnS was measured from 90 to 800°K by an absolute Gouy method. The Néel temperature was found to be 154°K. There was no evidence of thermal hysteresis and the susceptibility was independent of field strength over a range of fields between 2000 and 3000 oersted. Two sets of Weiss–Curie constants fitted the data above the Néel temperature. Between the Néel temperature and 300°K, values of $\theta = 490$°K and $C_M = 4.40$ were calculated. Above 400°K, the respective values were 380°K and 3.90. It is suggested that the persistence of short-range ordering effects to temperatures well above the Néel temperature affects the value of these constants and that the values above 400°K are probably more representative. (*PA*, 1957, #1443)

1608. ON CERTAIN POSSIBILITIES OF MEASURING MAGNETIC FIELD STRENGTHS USING THIN FILM HALL-E.M.F. PROBES PREPARED FROM HgSe, HgTe AND THEIR SOLID SOLUTIONS
Elpat'evskaya, O. D. and Regel, A. R.
***Zhurnal Tekhnicheskoi Fiziki*, v. 26, no. 11, pp. 2432–2438, 1956 (in Russian)**

Evaporated films of HgSe have been found to have room temperature electron mobilities of up to 3000 cm^2 V^{-1} sec^{-1} and carrier concentrations of 10^{17} to 10^{18} cm^{-3}. They can thus be used for magnetic field measurements, using the Hall effect, having sensitivities of the same order as single crystal Ge or InSb. Films deposited on mica, 1 cm wide, had sensitivities of 20 to 40 μv/gauss (or even 100 μv/gauss in extreme cases) at room temperature with no special cooling or heat dissipation arrangements. Advantages claimed are: (1) suitability for use in small gaps, (2) flexibility, (3) absence of contact rectification, (4) simplicity of manufacture, (5) cheapness and ready availability of materials. (*PA*, 1957, #7211)

1609. A MAGNETIC HEATING EFFECT IN OXIDIZED NICKEL WIRES
Schwink, C.
***Naturwissenschaften*, v. 44, no. 18, pp. 485–486, 1957 (in German)**

Electron-optical shadow experiments are reported on stressed oxidized nickel wires which enable the distance p between the effective pole position (that where the leakage field is perpendicular to the wire) and the end of the wire to be determined. The oxide layer is found to alter p due to its straining action on the underlying metal. The effect of an alternating field was also investigated. (*PA*, 1958, #235)

1610. CRYSTAL STRUCTURE AND MAGNETIC SUSCEPTIBILITY OF RECTIFYING CUPROUS OXIDES
Dixit, K. R. and Agashe, V. V.
***Indian Journal of Physics*, v. 31, no. 9, pp. 466–482, September 1957**

Oxides of copper were prepared in air at 0.5 mm Hg in the temperature range 200 to 1030°C. Their composition, rectification, magnetic susceptibility and crystal structure – all these as a function of the thickness of the film and their subsequent heat treatment – were studied. The films formed at 800°C begin to show an appreciable rectification, which increases rapidly with the temperature of formation of the film. The appearance of an appreciable amount of rectification is accompanied by changes in the crystal structure at the surface and in the body of the film. There is also a characteristic change of the magnetic susceptibility. In a rectifying film the surface layer contains large Cu_2O crystals showing 111 orientation, while in the body of the film, small crystallites of Cu_2O, containing traces of excess oxygen and showing a zinc blende structure, are present. The effect of heat treatment is to reduce the oxygen content and increase the diamagnetic susceptibility. The presence of an additional atom of oxygen in each crystallite of Cu_2O appears to give the maximum rectification. A mechanism for the formation of these rectifying films is suggested. (*PA*, 1959, #8103)

1611. ON THE OBSERVATION OF WEISS DOMAINS IN POLYCRYSTALLINE MATERIAL THROUGH THE INTENSIFIED MAGNETO-OPTICAL KERR ROTATION
Kranz, J. and Drechsel, W.
***Zeitschrift für Physik*, v. 150, no. 5, pp. 632–639, 1958 (in German)**

A film of ZnS was evaporated on to a polished ferromagnetic specimen. Interference of the multiply reflected beams, using plane polarized monochromatic light, so increased the Kerr rotation that the domains could be

readily observed during magnetization, either visually or photographically. (*PA*, 1958, #8117)

1612. CRYSTALLOGRAPHIC ORIENTATION RELATIONSHIP BETWEEN Ni AND Ni OXIDE AND BETWEEN Co AND Co OXIDE
Newkirk, J. B. and Martin, W. G.
***Transactions of the Metallurgical Society of the AIME*, v. 212, no. 3, pp. 398–401, June 1958**

Oxidized cobalt powder has magnetic hysteresis loop which is asymmetric with respect to magnetization axis; orientation relationship between basal plane of hexagonal cobalt and oxide which forms upon it at 400°C is determined experimentally; epitaxial relationship of NiO and Ni also investigated; no shifted hysteresis loop observed with nickel powder. (*EI*, 1958)

1613. THE MEASUREMENT OF THE REMANENT MAGNETISM OF THIN FILMS
Yamaguchi, S.
***Naturwissenschaften*, v. 45, no. 9, p. 205, 1958 (in German)**

Reports results of measurements using electron diffraction methods of the field at the edge of a nickel oxide film of thickness about 500 Å. (*PA*, 1958, #7196)

1614. THEORETICAL APPROACH TO THE ASYMMETRICAL MAGNETIZATION CURVE
Aharoni, A., Frei, E. H., and Shtrikman, S.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) p. 79S, April 1959**

A method of calculating the magnetization curve of an infinite ferromagnetic cylinder is applied to a material made of Co particles in a CoO shell. Only an abstract appears in the Journal Supplement; a full version of the paper was to be published elsewhere.

(See also reference 1643.)

B. General

1615. DOMAIN STRUCTURE AND DIELECTRIC RESPONSE OF BARIUM TITANATE SINGLE CRYSTALS
Matthias, B. and von Hippel, A.
***The Physical Review*, v. 73, pp. 1378–1384, 1948**

1616. MAGNETIC SUSCEPTIBILITY OF VANADIUM DIOXIDE
Archer, M. S., Roebuck, D. S. P., and Whitby, F. J.
Letter in *Nature*, v. 174, pp. 754–755, October 16, 1954

Describes the method of preparation (reduction of V_2O_5) and susceptibility measurements (between 20 and 450°C) for the oxides VO_x ($1.98 \leq x \leq 2.3$) which show only a slight susceptibility change at 341°K (the usually quoted Néel temperature); above this temperature the results follow the Curie–Weiss law ($p_B = 1.8 - 2.2$). After fusion at 750°C in N_2 pronounced susceptibility discontinuities were observed at 341°K for those oxides for which x lies between 2.2 and 2.3. Two forms of VO_2 are thus suggested to exist, depending on whether the oxide has been sintered during preparation or not. (*PA*, 1955, #1997)

1617. INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF MAGNETIC SUSCEPTIBILITY OF $MnCl_2$ BELOW 4.2°K
Kostryukova, M. O.
Letter in *Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 27, no. 5(11), pp. 655–656, 1954 (in Russian)

The susceptibility shows a flat maximum at about 1.8°K, confirming a transition to antiferromagnetism suggested by a previously found specific heat anomaly at 1.96°K. (*PA*, 1955, #7200)

1618. MAGNETIC BEHAVIOR OF THE SYSTEM CoO–MgO AT ELEVATED TEMPERATURES
Elliott, N.
***Journal of Chemical Physics*, v. 22, no. 11, pp. 1924–1925, November 1954**

The magnetic susceptibilities of solid solutions of CoO and MgO have been measured at elevated temperatures. The data fit a Curie–Weiss law $\chi = C/(T + \theta)$ with $C = 3.23 \pm 0.04$. θ varies linearly with the mol fraction of CoO. The magnetic measurements indicate that CoO has an antiferromagnetic ordering of spins of the first kind below the Curie point. (*PA*, 1955, #1050)

1619. MAGNETIC PROPERTIES OF SOME RARE EARTH METALS AND OXIDES. II
La Blanchetais, C. H.

Journal des recherches du centre national de la recherche scientifique, v. 6, no. 29, pp. 103–133, December 1954 (in French)

Gives results of measurements of the paramagnetic susceptibilities of the following substances between 80 and 1000°C: La_2O_3, Nd_2O_3, Pr_2O_3, Sm_2O_3, CeO_2, Pr_6O_{11}, Tb_4O_7, the oxide mixtures $La_2O_3 + Pr_6O_{11}$, $La_2O_3 + CeO_2$, metallic Ce and Pr. The results are analyzed in terms of the Curie–Weiss law. (*PA*, 1955, #1996)

1620. ANTIFERROMAGNETISM AND FERRIMAGNETISM OF NON-STOICHIOMETRIC COMPOUNDS

Elcock, E. W.

Proceedings of the Royal Society of London, Series A, v. 227, pp. 102–114, December 21, 1954

By an extension of the Heitler–London equivalent field methods, a treatment is given of the temperature-dependence of the magnetic properties of an antiferromagnetic substance containing vacancies. For the body-centered cubic lattice with nearest neighbor interactions the results may be conveniently summarized in terms of the magnetic Curie temperature, θ; the critical temperature, T_c, below which a superstructure of the vacancies begins to form; and a parameter x specifying the number of vacancies. For $x = 0$ the substance is a normal antiferromagnet. For $x > 0$ and such that $\theta > T_c$ the susceptibility-temperature curve is similar to that of a normal antiferromagnet ($x = 0$) for the range $T \gtrsim T_c$ but, as $T \to T_c$ the susceptibility increases rapidly with an eventual transition to a ferrimagnetic state at $T = T_c$. For $x > 0$ and such that $T_c > \theta$ there is a discontinuity in slope of the susceptibility-temperature curve at $T = T_c$ followed by a rapid rise in susceptibility with an eventual transition to a ferrimagnetic state at $T = \theta$. For other lattices, or other than nearest neighbor interactions only, the possible kinds of behavior are more complicated and do not lend themselves to a brief summary. The theoretical predictions are discussed in relation to the experimental results for non-stoichiometric compounds such as the iron and chromium sulphides, selenides and tellurides. (*PA*, 1955, #1983)

1621. THE MAGNETIC SUSCEPTIBILITY OF POTASSIUM MANGANICYANIDE

Cooke, A. H. and Duffus, H. J.

Proceedings of Physical Society, London, Section A, v. 68, Part 1, pp. 32–34, January 1955

This was measured at temperatures from 4.2 to 300°K. The susceptibility, which at room temperature approximately follows Curie's law, approaches a temperature-independent value at very low temperatures. This behavior is compared with the theoretical prediction of Kotani. (*PA*, 1955, #1999)

1622. ON THE PARA- AND ANTIFERROMAGNETIC STATES OF COBALT FLUORIDE

Nakamura, T. and Taketa, H.

Progress of Theoretical Physics, v. 13, no. 2, pp. 129–147, February 1955

The magnetic behavior of CoF_2 in the solid state can be satisfactorily described in terms of Pryce's effective Hamiltonian with $\Lambda_x = 1.34 \times 10^{-3}$, $\Lambda_y = 1.73 \times 10^{-3}$ and $\Lambda_z = 0.19 \times 10^{-3}(cm^{-1})^{-1}$, where the c-axis is taken as x-axis and a line connecting Co^{++} and its first neighbors F^- as z-axis. In the paramagnetic regions $\chi_{\parallel}$ is of the ordinary type, obeying the Curie–Weiss law approximately. $\chi_{\perp}$, however, is similar to the paramagnetic susceptibility of ferrimagnetics. These predictions are in good agreement with the experimental results of Stout and Matarrese. $\chi_{\parallel}$ has a finite value of the order 10^{-2} emu even at 0°K because of the fact that the magnetic field parallel to the c-axis induces a virtual transition from the lowest energy level to a higher one separated by about 10^2 cm^{-1}. The value of $\chi_{\perp}$ at 0°K is also computed. (*PA*, 1956, #1360)

1623. ANTIFERROMAGNETISM

Pratt, G. W., Jr.

The Physical Review, v. 97, no. 4, pp. 926–932, February 15, 1955

Theoretical discussion of nature of spin coupling in MnO; use of nonorthogonal orbitals, orthogonal orbitals and Kramers' method; requirements of adequate description of spin coupling. (*EI*, 1955)

1624. STRUCTURE AND MAGNETIC PROPERTIES OF SOME TRANSITION METAL NITRIDES

Wiener, G. W. and Berger, J. A.

Journal of Metals, v. 7, no. 2, pp. 360–368, February 1955

Several transition metal nitrides have been prepared and their saturation magnetization determined; on basis of atomic model of ferromagnetism involving considera-

tions of nearest neighbor interactions and assumption that all atomic moments of metal point in same direction, it appears that nitrogen interacts with d-shell of transition metal in such way as to reduce magnetic moment. (*EI*, 1955)

1625. THE DEPENDENCE OF COERCIVE FORCE AND PERMITTIVITY OF BARIUM TITANATE CERAMIC UPON MECHANICAL STRESSES

Roi, N. A.

***Akustische Zhurnal*, v. 1, no. 4, pp. 352–355, 1955 (in Russian)**

Application of mechanical stress is shown to increase the coercive force of barium titanate. A study of the variation of dielectric constant with temperature of the ceramic both in the free and stressed states leads the author to the conclusion that current thermodynamic theory, taking no account of domain structure, does not fit the facts. (*PA*, 1956, #5067)

1626. MAGNETIC PROPERTIES OF ZINC SULFIDE AND CADMIUM SULFIDE PHOSPHORS

Larach, S. and Turkevich, J.

***The Physical Review*, v. 98, no. 4, pp. 1015–1019, May 15, 1955**

Measurements of magnetic susceptibility were made of various preparations of zinc sulphide and cadmium sulphide by the Gouy method, from 77 to 300°K. The materials differed in crystalline state and modification, type and content of impurities, methods of preparation and neutron radiation treatment. No temperature-dependent paramagnetism was found for either the zinc sulphides or the cadmium sulphides. The diamagnetism was dependent on the variables cited above. Uncrystallized zinc sulphide obtained by precipitation had a specific diamagnetic susceptibility of -0.36×10^{-6}, while that of cadmium sulphide was -0.268×10^{-6}. On crystallization, the susceptibility values obtained depended on whether air, nitrogen or hydrogen-sulphide atmospheres were used during the crystallization, and whether chloride or aluminum ion "flux" was used. Only small differences were found in the susceptibilities of the cubic and of the hexagonal forms of zinc sulphide. It has been postulated that Cl^{-1} or Al^{+3} aided in the luminescence of zinc sulphide phosphors by allowing the formation of monovalent zinc, through charge compensation. It would be expected that this monovalent zinc would give rise to a temperature-dependent paramagnetic species. No such paramagnetism was found. Instead, the diamagnetism increases, suggesting that the role of the Cl^{-1} and Al^{+3} ions is to perturb the lattice. The radial extent of such a perturbed volume in a zinc sulphide phosphor, optimally activated with Ag or Cu, is calculated as approximately 50 Å. The luminescence centre in such phosphors is identified with the metallic activator surrounded by the perturbed volume. High-intensity neutron bombardment of a zinc sulphide: Cu phosphor causes a marked increase in the value of the diamagnetic susceptibility. (*PA*, 1955, #6291)

1627. MEASUREMENT OF THE MAGNETIC SUSCEPTIBILITY OF MANGANESE NITRIDE Mn_5N_2 BY A MICROVIBRATION METHOD

Yousef, Y. L., Girgis, R. K., and Mikhail, H.

***Journal of Chemical Physics*, v. 23, no. 5, pp. 959–963, May 1955**

The susceptibility-temperature relationship of carefully prepared manganese nitride Mn_5N_2 was measured over the temperature range -180 to 530°C. The Curie–Weiss law $\chi = C/(T - \theta)$ was found to hold, with $\theta = -1070$ and $C = 0.0316$ emu deg/g. The effective Bohr magneton number is 3.94 per Mn, and is in reasonable agreement with the theoretical value 3.87 for 3 unpaired electrons. This suggests that Mn_5N_2 behaves as a coordination compound with 4 electron-pair bonds. A new microvibration technique, particularly suitable for susceptibility investigations of materials available in small amounts, has been developed for the present work. The underlying principle is to modulate the magnetic field to translate the periodic force on the material into a periodic displacement of an elastic strip. The force is measured dynamically in terms of a compensating electrostatic force, an electronic circuit being used as a null detector. Accuracy to 10^{-4} dyne is claimed. (*PA*, 1955, #6304)

1628. THERMOMAGNETIC INVESTIGATION OF A VERY PURE SPECIMEN OF THULIUM SESQUIOXIDE [TM_2O_3]

Perakis, N. and Serres, A.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 240, no. 23, pp. 2215–2217, June 6, 1955 (in French)**

Gives results of susceptibility measurements between 82 and 978°K. After correction for core diamagnetism the results obey the Curie–Weiss law with $p_B = 7.56$, $\theta = -25$°K for the ion Tm^{+++}. (*PA*, 1955, #8079)

1629. MEAN MAGNETIC SUSCEPTIBILITY OF THE COBALT OXIDE CoO AND THE SOLID SOLUTIONS 90 CoO–10 NiO AND 91.7 CoO–8.3 CuO
Bizette, H. and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 240, no. 23, pp. 2213–2215, June 6, 1955 (in French)**

Gives results of measurements between 20 and 350°K. Susceptibility maxima were observed at 290, 311 and 285°K respectively. For specimens cooled in a magnetic field of strength $2 \cdot 45 \times 10^4$ oersted from above these temperatures the susceptibilities were found to be temperature independent below these temperatures, the magnetic field being maintained during the measurements. (*PA*, 1955, #8078)

1630. MAGNETIC PROPERTIES OF COBALT TELLURIDE
Uchida, E.
***Journal of the Physical Society of Japan*, v. 10, No. 7, pp. 517–522, July 1955**

Measurements of the magnetization have been made over a range of temperatures between liquid air and 1150°C. The results of these measurements show that this compound, when stoichiometric, possesses a ferromagnetic character. The value of the saturation magnetization is 7.52 gauss per gram ($0.25\mu_B$). Evidence was found of a magnetic transition with a sudden disappearance of ferromagnetism at about 1000°C. These characteristic magnetic properties are similar to those of MnAs studied by Guillaud. Increase in tellurium content decreases the saturation moment of this compound, and when x is equal to 1.20 the compound is no longer ferromagnetic but shows a feeble constant paramagnetism which is independent of temperature. (*PA*, 1955, 8073)

1631. DEMAGNETIZATION EXPERIMENTS ON CERIUM ETHYL SULPHATE
Cooke, A. H., Whitley, S., and Wolf, W. P.
***Proceedings of the Physical Society*, London, Section B, v. 68, Part 7, pp. 415–421, July 1955**

At temperatures below 1°K the magnetic susceptibility of cerium ethyl sulphate is highly anisotropic, the molar Curie constant being 1.35 parallel to the crystal axis and less than 0.01 perpendicular to the axis. Demagnetization experiments using fields along the axis show that the magnetic susceptibility in this direction passes through a maximum at low temperatures, and that the specific heat is too large to be accounted for by magnetic dipole interaction between the magnetic ions. This behavior is attributed to antiferromagnetic coupling of the ions, possibly due to the atomic electric quadrupole–quadrupole coupling suggested by Finkelstein and Mencher. It is shown that after demagnetization to a low temperature it is possible to apply a magnetic field in a direction of low susceptibility without greatly raising the temperature, so that magnetic measurements can be made below 1°K. This technique has been applied to the determination of the critical fields of superconducting zinc and lead at temperatures below 1°K. (*PA*, 1955, #8084)

1632. MAGNETIC SUSCEPTIBILITY OF CUPRIC OXIDE CuO
Bizette, H. and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 2, pp. 182–184, July 11, 1955 (in French)**

Reports results of susceptibility measurements between 4 and 360°K. A broad minimum occurs near 100°K. (*PA*, 1955, #8909)

1633. MAGNETIC PROPERTIES OF TITANIUM SESQUIOXIDE BETWEEN 300 AND 1700°K
Foex, M. and Wucher, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 2, pp. 184–186, July 11, 1955 (in French)**

Reports results of susceptibility measurements. A rapid increase in susceptibility takes place at 473°K, followed at higher temperatures by a more gradual increase. (*PA*, 1955, #8910)

1634. ATTEMPT AT INTERPRETING THE HIGH TEMPERATURE MAGNETIC PROPERTIES OF THE RHOMBOHEDRAL SESQUIOXIDES OF TITANIUM, VANADIUM, CHROMIUM AND IRON (Ti_2O_3, V_2O_3, Cr_2O_3, Fe_2O_3)
Wucher, J.

Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 241, no. 3, pp. 288–290, July 18, 1955 (in French)

The experimental susceptibility data are interpreted by assuming antiparallel spin coupling for nearest neighbor ions, the interactive energies per ion pair, deduced from the data, being respectively 1600, 400, 280, 280 (in units k). (*PA*, 1955, #8911)

1635. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF A CRYSTAL OF DIALOGITE ($MnCO_3$)

Bizette, H. and Tsai, B.

Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris, v. 24, no. 4, pp. 369–371, July 25, 1955 (in French)

Measurements between 300°K and liquid helium temperature indicate that the magnetic anisotropy $(\chi_{\parallel} - \chi_{\perp})$ changes sign at a temperature which depends upon the strength of the applied field. (*PA*, 1956, #462)

1636. ANTIFERROMAGNETIC RESONANCE IN HYDRATED COPPER CHLORIDE AT 32000 MH_z

Gerritsen, H. J., Okkes, R., Bolger, B., and Gorter, C. J.

Physica, v. 21, no. 8, pp. 629–638, August 1955

Antiferromagnetic resonance was studied in single crystals of $CuCl_2 \cdot 2H_2O$ at a frequency of 32000 Mc and temperatures from 1.35 to 4.3°K. The constant field was applied along different directions in the *ab*- and the *ac*-plane. One of the resonances observed occurred on the threshold hyperbola and had a width of only 15 oersted at the lowest temperature. Other resonances permitted the determination of the parameters: H_c, H_a and α, which characterize respectively: and anisotropy of the exchange field in two directions and the anisotropy of the susceptibility. On the whole the agreement with earlier data at 9400 Mc and with the theoretical expectations of Ubbink and Yosida is excellent. Below about 2.5°K a so far unexplained structure of certain resonances was observed. A few data are given on the g-values and widths of the paramagnetic resonance above the Néel temperature. (*PA*, 1955, #9766)

1637. ON THE INTERPRETATION OF SOME DATA OBTAINED WITH ANTIFERROMAGNETIC RESONANCE IN HYDRATED COPPER CHLORIDE

Gerritsen, H. J.

Physica, v. 21, no. 8, pp. 639–650, August 1955

The theories of Ubbink and Yosida are compared with the experiments on $CuCl_2 \cdot 2H_2O$ at 32000 Mc. Within the accuracy of the experiments a complete agreement has been found with these theories; the experiments gave the values: $H_c = 6500$ oersted and $H_a = 9150$ oersted. The temperature dependence of αH_c^{*2} is compared with $\bar{M}^2(T)$, based on the molecular field theory. The general behavior of the resonance fields as a function of temperature is discussed. (*PA*, 1955, #9767)

1638. FURTHER RESEARCHES ON THE MAGNETIC PROPERTIES OF POTASSIUM CHROMIUM ALUM BELOW 1°K

Beun, J. A., Steenland, M. J., De Klerk, D., and Gorter, C. J.

Physica, v. 21, no. 8, pp. 651–662, August 1955

A refinement of the ballistic method for measuring susceptibilities is described. With this method measurements on a sphere ground from a single crystal $CrK(SO_4)_2 \cdot 12H_2O$ were made in constant external fields. The results are used to test a formula of Garrett for determining the absolute temperatures and to calculate the temperature variations along isentropics. The behavior of the remanent magnetic moment in constant external fields was also studied. (*PA*, 1955, #9777)

1639. MAGNETISM ON OPTICAL EXCITATION OF MANGANESE-ACTIVATED ZINC SULFIDE PHOSPHORS

Oshima, K. and Nagano, H.

Journal of Chemical Physics, v. 23, no. 8, pp. 1473–1475, August 1955

Changes of magnetic susceptibility accompanying the optical excitation of manganese-activated zinc sulphide phosphors were measured. It was found that there was some change in susceptibility for phosphors containing manganese more than 9.0×10^{-4} g Mn/g ZnS. While there was concentration quenching for manganese emission intensity at high manganese concentration, the value of susceptibility change increased monotonically with concentration. From these results it is concluded that the nonradiative process in concentration quenching does not affect much the excitation probability and the lifetime of the excited state which is of the multiplicity giving rise to the susceptibility change. (*PA*, 1955, #8636)

1640. MAGNETIC PROPERTIES OF NEUTRAL CRYSTALLINE ANHYDROUS NICKEL CARBONATE $NiCO_3$
Bizette, H. and Tsai, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 6, pp. 546–548, August 8, 1955 (in French)**

This substance is shown to be ferromagnetic below about 40°K, exhibiting magnetically hard properties. Between 60° and 290°K the susceptibility obeys the Curie–Weiss law, with $p_B = 3.2$. (*PA*, 1956, #469)

1641. DIPOLAR SUMS IN THE PRIMITIVE CUBIC LATTICES
Cohen, M. H. and Keffer, F.
***The Physical Review*, v. 99, no. 4, pp. 1128–1134, August 15, 1955**

Dipole-wave sums, important in many magnetic and electric problems involving dipole–dipole interactions, are defined, and numerical values are given at sets of independent points in k-space equivalent to a 512-fold sampling of the first Brillouin zone of each of the three primitive cubic lattices. Strong size, shape and position dependence of these sums is shown to occur in a pathological region about the origin in k-space. The dipole-wave sums are shown to be related to dipole-field factors at points within the unit cell. The dipolar anisotropy energy in the anti-ferromagnet MnO is discussed as an illustration of the use of dipole-wave sums. (*PA*, 1955, #8893)

1642. RELATION OF MAGNETIC STRUCTURE TO ELECTRICAL CONDUCTIVITY IN NiO AND RELATED COMPOUNDS
Heikes, R. R.
***The Physical Review*, v. 99, no. 4, pp. 1232–1234, August 15, 1955**

A qualitative theory is presented in an effort to understand the insulating properties of NiO. If one generalizes this theory to include all stoichiometric binary compounds, having a transition element as cation and an element from group V or VI as anion, a rather startling correlation between the magnetic and electric properties is predicted. Ferromagnetic compounds should be good conductors with a positive temperature coefficient of resistivity while antiferromagnets should be insulators with a negative temperature coefficient of resistivity. The available data indicate that this correlation does exist. (*PA*, 1955, #8744)

1643. ON THE SUSCEPTIBILITY OF $CuCl_2 \cdot 2H_2O$ POWDER IN THE ANTIFERROMAGNETIC AND PARAMAGNETIC STATES
van der Marel, L. C., van den Broek, H., Wasscher, J. D., and Gorter, C. J.
***Physica*, v. 21, no. 9, pp. 685–694, September 1955**

The magnetic susceptibility of $CuCl_2 \cdot 2H_2O$ powder has been measured in the temperature regions of liquid hydrogen and helium. It is found to deviate appreciably from the predictions of molecular field theory: its value at T_N is about 30 percent too low and it has not a sharp peak at the Néel temperature. Comparison with simultaneous specific heat measurements gives indications of a short-range ordering persisting above the Néel temperature. The field dependence of the powder susceptibility is in qualitative agreement with expectations on the basis of Nagamya and Yosida's formula. Preliminary measurements on the susceptibility of a single crystal are in reasonable agreement with the values calculated from the powder measurements. (*PA*, 1956, #3000)

1644. ANTIFERROMAGNETIC RESONANCE AT LOW FREQUENCY
Hardeman, G. E. G. and Poulis, N. J.
***Physica*, v. 21, no. 9, pp. 728–736, September 1955**

When interacting with a very small or zero external magnetic field the antiparallel spins in an antiferromagnetic single crystal have fixed orientations along the most preferred axis. This preferred direction is due to the anisotropy energy. In increasing external fields the spins deviate from this preferred direction, the deviation depending on direction and strength of the external field and on temperature. At certain field strengths and directions, a transition occurs in which the spins flop over and orientate approximately perpendicular to the field. At these so-called threshold or critical fields electron resonance absorption can be found at low frequencies. The critical fields were therefore determined by adjusting the external field for maximum absorption. The measurements were done on the orthorhombic single crystal of $CuCl_2 \cdot 2H_2O$ which is antiferromagnetic below about 4.3°K. (*PA*, 1956, #3828)

1645. MAGNETIC PROPERTIES OF URANIUM HYDRIDE

Gruen, D. M.

***Journal of Chemical Physics*, v. 23, no. 9, pp. 1708–1710, September 1955**

The magnetic susceptibility of βUH_3 has been measured in the temperature range 191 to 603°K. From the high-temperature portion of the χ^{-1} vs. T curve a magnetic moment of 2.79 Bohr magneton is calculated, with $\Delta = -137$°K. A ferromagnetic transition occurs in the neighborhood of 173°K. Magnetic moment measurements made in the temperature range 63 to 196°K in fields of 1550 to 8700 oersted can be extrapolated to yield a saturation magnetic moment of about one Bohr magneton. (*PA*, 1955, #9776)

1646. MAGNETIC RESEARCHES ON ADIABATICALLY DEMAGNETIZED CHROMIUM METHYLAMINE ALUM

Beun, J. A., Steenland, M. J., De Klerk, D., and Gorter, C. J.

***Physica*, v. 21, no. 10, pp. 767–782, October 1955**

The magnetic susceptibility in zero external field of $CrCH_3NH_3(SO_4)_2 \cdot 12H_2O$ has been studied first. The influence of the amplitude and the frequency of the measuring field on the value of the susceptibility was measured. Also the hysteresis effects were investigated. Special attention was paid to the behavior of the susceptibility in external fields, both transverse and longitudinal, below its maximum as a function of entropy. Two marked bends have been found in the magnetization curves. In transverse fields striking anisotropies with a binary symmetry showed up. A discussion is given of the measured curves, especially for the lowest temperatures, based on the occurrence of antiferromagnetic domains. (*PA*, 1956, #3017)

1647. NEUTRON DIFFRACTION STUDY OF THE MAGNETIC PROPERTIES OF THE SERIES OF PEROVSKITE-TYPE COMPOUNDS $[(1-x)La, xCa]MnO_3$

Wollan, E. O. and Koehler, W. C.

***The Physical Review*, v. 100, no. 2, pp. 545–563, October 15, 1955**

The investigations have been made primarily by neutron diffraction methods, but X-ray diffraction measurements of lattice distortions and ferromagnetic saturation data are also included. This series of compounds exhibits ferromagnetic and antiferromagnetic properties which depend upon the relative trivalent and tetravalent manganese ion content. The samples are purely ferromagnetic over a relatively narrow range of composition (x about 0.35) and show simultaneous occurrence of ferromagnetic and antiferromagnetic phases in the ranges $(0 < x < 0.25)$ and $(0.40 < x < 0.5)$. Several types of antiferromagnetic structures at $x = 0$ and $x > 0.5$ have also been determined. The growth and mixing of the various phases have been followed over the whole composition range, the ferromagnetic and antiferromagnetic moment contributions to the coherent reflections have been determined, and Curie and Néel temperatures have been measured. The results have been organized into a scheme of structures and structure transitions which is in remarkable accord with Goodenough's predictions based on a theory of semicovalent exchange. (*PA*, 1956, #2563)

1648. MAGNETIC MOMENT ARRANGEMENTS AND MAGNETOCRYSTALLINE DEFORMATIONS IN ANTIFERROMAGNETIC COMPOUNDS

Li, Y.-Y.

***The Physical Review*, v. 100, no. 2, pp. 627–631, October 15, 1955**

The neutron-diffraction data of Shull et al. on the powder specimens of MnO, FeO, CoO, etc., are re-examined. It is found that except for FeO the observed Debye–Scherrer patterns may be produced by a number of magnetic moment arrangements with the antiparallel coupling among the moments on the next nearest neighboring ions, but with different sublattice correlations and different orientations of magnetic axis (or axes). The symmetry change observed at the Néel point is interpreted as a strong effect of spontaneous anisotropy magnetostriction. As a consequence the uniaxial direction of the modified symmetry must coincide with that of the magnetic axis. Assignments of antiferromagnetic arrangements for the compounds are reached. The prescription does not agree with that of Shull, et al., except in the case of FeO. The sharp readjustment of lattice parameters at the transition temperature and the orientation of spin axis in other antiferromagnetic compounds are discussed from the viewpoint of the anisotropy-magnetostriction approach. (*PA*, 1956, #1368)

1649. MAGNETIC SUSCEPTIBILITY OF RED PERCHROMATES OF MAGNESIUM AND POTASSIUM

Rios, B. R. and Hoarau, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 241, no. 19, pp. 1299–1301, November 7, 1955 (in French)**

From magnetic measurements on $KMgCrO_8 \cdot 7\frac{1}{2}H_2O$ and K_3CrO_8 using a Weiss–Foex–Forrer magnetic balance, the chromium in these compounds is shown to be pentavalent, the observed paramagnetism indicating the presence of an unpaired electron. (*PA*, 1956, #2243)

1650. MAGNETIC AND THERMAL PROPERTIES OF $MnCl_2$ AT LIQUID HELIUM TEMPERATURES I. MAGNETIC SUSCEPTIBILITY

Murray, R. B. and Roberts, L. D.
***The Physical Review*, v. 100, no. 4, pp. 1067–1070, November 15, 1955**

Measurements of the magnetic susceptibility of polycrystalline and single-crystal samples of anhydrous $MnCl_2$ have been carried out from 1.1 to 4.2°K with an a.c. mutual-inductance bridge. The susceptibility was found to be essentially independent of an applied magnetic field up to 2400 oersted throughout this region, and displayed anomalous behavior near 2°K indicating a magnetic ordering transition. In view of the observed susceptibility behavior this transition is interpreted as one of an antiferromagnetic nature, although the susceptibilities of both the single-crystal and polycrystalline samples were found to rise slowly with decreasing temperature below the transition region. This interpretation is supported by preliminary neutron diffraction studies below 2°K. A calculation of the magnetic anisotropy is in reasonable agreement with that observed at 4.2°K. (*PA*, 1956, #1373)

1651. MAGNETIC AND THERMAL PROPERTIES OF $MnCl_2$ AT LIQUID HELIUM TEMPERATURES II. SPECIFIC HEAT

Murray, R. B.
***The Physical Review*, v. 100, no. 4, pp. 1071–1074, November 15, 1955**

The specific heat of anhydrous $MnCl_2$ has been measured from 1.25 to 4.2°K in a search for the anomaly associated with the magnetic transition observed near 2°K. The measuring techniques are discussed briefly. The results of a series of experiments show two λ-type anomalies, each of magnitude 12 joules/mole degree, located at 1.81 and 1.96°K. These two maxima are interpreted as arising from a multiple transition from the paramagnetic to an antiferromagnetic state. A plot of magnetic-entropy vs. temperature, obtained by integration of the specific heat data, shows that approximately ⅔ of the available spin entropy has been achieved at the upper transition point. (*PA*, 1956, #1374)

1652. THE MAGNETIC AND SPECTROSCOPIC PROPERTIES OF CERTAIN RARE-EARTH DOUBLE NITRATES

Judd, B. R.
***Proceedings of the Royal Society of London*, Series A, v. 232, pp. 458–474, November 22, 1955**

The theory that has been developed for rare-earth ions in crystals is here applied to the double nitrates. The paramagnetic resonance data and certain spectroscopic properties of the different rare-earth double nitrates, depending as they do on the crystalline electric field at a rare-earth ion, are related to the six parameters through which the field is defined. It is found that most of the experimental results can be fitted to values of the parameters that vary in a systematic fashion along the rare-earth series. (*PA*, 1956, #3025)

1653. MAGNETIC PROPERTIES OF TRIVALENT IONS OF EUROPIUM AND SAMARIUM

Borovik-Romanov, A. S. and Kreines, N. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 29, no. 6(12), pp. 790–797, 1955 (in Russian) (English translation in *Soviet Physics–JETP*, New York, v. 2, no. 4, pp. 657–663, July 1956)**

The magnetic susceptibilities of Eu_2O_3, Sm_2O_3 (in two crystalline modifications) and $Sm_2(C_2O_4)_3 \cdot 10\ H_2O$ have been measured from 12 to 300°K. A strong dependence of the magnetic properties of the samarium ion on the crystalline structure of the compound in which it occurs was found. With a decrease in the effect of the crystalline field, the experimental curves of the temperature dependence of the magnetic susceptibility approximate the theoretical curve of Van Vleck for free ions. An apparatus for measuring magnetic susceptibility over a wide temperature interval is described. (*PA*, 1956, #8859)

1654. MAGNETIC AND ELECTRICAL PROPERTIES OF MANGANESE TELLURIDE

Uchida, E., Kondoh, H., and Fukuoka, N.
***Journal of the Physical Society of Japan,* v. 11, no. 1, pp. 27–32, January 1956**

The temperature dependence of the susceptibility of the antiferromagnetic compound MnTe was measured over a range of temperature between liquid nitrogen temperature and 720°C. An abrupt change in slope and a maximum of the susceptibility curve were found at 37°C and at 55°C respectively. These results are compared with the observed Néel temperatures previously reported by Squire and by Serre. A thermal hysteresis was also found above the Néel temperature, relating to the heat history of the specimen. It is shown that the susceptibility of $MnTe_{1+x}$ (where x, the excess content of tellurium, lies between 0 and 1), is explicable in terms of two phases, MnTe and $MnTe_2$, which possess different susceptibilities. The electrical properties, i.e., the resistivity, the thermo-e.m.f. and the Hall e.m.f., were measured as functions of temperature. Evidence was found of anomalous behavior at the Néel temperature. A large thermal hysteresis of the resistivity is also found above the Néel temperature, which suggests a change of the crystal structure at about 130°C. (*PA*, 1956, #3730)

1655. DEVIATIONS FROM THE CURIE–WEISS LAW IN CUPRIC COMPOUNDS

Perakis, N., Serres, A. and Karantassis, T.
***Journal de physique et le Radium,* v. 17, no. 2, pp. 134–139, February 1956 (in French)**

Reports susceptibility measurements on $CuCl_2$, $CuBr_2$, CuO and $Cu(CH_3COO)_2 \cdot H_2O$ between 90° and 1200°K. Susceptibility maxima were observed at varying temperatures, followed at higher temperatures by Curie–Weiss behavior with Curie constant 0.45 and varying negative Curie temperatures. (*PA*, 1956, #4507)

1656. MAGNETIC PROPERTIES OF SOME ANHYDROUS CHLORIDES OF THE IRON GROUP I. MAGNETIC RESONANCE

Leech, J. W. and Manuel, A. J.
***Proceedings of the Physical Society,* London, v. 69, Part 2, pp. 210–219, February 1956**

Measurements of paramagnetic resonance absorption in $CrCl_3$ and $NiCl_2$ in the temperature range 13.15 to 293°K are reported. The height of the absorption curve decreases and the line width increases as the temperature is lowered through the region of the cryomagnetic anomalies in these salts. The results are discussed in Part II where consideration of other experimental work suggests that the magnetic transition in these salts at low temperatures is essentially ferromagnetic rather than antiferromagnetic. $FeCl_2$ and $CoCl_2$ were also examined in the same temperature range but paramagnetic resonance was not observed. (*PA*, 1956, #3001)

1657. CHANGES IN LATTICE CONSTANT OF Cr_2O_3 NEAR THE CURIE TEMPERATURE

Greenwald, S.
***Nature,* v. 177, pp. 286–287, February 11, 1956**

Re-examination of previous results shows that the c-axis lengthens as the material is cooled through the antiferromagnetic transition region, whereas the a-axes decrease in a nonlinear fashion in the same temperature range. New observations confirm these results. (*PA*, 1956, #3827)

1658. CLEARLY DEFINED FERROMAGNETISM INDUCED BY THE ADDITION OF LITHIUM IONS IN NICKEL OXIDE

Perakis, N., Serres, A., Parravano, G., and Wucher, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences,* Paris, v. 242, no. 10, pp. 1275–1277, March 5, 1956 (in French)**

The susceptibility of NiO, containing Li ions with concentrations 10^{20} to 10^{21} cm^{-3}, measured over the temperature range 80 to 1100°K, was found to be field-dependent over part of the range. (*PA*, 1956, #4490)

1659. SOME FURTHER DETAILS OF THE ANTIFERROMAGNETIC RESONANCE DIAGRAM IN $CuCl_2 \cdot 2H_2O$ AT 9500 MH$_z$

Garber, M. and Gerritsen, H. J.
***Physica,* v. 22, no. 3, pp. 189–193, March 1956**

Minor discrepancies are observed between careful resonance field measurements at 9500 Mc and the predictions of the molecular field theory. No explanation is proposed for these discrepancies. (*PA*, 1956, #4499)

1660. MEASUREMENTS ON THE INTENSITY OF THE RESONANCE ABSORPTION IN $CuCl_2 \cdot 2H_2O$ AT 9400 MH_z
Gerritsen, H. J. and Garber, M.
***Physica*, v. 22, no. 3, pp. 197–207, March 1956**

The intensity of the antiferromagnetic resonance absorption was measured at different temperatures as a function of the relative orientation of the static field H, the high-frequency field h, and the crystal axes. At the lowest temperatures and with H along the a-axis, there is no absorption when h is parallel with the a-axis, and the absorption is maximal when h is along the b-axis. At higher temperatures the lower resonance line H_L, is excited predominantly by components of h along the c-axis, while the higher resonance line, H_H, is excited predominantly by components of h along the a-axis. The intensity of the antiferromagnetic resonance lines was the same order as that usually encountered in paramagnetic resonance at low temperatures. Reasonably good quantitative agreement is found between the detailed measurements and calculations based on the classical field model, as will be described in a forthcoming paper. (*PA*, 1956, #4500)

1661. ANTIFERROMAGNETIC RESONANCE LINE WIDTHS IN $CuCl_2 \cdot 2H_2O$ AT 9400 MH_z
Gerritsen, H. J., Garber, M., and Drewes, G. W. J.
***Physica*, v. 22, no. 3, pp. 213–223, March 1956**

Linewidth measurements in the 3 cm antiferromagnetic resonance of copper chloride are described. These data supplement the detailed studies already made on the resonance diagrams. While the latter are fairly well explained by the molecular field models of Ubbink and of Yoshida and Nagamiya, there is as yet no theory for the linewidths. (*PA*, 1956, #4501)

1662. ANTIFERROMAGNETISM IN THE SYSTEM Ti–H
Wohlfarth, E. P.
***Acta Metallurgica*, v. 4, no. 2, pp. 225–227, March 1956**

The experimental results of Trzebiatowski and Stalinski on the paramagnetic susceptibilities of titanium hydrides are tentatively interpreted. The observed susceptibility maxima at concentrations H/Ti above about 1.5 are ascribed to the antiferromagnetism of the phase TiH_2, arising as a result of superexchange interaction between Ti atoms through the intermediary of molecular hydrogen. (*PA*, 1956, #4504)

1663. ON THE MAGNETIC ANISOTROPY OF FeF_2 AND CoF_2
Moriya, T., Motizuki, K., Kanamori, J., and Nagamiya, T.
***Journal of the Physical Society of Japan*, v. 11, no. 3, pp. 211–225, March 1956**

The magnetic anisotropies of FeF_2 and CoF_2 are studied in detail by calculating the crystalline field acting on their magnetic ions and considering the effect of the spin-orbit coupling. The electronic energy level splittings of the ions Fe^{++} and Co^{++} in the crystalline field are calculated assuming first that all the surrounding ions are point charges, and then taking account of the overlapping of their 3 d electrons with the electron clouds of the surrounding fluorine ions. The spin-orbit coupling is then introduced and the g-values are calculated. Further, introducing exchange coupling in the approximation of molecular field, the parallel and perpendicular susceptibilities of FeF_2 are calculated and a reasonable agreement is found. For CoF_2, however, the calculated level splitting is not successful in explaining the observed susceptibilities. The possible sources of this disagreement and the nature of the approximations made are discussed. (*PA*, 1956, #3816)

1664. MAGNETIC SUSCEPTIBILITY OF PLUTONIUM HEXAFLUORIDE
Gruen, D. M., Malm, J. G., and Weinstock, B.
***Journal of Chemical Physics*, v. 24, no. 4, pp. 905–906, April 1956**

After correction for the magnetic susceptibility of the PuF_4 in the sample formed by decomposition, the low observed χ_M values of PuF_6, determined at 81° and 295°K, indicate that the ground electronic state of the molecule is nondegenerate. (*PA*, 1956, #5230)

1665. STUDIES ON THE MAGNETIC SUSCEPTIBILITY OF THE Cr^{+3} ALUMS IN THE RANGE 300°K TO 100°K
Dutta Roy, S. K.

Indian Journal of Physics, v. 30, no. 4, pp. 169–188, April 1956

The results of some accurate measurements of the magnetic susceptibility of a series of Cr^{+3} double sulphate, sulphato-selenate and selenate alums in the range 300°K to 100°K are discussed. Analysis of the mean square moments shows the existence of an appreciable contribution from Van Vleck's high frequency paramagnetism and an orbital contribution to the Curie term comparable to the high-frequency term, over and above the spin contribution. The Weiss term due to spin separation by the anisotropic crystalline field, is, however, negligibly small in the Cr^{+3} alums in the temperature range considered. In most of the alums an appreciable temperature-dependence of the h.f. and Curie term is observed, stimulating the effect of a Weiss term. This temperature dependence is reversible and may be better represented by two sets of h.f. and Curie coefficients, one for the upper and the other for the lower range of temperature, and evidently arises from the thermal expansion of the alum lattice, and very probably also from the variation with temperature in the proportion of the two coexisting phases of the α, β and γ alums or the thermal conversion from one phase to another, and the consequent changes in the crystalline electric field acting on the Cr^{+3} ion. Taking the spin orbit coupling to be not very different from the free ion value of $+ 87$ cm^{-1}, optical absorption and paramagnetic resonance results have been compared with the magnetic susceptibility data and an estimate of the covalency factor and cubic separation of the orbital levels made. (*PA*, 1957, #529)

1666. MAGNETIC PROPERTIES OF BETA-URANIUM HYDRIDE

Lin, S. T. and Kaufmann, A. R.

The Physical Review, v. 102, no. 3, pp. 640–646, May 1, 1956

The curve of reciprocal paramagnetic susceptibility against temperature generally follows the Curie–Weiss law and shows the same curvatures near the Curie point and at high temperatures as do the data for the ferromagnetic elements above their Curie points. A considerable number of magnetization curves have been obtained for a wide range of temperatures. Three methods were used for deducing the spontaneous magnetization for comparison. The curve of reduced spontaneous magnetization against reduced temperature lies very close to the curves of iron, nickel and cobalt. The paramagnetic Curie temperature, 173°K, is about 8°K lower than the ferromagnetic Curie point. The number of electron spins per molecule obtained from the saturation magnetization and from the temperature dependence of the paramagnetic susceptibility shows the same discrepancy as do the ferromagnetic elements. Three hysteresis loops at about 161.1, 75 and 4.2°K and the coercive forces from about 170°K down to 4.2°K have been obtained. The magnetocrystalline anisotropy constants for the whole low-temperature range calculated from the magnetization curves and from the coercive forces agree in order of magnitude. (*PA*, 1956, #4509)

1667. FERRIMAGNETISM OF Mn_4N

Juza, R. and Puff, H.

Naturwissenschaften, v. 43, no. 10, p. 225, 1956 (in German)

Reports results of measurements of the saturation magnetization of Mn_4N with reduced N content. N replaced by C or Mn replaced by Cu. The p_B values vary linearly with composition and the results are discussed quantitatively. (*PA*, 1957, #534)

1668. ANTIFERROMAGNETISM IN Cr_2O_3 CRYSTAL

McGuire, T. R., Scott, E. J., and Grannis, F. H.

The Physical Review, v. 102, no. 4, pp. 1000–1003, May 15, 1956

Measurements of magnetic susceptibility and microwave resonance of single crystal Cr_2O_3; comparison of data with theory of polycrystalline materials; antiferromagnetic Curie temperature is 307°K. (*EI*, 1956)

1669. THE MAGNETIC PROPERTIES OF CHROMIUM–TELLURIUM–SELENIUM SYSTEM

Tsukobawa, I.

Journal of the Physical Society of Japan, v. 11, no. 6, pp. 662–665, June 1956

The change of magnetic properties due to the replacement of tellurium by selenium in CrTe, which has NiAs structure, was investigated. Ferromagnetism is observed in the concentration range from $x = 0$ to $x = 0.8$, where x is defined by $Cr(Te_{1-x}Se_x)$. The compounds outside this range are para- or antiferromagnetic. In the paramagnetic

range of temperature the Curie–Weiss law is found to be valid. It was also found that the Curie–Weiss constant is independent of concentration in the neighborhood of CrTe and CrSe respectively, and varies abruptly at the transition concentration from ferro- to antiferromagnetic state. (*PA*, 1956, #6771)

1670. NEW LOW-TEMPERATURE FERROMAGNETS
Holden, A. N., Matthias, B. T., Anderson, P. W., and Lewis, H. W.
***The Physical Review*, v. 102, no. 6, p. 1463, June 15, 1956**

Certain of the complex cyanides of elements of the 3 *d* transition group appear to be ferromagnetic at very low temperatures. (*PA*, 1956, #6013)

1671. NOTE ON THE MAGNETIC ANISOTROPY OF THE COBALT AMMONIUM TUTTON SALT $Co(NH_4)_2(SO_4)_2 \cdot 6H_2O$
Urvu, N.
***Journal of the Physical Society of Japan*, v. 11, no. 7, pp. 770–774, July 1956**

Magnetic anisotropy of cobalt ammonium Tutton salt in the temperature region from about 10 to 300°K is studied, using the wave functions obtained by Abragam and Pryce. The temperature dependence of the effective Bohr magneton is also studied. The agreements of the present theoretical results with the experimental ones are excellent. (*PA*, 1956, #7517)

1672. ANTIFERROMAGNETISM OF ANHYDROUS SULPHATES OF Ni^{++}, Fe^{++}, Co^{++}, Cu^{++}
Borovik-Romanov, A. S., Karasik, V. R., and Kreines, N. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 31, no. 1(7), pp. 18–24, 1956 (in Russian)**

The temperature dependence of the magnetic susceptibility of four anhydrous sulphates: $NiSO_4$, $FeSO_4$, $CoSO_4$ and $CuSO_4$ was investigated in the temperature range from 12 to 300°K. Susceptibility peaks characteristic of the antiferromagnetic transition were detected. It is suggested that $CuSO_4$ at 35°K half of the Cu^{++} ions have antiferromagnetic ordering. It is shown that below the Curie point the magnetic susceptibility of $NiSO_4$ decreases with temperature according to a quadratic law. (*PA*, 1957, #538)

1673. MAGNETIC COMPOUNDS WITH PEROVSKITE STRUCTURE IV. CONDUCTING AND NON-CONDUCTING COMPOUNDS
Jonker, G. H.
***Physica*, v. 22, no. 8, pp. 707–722, August 1956**

An experimental study of the magnetic interactions in compounds with perovskite structure is given. $LaMnO_3$ is an antiferromagnetic compound, but it is shown that it would be ferromagnetic if the cubic perovskite structure, present at high temperatures, could be preserved at low temperature. Besides the positive magnetic interaction between Mn^{3+} and Mn^{4+} ions an interaction of the same sign is found between Mn^{3+} and Cr^{4+} ions. A survey is given of the results of this and former investigations. (*PA*, 1956, #7530)

1674. ON THE FERRIMAGNETISM OF SOME SULPHIDES AND OXIDES
Lotgering, F. K.
***Philips Research Reports*, v. 11, no. 4, pp. 337–350, August 1956**

Magnetic measurements are reported on MCo_2O_4 (M = Mn, Fe, Ni, Co, Zn), Co_3S_4, $NiCo_2S_4$ and Co_9S_8. Only MCo_2O_4 (M = Mn, Fe, Ni) exhibit spontaneous magnetization. The Fe compound exhibits high coercive force, 1.3×10^4 oersted at 77°K, which decreases rapidly with rising temperature. For the Ni compound the magnetization temperature curve has an anomalous shape. Paramagnetic measurements are reported for all the compounds. The results are discussed in connection with the lattice structure. (*PA*, 1957, #1442)

1675. THE MAGNETIC SUSCEPTIBILITIES OF TWO POLYMORPHIC FORMS OF MANGANESE SULPHIDE
Carter, W. S. and Stevens, K. W. H.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 10, pp. 1006–1012, October 1956**

The magnetic susceptibilities of two polymorphic forms of MnS, one of zinc blende type and the other of wurtzite type have been measured. Antiferromagnetism occurs in the former at 100°K, with θ/T_c equal to 9.4. The results are discussed in the light of current views on antiferromagnetism and it is concluded that in the wurtzite type it may not be possible to form magnetic super-lattices.

Some ordering will however occur, but it is not clear whether this can be detected magnetically. The considerations are extended and applied to the rare earth metals. (*PA*, 1957, #1444)

1676. MAGNETIC PROPERTIES OF COBALT AND MANGANESE CARBONATES

Borovik-Romanov, A. S. and Orlova, M. P.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 31, no. 4(10), pp. 579–582, 1956 (in Russian)**

The magnetic properties of $MnCO_3$ and $CoCO_3$ have been investigated in the temperature range from 14°K to 300°K. It is found that the magnetic susceptibility rises below T_c($T_c = 31.5$°K for $MnCO_3$ and $T_c = 17.5$°K for $CoCO_3$) and depends strongly on the field strength. To explain the observed anomalies it is suggested that below T_c the carbonates go over to the antiferromagnetic state in which the sublattice moments do not completely compensate each other. (*PA*, 1957, #3435)

1677. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF ANHYDROUS COBALT AND NICKEL CHLORIDES

Bizette, H., Terrier, C., and Tsaï, B.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 243, no. 18, pp. 1295–1297, October 29, 1956 (in French)**

Reports results of susceptibility measurements on single crystals of $CoCl_2$ and $NiCl_2$ between 2° and 300°K. For $CoCl_2$ a maximum is observed in both $\chi_\perp$ and $\chi_\parallel$ at 25°K. For $NiCl_2$ the susceptibility maximum lies at a field dependent temperature near 50°K, and there is a minimum at 33°K. The results are discussed in relation to the crystal structure. (*PA*, 1957, #4545)

1678. ANTIFERROMAGNETISM AND ANTIFERROMAGNETIC RESONANCE IN $CuBr_2 \cdot 2H_2O$ AT 9800 Mc/sec

Date, M.
***The Physical Review*, v. 104, no. 3, pp. 623–624, November 1, 1956**

Antiferromagnetic resonance was observed in a single crystal of $CuBr_2 \cdot 2H_2O$ at liquid helium temperature. This crystal shows an isomorphous structure with that of $CuCl_2 \cdot 2H_2O$ and the experimental results are analogous to those for the latter. However, the resonance field shifts to the higher field side and this is considered to be the result of a stronger molecular field than that of $CuCl_2 \cdot 2H_2O$. The Néel point of $CuBr_2 \cdot 2H_2O$ was inferred to lie between 5 and 6.5°K. (*PA*, 1957, #2420)

1679. ANTIFERROMAGNETIC RESONANCE IN MnF_2

Johnson, F. M. and Nethercot, A. H., Jr.
***The Physical Review*, v. 104, no. 3, pp. 847–848, November 1, 1956**

Reports results of measurements between 36 and 65°K and at frequencies between 96 and 213.3 kMc. The resonance frequency was found to be given by $\nu = 264B_{5/2}(T/67.7)$ kMc in zero field. The line width and g-value were obtained, and the value of $(2H_EH_A)^{1/2}$ was found to equal 9×10^4 oersted, in good agreement with a calculation by Keffer. (*PA*, 1957, #2419)

1680. CRYSTAL STRUCTURE OF FERROMAGNETIC NICKEL OXIDE

Shimomura, Y., Kojima, M., and Saito, S.
***Journal of the Physical Society of Japan*, v. 11, no. 11, pp. 1136–1146, November 1956**

The determination of crystal structure was performed on the ferromagnetic nickel oxide obtained by the flame fusion method. Apart from a slight deviation of axial angle from 90°, it has a defect tetragonal structure belonging to the space group $I4_1/amd$ (D_{4h}^{19}), the lattice constants being $a = 5.889_6$ kX and $c = 8.343_4$ ($c/a = \sqrt{2}$) at 31.5°C. Considering the deviation, the structure must be altered to a monoclinic one belonging to $C2/m(C_{2h}^3)$, the lattice constants being $a = 5.104_4 kX$, $b = 2.951_5 kX$, and $\beta = 125°\ 11.4'$ at the same temperature as above. The details of the atomic arrangements in both cases are given. The saturation magnetization estimated under an appropriate assumption for the spin alignment agrees fairly well with the observation. Thus the comparison of the present structure with that of the ordinary nickel oxide may elucidate one of the processes of transition from an antiferromagnetic state to a ferromagnetic one. (*PA*, 1957, #4905)

1681. MAGNETIC SUSCEPTIBILITY OF NiO AND CoO SINGLE CRYSTALS

Singer, J. R.
***The Physical Review*, v. 104, no. 4, pp. 929–932, November 15, 1956**

The magnetic susceptibility of a NiO single crystal grown by the flame fusion method was found to be isotropic below the Curie temperature as it is for the case of powdered material. Such characteristics can be explained by twinning or domain structure within the crystal. Stressing the crystal along a [111] direction, while annealing, produces an anisotropic susceptibility with the maximum and minimum values found when the applied field was parallel and perpendicular, respectively, to the direction of stress. By using the Van Vleck theory, the results can be explained on the basis that the stress rotates some of the atomic spins from the direction of the [111] stress axis to the perpendicular planes. An assignment of spin direction to (111) planes of each domain agrees with the most recent neutron diffraction interpretation. The antiferromagnetic susceptibility of a single crystal of CoO was found to decrease when measured along one cubic edge and remain approximately constant along the other two [100] directions for temperatures down to 77°K. At liquid helium temperatures the susceptibility increases for all [100] directions. (*PA*, 1957, #2424)

1682. MAGNETIC STRUCTURES OF THE POLYMORPHIC FORMS OF MANGANOUS SULFIDE

Corliss, L., Elliott, N., and Hastings, J.
***The Physical Review*, v. 104, no. 4, pp. 924–928, November 15, 1956**

Manganous sulphide exists in three polymorphic forms. There are two cubic modifications, α-MnS having the rock salt structure and β-MnS with the zinc blende structure. The third form is hexagonal β-MnS with the wurtzite structure. The magnetic susceptibilities of all three forms and the antiferromagnetic structures, as determined by neutron diffraction, are reported. α-MnS exhibits ordering of the second kind, in agreement with earlier work. The spin direction, however, is found to be in the ferromagnetic (111) sheets rather than along cube edges. In the cubic β-MnS case, the magnetic structure is the hitherto unobserved "improved ordering of the first kind" proposed by Anderson. The spin direction is normal to the unique cubic axis. The hexagonal β-MnS antiferromagnetic structure can be derived from the cubic β-MnS by stacking the close-packed (111) sheets of the zinc blende form according to the scheme ABA—appropriate to hexagonal close-packing. The magnetic unit cell is orthohexagonal with $a_0' = a_0\sqrt{3}$, $b_0' = 2a_0$, $c_0' = c_0$, where the unprimed symbols refer to the original hexagonal cell. The spin direction is normal to the (011) plane. These magnetic structures are discussed on the basis of an indirect exchange coupling mechanism. (*PA*, 1957 #2423)

1683. THE SUSCEPTIBILITY AND MAGNETIC SPECIFIC HEAT OF POTASSIUM FERRICYANIDE AT LOW TEMPERATURES

McKim, F. R. and Wolf, W. P.
***Proceedings of the Physical Society*, London, Section B, v. 69, Part 12, pp. 1231–1236, December 1956**

The temperature variation of the susceptibility of single crystals of potassium ferricyanide has been measured between 20 and 1°K, using an a.c. mutual inductance method. The results of measurements along each of the three crystalline axes were fitted to expressions of the form $\chi_x = (\lambda_x/T)\ (1 + \Delta_x/T + \ldots)$ and values of λ_x and Δ_x deduced. It was found that the effect of higher order terms was very small. The magnetic specific heat was measured at 1.05°K using the relaxation method. An attempt was made to relate the values of Δ to the measured specific heat and paramagnetic resonance line width, on the basis of exchange interaction with n equivalent nearest neighbors. It was found, however, that only approximate agreement could be obtained, and this with the rather small value of $n = 2$. (*PA*, 1957, #2426)

1684. MAGNETIC SUSCEPTIBILITIES OF URANIUM (V) AND URANIUM (III) CHLORIDES

Handler, P. and Hutchison, C. A., Jr.
***Journal of Chemical Physics*, v. 25, no. 6, pp. 1210–1213, December 1956**

The magnetic susceptibilities of UCl_3, UCl_2, and solutions of UCl_3 in $LaCl_3$ have been measured in the temperature range from 14 to 300°K. The results are presented graphically and their general form is discussed. The susceptibility of UCl_3 apparently undergoes an antiferromagnetic transition just above the boiling point of H_2. As UCl_3 is diluted with $LaCl_3$ the behavior of the magnetic susceptibility approaches closely that of $Nd(C_2H_5SO_4)_3 \cdot 9H_2O$. The magnetic behavior of UCl_3 is consistent with that expected for an ion with three unimpaired f electrons. (*PA*, 1957, #2408)

1685. ANTIFERROMAGNETIC STATE IN THE CHROME ALUMS

O'Brien, M. C. M.

The Physical Review, v. 104, no. 6, pp. 1573–1579, December 15, 1956

The molecular field method is applied to the magnetic interactions in the chrome alums to describe the ordered state that occurs at low temperatures. An antiferromagnetic Curie point is predicted even in the absence of any exchange between the chromium ions. The predicted critical temperature is $T_c = 1.7\tau(\sigma + \upsilon)$, where τ is the characteristic temperature, $15N\beta^2/k$, υ represents the exchange interaction between nearest neighbors in units of the magnetic interaction, and $\sigma = 0.78$ is a sum of $(1–3\cos^2\theta)/r^3$ over lattice points. The entropy and susceptibility are calculated as functions of the temperature and applied field. The variation of the zero-field susceptibility with entropy below the critical temperature fits the observed results if υ is put equal to -0.13, and this value of υ gives a critical temperature within the range of observed values. (*PA*, 1957, #3442)

1686. FARADAY EFFECT IN CUBIC CRYSTALS

Sivaramakrishnan, V.

Journal of the Indian Institute of Science, Section A, v. 39, no. 1, pp. 1–7, January 1957

The magneto-optical rotation was measured in five cubic crystals (KCl, KBr, KI, LiF and MgO) for a number of wavelengths from 5780 to 2848 Å. Dispersion formulae are proposed for both optical refraction and magneto-optical rotation, the formula for the latter fitting the experimental data to within ½%. It is found that in the case of alkali halides all the absorption wavelengths, characteristic of the substances, affect the rotation in the same proportion as they do the refraction, i.e. the value of the anomaly factor for different absorption frequencies is the same. The values of anomaly factor are less than unity (which is the value to be expected of atoms and ions having the inert gas structure), being 0.85, 0.85, 0.87 and 0.84 for KCl, KBr, KI, and LiF respectively. In MgO, the value of the anomaly factor for 1300 Å is found to be 0.96, while that for the other wavelength 400 Å is zero. (*PA*, 1958, #3009)

1687. ON THERMOMAGNETIC BEHAVIOR OF CoO–MgO AND CoO–NiO SYSTEMS

Perkis, N. and Serres, A.

Journal de physique et le Radium, v. 18, no. 1, pp. 47–50, January 1957 (in French)

Magnetic susceptibility measurement on 3CoC + 2MgO, 2CoO + MgO and 2CoO + NiO, made by the Faraday method, in the temperature range 80–900°K, are reported. The thermomagnetic analysis, in agreement with X-ray powder photographs, show that the samples investigated, prepared at very high temperature, are homogeneous solid solutions. The data fit a Curie–Weiss law $\chi_M = C/(T - \Theta)$ with C = 3.25, within 1% the Curie constant found by Elliott for the system CoO–MgO, and a Néel condition $\Theta \cong T_c$. (*PA*, 1957, #4538)

1688. THEORY OF ANTIFERROMAGNETISM

Amatuni, A. Ts.

Physics of Metals and Metallography (translation of *Fizika Metallov i Metallovedenie*) v. 4, no. 1, pp. 12–19, 1957

With aid of method of excitations developed by Bogoliubov and S. V. Tiablikov, expressions are obtained for magnetization and magnetic susceptibility of anisotropic antiferromagnetic substance, valid for temperatures less than T_N (Néel temperature); satisfactory agreement found with results of measurements on monocrystal $CuCl_2 2H_2O$. (*EI*, 1957)

1689. ON THE MAGNETIC PROPERTIES OF NICKEL-ARSENIDE TYPE CRYSTALS

Hirone, T. and Adachi, K.

Journal of the Physical Society of Japan, v. 12, no. 2, pp. 156–163, February 1957

The formation of the ordered arrangement of the magnetic moments of cations (spin ordering or spin arrangement) in the crystal lattice of the nickel-arsenide type is studied theoretically with the molecular field approximation, taking into account interaction between pairs of cations, which form the first, second or third neighbors in the crystal lattice. Various types of spin arrangement in this structure with two kinds of cations are derived. Based on the results obtained the magnetic properties of the compounds are discussed. The theory is applied as a typical example to the interpretation of the magnetism of the ternary solid solution of manganese–chromium–antimony system. (*PA*, 1957, #5114)

1690. THE ANTIFERROMAGNETIC STATE IN THE CHROME ALUMS

Van Vleck, J. H.

Il Nuovo Cimento Supplement, v. 6, no. 3, p. 1235, 1957

Presented at the Summer School of the Italian Physical Society, Varenna, July–August 1956. (*PA*, 1959, #440)

1691. HIGH TEMPERATURE SUSCEPTIBILITIES
Danielian, A. and Stevens, K. W. H.
***Proceedings of the Physical Society*, London, Section B, v. 70, Part 3, pp. 326–328, March 1957**

Following recently reported measurements on MnS a study has been made of the high-temperature properties of antiferromagnetics in which the magnetic ions are on a face-centered cubic lattice with nearest neighbor interactions only. It is concluded that to obtain the correct asymptotic Curie temperature by extrapolation of the $(1/\chi,T)$ curve it is necessary to use data obtained at temperatures at least ten times the Néel temperature, and the failure to do this may account for both the high value of the asymptotic Curie temperature obtained in MnS and for some error in the magneton number. (*PA*, 1957, #5468)

1692. REINVESTIGATION OF REPORTED FERROMAGNETISM IN $Li_x Ni_{(1-x)}O$
Janusz, T. P., Heikes, R. R., and Johnston, W. D.
***Journal of Chemical Physics*, v. 26, no. 4, pp. 973–974, April 1957**

The experiments of Perakis et al. were repeated on a compound with $x = 0.018$. The susceptibility was measured between 190° and 480°K and no signs of ferromagnetism were detected. (*PA*, 1957, #6336)

1693. ON THE MAGNETIC PROPERTIES OF CHROMIUM SULFIDES
Yuzuri, M., Hirone, T., Watanabe, H., Nagasaki, S., and Maeda, S.
***Journal of the Physical Society of Japan*, v. 12, no. 4, pp. 385–389, April 1957**

The thermomagnetic properties of chromium sulphide $CrS_{1.17}$ were studied. The spontaneous magnetization of this compound, which is probably of the ferrimagnetic origin, suddenly disappears during cooling at −120°C. A slight heat absorption was observed at this transition point. By X-ray analysis excess diffraction lines, besides those of the ideal crystal lattice of the nickel arsenide type, were observed at room temperature, which shows a superlattice structure with parameters of 2 c and $2\sqrt{3}$ a, c and a being those of the original lattice. It was also found by X-ray analysis that there was no change of the crystal lattice at the magnetic transition temperature, −120°C. This compound showed a ferrimagnetic behavior with the asymptotic Curie temperature at 150°K. A peak in the susceptibility vs. temperature curve was found by thermomagnetic measurements in the temperature range from liquid helium temperature to −120°C. The nature of transition is briefly discussed. (*PA*, 1958, #6039)

1694. NEUTRON DIFFRACTION STUDY OF THE MAGNETIC STRUCTURES FOR THE PEROVSKITE-TYPE MIXED OXIDES La(Mn, Cr)O_3
Bents, U. H.
***The Physical Review*, v. 106, no. 2, pp. 225–230, April 15, 1957**

A neutron diffraction study has been made of the magnetic properties of the series of perovskite-like compounds $La[(1-x)Mn, xCr]O_3$. This series exhibits ferromagnetic and antiferromagnetic properties which depend on the composition of the sample. The antiferromagnetic structure of pure $LaMnO_3$ persists only for very small concentrations of Cr^{+3}; the antiferromagnetic structure characteristic of pure $LaCrO_3$ is found over a large composition range. For samples of intermediate composition a ferromagnetic moment is observed, the maximum occurring at about 20% Cr^{+3}. In contrast to the mixed oxides $[(1-x)$ La, xCa]–MnO_3, which for certain compositions were truly ferromagnetic, the maximum ferromagnetic moment in this series is very much less than that expected if all the spins were contributing to the moments. A complex ferrimagnetic structure is suggested for the intermediate composition range. (*PA*, 1957, #5462)

1695. MAGNETIC PROPERTIES OF MANGANESE OXIDES AT TEMPERATURES FROM 20 TO 300°K
Borovik-Romanov, A. S. and Orlova, M. P.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 32, no. 5, pp. 1255–1256, 1957 (in Russian)**

The susceptibility of χ of natural samples of Mn_2O_3, and Mn_3O_4 was measured. The former showed ferromagnetic behavior (saturation and hysteresis) below 42.5°K and a $1/\chi - T$ curve at higher T in rough agreement with Néel's formula for a ferrimagnetic. The latter remains

paramagnetic over the whole range but the $1/\chi - T$ curve is anomalous, possibly due to impurities. (*PA*, 1958, #653)

1696. ANTIFERROMAGNETIC RESONANCE IN Cr_2O_3

Dayhoff, E. S.
***The Physical Review*, v. 107, no. 1, pp. 84–91, July 1, 1957**

The antiferromagnetic resonance spectrum of single-crystal Cr_2O_3 has been mapped within the wavelength region from 12 mm to 2.8 mm and magnetic field intensities from 0 to 30,000 oersted. The resonance frequencies were observed in this region in a temperature interval from about 17°C to 35°C, the Néel temperature, T_N. When the [111] crystal axis is perpendicular to the direction of the external magnetic field, the observed resonance locus on a frequency vs. magnetic field diagram forms a single curve at each temperature; when the two are parallel, the resonance locus forms a curve of two branches, one of which has not previously been observed for this material. These loci are found to be in good agreement with the resonance theory of Nagamiya, and of Keffer and Kittel. Good theoretical agreement is also found for variations of line width with magnetic field strength and for variations in the peak absorption intensity at resonance. The anisotropy energy K which depends upon the temperature, T, as obtained from the data is proportional to $(T_N - T)^{0.87}$ over the observable interval. Assuming that K is proportional to a fixed power of sublattice magnetization at all temperatures and that sublattice magnetization behaves as the appropriate Brillouin function of temperature, one can extrapolate to absolute zero and thus find $K = 800{,}000$ ergs/cm^3. (*PA*, 1957, #8013)

1697. APPLICATION OF THE ISING–BETHE THEORY TO THE SUSCEPTIBILITIES OF THE POLYMORPHIC FORMS OF MnS

Wojtowicz, P. J.
***The Physical Review*, v. 107, no. 2, pp. 429–430, July 15, 1957**

With the aid of the Ising–Bethe theory it has been shown that the susceptibilities of the three polymorphic forms of MnS can be correlated with the same indirect exchange mechanism as that required to explain the observed magnetic structures. It has also been possible to obtain certain semiquantitative information concerning the Mn–S–Mn indirect exchange interaction. In view of the results reported in this paper, it is recommended that greater use be made of the Ising–Bethe or Bethe–Weiss–Li theories in the interpretation of susceptibility data obtained at temperatures not too far above the Néel temperature. (*PA*, 1958, #655)

1698. FERRIMAGNETIC RESONANCE OF ERBIUM GARNET AT 9.4 kMc

Paulevé, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 245, no. 4, pp. 408–411, July 22, 1957 (in French)**

The resonance field was measured between 4 and 530°K an an anomaly observed at the compensation temperature 84°K. The results are explained by attributing a g factor 5 to the Er ions above 100°K; the low temperature results are inconclusive. (*PA*, 1957, #9264)

1699. HIGH-FIELD ANTIFERROMAGNETIC RESONANCE IN MnF_2 USING PULSED FIELDS AND MILLIMETER WAVELENGTHS

Foner, S.
***The Physical Review*, v. 107, no. 3, pp. 683–685, August 1, 1957**

Preliminary observations of the high-field antiferromagnetic resonance mode in MnF_2 from 4.2°K up to T_N are presented. The experiments, which employ pulsed magnetic fields and relatively low frequencies (4 and 8 millimeter wavelengths), are briefly described. The absolute value and general temperature dependence of $(2H_EH_A)^{\frac{1}{2}}$ are in close agreement with estimates made earlier by Keffer and recent high-frequency measurements by Johnson and Nethercot near T_N. The results demonstrate the general validity of the molecular-field approximation of antiferromagnetic resonance. Qualitative features of the resonance absorption and upper bounds of the line widths are also presented. (*PA*, 1958, #2404)

1700. LITHIUM–NICKEL FLUORIDE, Li_2NiF_4, A FLUORSPINEL

Rüdorff, W. and Kandler, J.
***Naturwissenschaften*, v. 44, no. 15, p. 418, 1957 (in German)**

Describes the preparation and some of the properties

of a new compound Li_2NiF_4. This is an inverted spinel with a face-centered cubic structure of lattice parameter 8.313 Å. The Curie law is obeyed from 77° to 473° K, and the magnetic moment is found to be 3.18 Bohr magnetons. (*PA*, 1958, #228)

1701. MAGNETIC PROPERTIES OF COBALT FLUORIDE IN THE ANTIFERROMAGNETIC STATE
Astrov, D. N., Borovik-Romanov, A. S., and Orlova, M. P.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 3(9), pp. 812–815, 1957 (in Russian)**

Measurements of magnetic susceptibility of CoF_2 in the range 20–250°K are reported and discussed. (*PA*, 1958, #2409)

1702. COMPLEX MAGNETIC PERMEABILITY TENSOR AND PARAMAGNETIC RESONANCE ABSORPTION IN $CuSO_4 \cdot 5H_2O$
Sundaramma, K.
***Proceedings of the Indian Academy of Sciences*, Section A, v. 46, no. 3, pp. 232–237, September 1957**

Absolute values of the imaginary part of the magnetic susceptibility are obtained from electron resonance intensities in a single crystal of $CuSO_4 \cdot 5H_2O$. Despite large variations of line widths and peak intensities, the integrated absorption tensor is nearly spherical with axes 6.81 cm^3gauss along L_1, the normal to the plane containing the tetragonal axes of the crystallographically distinct Cu^{++} ions, and 7.38 cm^3gauss in that plane. These values are in agreement with the static susceptibilities to which they are related by the Kramers–Kronig relationship. (*PA*, 1958, #232)

1703. MAGNETIC SUSCEPTIBILITY IN TELLURIUM TYPE SEMICONDUCTORS
Firsov, Yu. A.
***Zhurnal Tekhnicheskoi Fiziki*, v. 27, no. 10, pp. 2212–2228, 1957 (in Russian)**

The problem of the magnetic susceptibility in the presence of abutting zones in tellurium type semiconductors is considered. The case where the abutment of the zones is absent but there are some extremes of the function $E(k)$ is investigated. A method is proposed for investigating zonal structure according to the angular relationship of magnetic susceptibility in strong magnetic fields. (*PA*, 1958, #1698)

1704. MAGNETIC SUSCEPTIBILITIES OF SOME Pu^{+4} COMPOUNDS
Lewis, W. B. and Elliott, N.
***Journal of Chemical Physics*, v. 27, no. 4, pp. 904–908, October 1957**

The magnetic susceptibilities of $Pu(SO_4)_2 \cdot 4H_2O$, $Rb_4Pu(SO_4)_4 \cdot 2H_2O$, $Pu(C_2O_4)_2 \cdot 6H_2O$, $[(CH_3)_4N]_2$-$PuCl_6$, and PuF_4 were measured over the temperature range 77 to 334°K. The large departures from the Curie–Weiss law observed in these salts are discussed in terms of the crystalline field symmetry. (*PA*, 1958, #231)

1705. MAGNETIC SUSCEPTIBILITY OF TITANIUM (III) IN LANTHANUM TITANIUM OXIDES
Moeller, C. W.
***Journal of Chemical Physics*, v. 27, no. 4, pp. 983–984, October 1957**

Room-temperature susceptibility measurements for La_xTiO_3 ($x = 0.92, 0.76, 0.70$) are reported and the p_B values for the Ti (III) ions vary from 0.83 to 1.65 for this range of x. (*PA*, 1958, #2411)

1706. PROBLEM OF SPIN ARRANGEMENTS IN MnO AND SIMILAR ANTIFERROMAGNETS
Keffer, F. and O'Sullivan, W.
***The Physical Review*, v. 108, no. 3, pp. 637–644, November 1, 1957**

The magnetic dipolar energy is computed for ordering of the second kind with the four antiferromagnetic sublattices of a face-centered cube making arbitrary spin directions with respect to one another, and this energy is shown to be of the same form in the sublattice direction cosines as is the calculated powder neutron-diffraction pattern. (The dipolar energy is also calculated for ordering of the third kind and shown to lead to a spin arrangement in disagreement with powder neutron-diffraction results on β MnS). The observed neutron patterns in MnO and α MnS agree with minimum dipolar energy, but many spin arrangements can satisfy this and the spins are constrained only to certain regions. Other sources of anisotropy in Mn^{++} salts are shown to be much weaker. A model is introduced in which the spins are constrained by dipolar and exchange forces to point parallel to (111) planes and constrained by the weaker anisotropy to a threefold set of easy axes within these planes. Nagamiya's

small-field approximation for the field dependence of the powder susceptibility of a uniaxial antiferromagnet is extended to all values of the applied field, and a similar calculation is made for the powder susceptibility of the MnO model. Comparison with experimental data indicates that the weak within-plane anisotropy is $\sim 3 \times 10^4$ ergs/cm^3 which is to be contrasted with the theoretical out-of-plane dipolar anisotropy of 10^7 ergs/cm^3. A rough theory of antiferromagnetic resonance for the model seems to explain the partial paramagnetic-like absorption observed below the Néel point. (*PA*, 1958, #8110)

1707. CRYSTALLOGRAPHIC AND MAGNETOCHEMICAL STUDIES ON ABO_3 GROUP COMPOUNDS OF LANTHANON AND MANGANESE OXIDES
Vickery, R. C. and Klann, A.
***Journal of Chemical Physics*, v. 27, no. 5, pp. 1161–1163, November 1957**

Perovskite-structured compounds were prepared, containing manganese oxide with praseodymium, neodymium, and dysprosium oxides. X-ray crystallographic data were obtained for these compounds, and unit cell edge values of 3.82, 3.80, and 3.70Å are found for $PrMnO_3$, $NdMnO_3$, and $DyMnO_3$, respectively. Magnetic susceptibilities of these compounds were measured down to liquid-air temperatures and gram susceptibilities found to range from 40–158% above those indicated by additive values for the component oxides, highest increments being found in praseodymium systems. Susceptibility curves follow the Curie–Weiss law without deviation, and Weiss constants of 115, 112, and 62 were found for the praseodymium, neodymium, and dysprosium compounds, respectively. (*PA*, 1958, #6037)

1708. AN ANOMALOUS MAGNETIC TRANSITION IN ANHYDROUS COPPER SULPHATE
Borovik-Romanov, A. S. and Kreines, N. M.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 5(11), pp. 1119–1122, 1957 (in Russian)**

The magnetic properties of fine-grained anhydrous $CuSO_4$ in the region 1.5–300° K were investigated. Below $T_c = 34.4°$ K the substance has antiferromagnetic properties. The transition to the antiferromagnetic state is accompanied by an anomalous twofold growth in susceptibility in the temperature interval $\sim 1.5°$K. (*PA*, 1958, #6044)

1709. MAGNETIC SUSCEPTIBILITIES OF VANADATES OF NEODYMIUM AND PRASEODYMIUM
Vickery, R. C. and Klann, A.
***Journal of Chemical Physics*, v. 27, no. 5, pp. 1219–1220, November 1957**

Reports results of room temperature susceptibility measurements of MVO_3 prepared under different conditions of firing temperature and atmosphere; for $M = Nd$ the results obey approximately an additivity rule, but for $M = Pr$ the observed are larger than the calculated values. (*PA*, 1958, #3247)

1710. PREPARATION AND MAGNETIC PROPERTIES OF PYROCHLORE-TYPE TITANATES OF NEODYMIUM AND PRASEODYMIUM
Vickery, R. C. and Klann, A.
***Journal of Chemical Physics*, v. 27, no. 5, pp. 1220–1221, November 1957**

Results similar to those reported in the preceding abstract were obtained for MTi_2O_7. (*PA*, 1958, #3248)

1711. MAGNETIC AND ELECTRIC PROPERTIES OF VANADIUM TRIOXIDE
Teranishi, S. and Tarama, K.
***Journal of Chemical Physics*, v. 27, no. 5, pp. 1217–1218, November 1957**

Reports results of susceptibility measurements between 0 and 620°C and in fields up to 6000 oersted of nonstoichiometric V_2O_3 specimens; Néel temperatures between 258° and 385°C and p_B values between 1.95 and 3.04 were observed for the different specimens. Thermoelectric measurements are also reported. (*PA*, 1958, #3246)

1712. MAGNETIC ANALYSIS OF THE URANIUM–OXYGEN SYSTEM
Arrott, A. and Goldman, J. E.
***The Physical Review*, v. 108, no. 4, pp. 948–953, November 1957**

Magnetic susceptibility measurements were carried out on the uranium–oxygen system in the composition range of UO_2 to $UO_{2.67}$. The existence of an antiferromagnetic transition at compositions close to stoichiometric UO_2 was confirmed. The data make it possible to define clearly the

phase limits of the UO_2 and U_3O_8 structures and to determine unambiguously that the excess oxygen ions in the non-stoichiometric salts occupy interstitial positions in the lattice. (*PA*, 1958, #9175)

1713. CRYSTAL STRUCTURES OF NEW GROUP OF FERROMAGNETIC COMPOUNDS

Braun, P. B.

***Philips Research Reports*, v. 12, no. 6, pp. 491–548, 1957**

Description of crystal structures of four new compounds, for two of which chemical formulas were found simultaneously with structure; oxygen and barium atoms together form slightly expanded close-packed arrangement with Ba atoms in certain selected positions and smaller ions in certain of holes between large ones; structures of these compounds and magneto-plumbite structure are mutually related. (*EI*, 1958)

1714. ON THE MAGNETIC STRUCTURE OF TRANSITION METAL FLUORIDES

Dzyaloshinskii, I. E.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 6(12), pp. 1454–1456, 1957 (in Russian)**

The method described earlier is employed to investigate the magnetic structure of antiferromagnetic crystals of MnF_2, CoF_2, FeF_2 and NiF_2. It is shown that crystals with such symmetry may possess weak ferromagnetism. (*PA*, 1958, #6045)

1715. THE EFFECT OF HYDRAULIC PRESSURE ON THE TEMPERATURE OF ANTIFERROMAGNETIC TRANSFORMATION IN MANGANESE TELLURIDE

Grazhdankina, N. P.

***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 33, no. 6(12), pp. 1524–1525, 1957 (in Russian)**

The electrical resistance R of MnTe was measured at $T = 279$ to 363°K under hydraulic pressure $P = 1$–5200 kg/cm². R decreased with increasing P, the pressure coefficient of R varying with T between -3.5 and -0.73. Increasing P resulted also in raising the temperature of the antiferromagnetic transformation T_N (Néel point), the magnitude of the effect being $dT_N/dP = (2.0 \pm 0.4) \times 10^{-3}$. T_N calculated for $P = 4400$ kg/cm² from the slope of the $R(T)$ curve was +46°C. (*PA*, 1959, #448)

1716. FERRIMAGNETIC RESONANCE IN SOME POLYCRYSTALLINE RARE EARTH GARNETS

Rodrigue, G. P., Pippin, J. E., Wolf, W. P., and Hogan, C. L.

***IRE Transactions on Microwave Theory and Techniques*, v. MTT-6, no. 1, pp. 83–91, January 1958**

Ferrimagnetic resonance measurements carried out on series of polycrystalline garnets of varying composition; variations of line widths and effective g values over temperature range of 20°C to Curie points examined; garnets offer unusual possibilities in low frequency microwave applications. (*EI*, 1958)

1718. PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF COBALTOUS BROMIDE AND IODIDE

Bizette, H., Terrier, C., and Tsaï, B.

***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 2, pp. 250–252, January 13, 1958 (in French)**

Reports results of susceptibility measurements up to room temperature; for $CoBr_2$ susceptibility maxima were observed at 19°K and for CoI_2 parallel to the hexagonal axis at 3°K. (*PA*, 1958, #3245)

1719. SUPEREXCHANGE INTERACTION

Yamashita, J. and Kondo, J.

***The Physical Review*, v. 109, no. 3, pp. 730–741, February 1, 1958**

Superexchange interaction in the MnO crystal is studied by using the Heitler–London picture including overlap. Mechanisms proposed by Slater, Kramers and Anderson, and Goodenough are developed on the same basis. The energy difference between the antiparallel spin state and the parallel spin state is computed numerically in the case of the simple four-electron problem. (*PA*, 1958, #2387)

1720. THE PARAMAGNETIC SUSCEPTIBILITY OF SOME NICKEL SALTS

Haseda, T. and Date, M.

***Journal of the Physical Society of Japan*, v. 13, no. 2, pp. 175–178, February 1958**

These were measured in the temperature range between 1.40° and 290°K. The flat behavior of the

susceptibility vs. temperature curve in the lowest temperature region was especially prominent in $NiCl_2 \cdot 6H_2O$. The paramagnetic susceptibility of a powdered specimen of the nickel salt was calculated with the low field approximation. The characteristic behavior of a nickel ion in various salts was explained as due to the Stark splitting of the lowest spin triplet. The measured values of susceptibility were analyzed and consistent results were obtained. Especially in $NiCl_2 \cdot 6H_2O$, the crystalline field was expected to be much deformed from cubic symmetry and this is consistent with the fact that the paramagnetic resonance could not be detected at 9800 and 18000 Mc in this salt. (*PA*, 1959, #8283)

1721. SOME MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $Li_x^+Ni_{1-2x}^{++}Ni_x^{+++}O$

Goodenough, J. B., Wickham, D. G., and Croft, W. J.

***Journal of Physics and Chemistry of Solids*, v. 5, no. 1–2, pp. 107–116, 1958**

Crystallographic and magnetic measurements of the system $Li_x^+Ni_{1-2x}^{++}Ni_x^{+++}O$ for the entire range $0 \leq x \leq 0.5$ are reported. For values of $x \leq 0.3$, the lattice appears to be antiferromagnetic and is cubic above the Curie temperature. For the range of composition $0.3 < x < 0.5$, the lattice is rhombohedral and ferrimagnetic, a maximum magnetic moment per gram of 31 c.g.s. cm^3/g being observed at $x = 0.46$. A maximum ferrimagnetic Curie temperature of 241°K was observed for the composition $x = 0.41$. These properties are interpreted in terms of a partial ordering of lithium and nickel ions into alternative sets of (111) planes which couple antiparallel to one another, the moments within any set being either ferromagnetically coupled or paramagnetic, depending upon the number of nonmagnetic near neighbors in the neighboring planes. This system is compared with the ordered rock-salt-type compound $Cu_{0.25}Co_{0.75}O$. The lack of ferrimagnetism and the tetragonal distortion to $c/a < 1$ in $Cu_{0.25}Co_{0.75}O$ are explained. (*PA*, 1959, #1582)

1722. EFFECT OF EXCHANGE INTERACTION ON THE MAGNETIC AND THERMAL PROPERTIES OF COPPER SALTS AND COPPER COORDINATION COMPOUNDS

Eisenstein, J. C.

***Journal of Chemical Physics*, v. 28, no. 2, pp. 323–329, February 1958**

This paper has two purposes. The first is to derive general formulae for the specific heat and the susceptibility of a compound in which there are two magnetically inequivalent ions with effective spin ½ in each unit cell. Dipole–dipole and anisotropic exchange interactions are taken into account in the derivations. The second purpose is to explore in a rather tentative way the possibility of applying the theory to a compound in which the magnetic ions are strongly coordinated to the surrounding anions. The compound selected for detailed study is copper tetrammine sulphate monohydrate. Experimental data on this compound are neither as extensive nor as accurate as one might wish, and the theory contains a large number of adjustable parameters. Consequently it is impossible to make sharp judgments about the values of the parameters. It is concluded, however, that exchange interactions have important effects on the magnetic and thermal properties of copper tetrammine sulphate. Other substances to which the theory might be applied are mentioned. (*PA*, 1958, #8860)

1723. THE SUSCEPTIBILITY OF LEAD TELLURIDE PbTe

Matyás, M.

***Czechoslovak Journal of Physics*, v. 8, no. 3, pp. 301–308, 1958**

The results are given of the measurement of the temperature dependence of the susceptibility of samples of *n*- and *p*-type PbTe,, containing either an excess of one or other of the components or ions Cl^-, or Ag^+, as impurities. The concept of cation or anion vacancies, which can be occupied by a hole or electron, Ag^+ or Cl^- ions, was employed, in addition to the constants taken from other measurements, to explain the dependencies measured. (*PA*, 1959, #4781)

1724. THE SUSCEPTIBILITY OF SELENIDES AND TELLURIDES OF HEAVY ELEMENTS

Matyás, M.

***Czechoslovak Journal of Physics*, v. 8, no. 3, pp. 309–314, 1958**

The temperature dependence of the susceptibility $\chi(T)$ of samples of PbSe, Sb_2Se_3, Sb_2Te_3, Bi_2Se_3 and Bi_2Te_3 was measured. The connection between the molar susceptibility of the characteristic crystal lattice of these semiconductors and the total number of electrons in their molecules is pointed out. (*PA*, 1959, #4782)

1725. STRUCTURE AND FERRIMAGNETISM OF THE ILMENITE COMPOUND $MnNiO_3$
Bertaut, E. F. and Forrat, F.
***Journal of Applied Physics*, v. 29, no. 3, pp. 247–248, March 1958**

$MnNiO_3$ is a ferrimagnetic compound, belonging to the ilmenite type. The sublattices of Mn^{4+} and Ni^{2+} are coupled antiferromagnetically as the sublattices of Fe^{3+} in hematite. The saturation magnetization at $T = 0°K$ is 0.76 μ_B. (*PA*, 1958, #2400)

1726. PARAMAGNETIC FARADAY EFFECT
Soutif-Guicherd, J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 256–258, March 1958**

A theory is given for the Faraday rotation in paramagnetic salts and curves for the rotation angle as a function of applied field are calculated. For comparison with theory, results are given of measurements made on several manganese salts at a wavelength of 9.9 cm and the agreement is good.

1727. SOME FERRIMAGNETIC PROPERTIES OF THE SYSTEM $Li_xNi_{1-x}O$
Goodenough, J.B., Wickham, D. G., and Croft, W. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 382–383, March 1958**

Crystallographic and magnetic measurements of the system $Li^{+}_{x}Ni^{++}_{1-2x}Ni^{+++}_{x}O$ for the entire range $0 \leq x < 0.5$ are reported. For values of $x \leq 0.3$, the lattice appears to be antiferromagnetic and is cubic above the Curie temperature. For the range of compositions $0.3 < x < 0.5$, the lattice is rhombohedral and apparently ferrimagnetic, a maximum magnetic moment per gram of 31 cgs cm^3/g being observed at $x = 0.46$. A maximum ferrimagnetic Curie temperature of 241°K was observed for the composition $x = 0.41$. These properties are interpreted in terms of a partial ordering of Li and Ni ions into alternate sets of (111) planes which couple antiparallel to one another, the moments within any set being either ferromagnetically coupled or paramagnetic, depending upon the number of nonmagnetic near neighbors in the neighboring planes. (*PA*, 1958, #8899)

1728. MAGNETIC GERMANATES ISOSTRUCTURAL WITH GARNET
Tauber, A., Banks, E., and Kedesdy, H. H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 385–387 March 1958**

In order to study the magnetic interaction between the eightfold and the combined six- and fourfold sites in the garnet structure, several germanate garnets have been synthesized. If no magnetic cation is present in the fourfold site no spontaneous magnetization has been found in the temperature range 90 to 500°K. A partial substitution of the nonmagnetic cation in the fourfold site by magnetic cations, however, leads to a spontaneous magnetization. (*PA*, 1958, #8901)

1729. SOME MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $LaMn_{1-x}Ni_xO_{3+\lambda}$
Wold, A., Arnott, R. J., and Goodenough, J. B.
***Journal of Applied Physics*, v. 29, no. 3, pp. 387–389, March 1958**

The system $LaMn_{1-x}Ni_xO_{3+\lambda}$ was prepared under varying conditions for the entire range of compositions $0 \leq x \leq 1$. The saturation magnetization, lattice parameters, and chemical analysis were measured for each sample. The origin of discrepancies in the literature on the crystal structure of $LaMnO_3$ is shown to be due to different preparation procedures which result in the presence of differing amounts of Mn^{4+}: the lattice symmetry changes from orthorhombic to rhombohedral as the Mn^{4+} concentration exceeds 18% of the total manganese. The system is ferromagnetic with magnetization only slightly less than the spin-only value over the compositional range $0.2 \leq x \leq 0.5$: a ferromagnetic Ni^{3+}–Mn^{3+} interaction is indicated. The system remains orthorhombic throughout the range $0 \leq x < 0.5$; it shows an increasing distortion to an apparently monoclinic symmetry in the range $0.5 < x \leq 0.8$. $LaNiO_3$ is rhombohedral at room temperature. The lattice symmetry is compatible with Ni^{3+} in a low spin state: this is also in accord with the magnetization values. Qualitative concepts used to interpret the system (La,Ca) MnO_3 are applied to interpret the magnetic and crystallographic properties of this system as well as the magnetic properties of some rhombohedral perovskite-type systems rich in Mn^{3+} ions. (*PA*, 1959, #428)

1730. ANTIFERROMAGNETIC STRUCTURES OF MnS_2, $MnSe_2$, AND $MnTe_2$
Corliss, L. M., Elliott, N., and Hastings, J. M.
***Journal of Applied Physics*, v. 29, no. 3, pp. 391–392, March 1958**

The antiferromagnetic structures were obtained by neutron diffraction. The disulphide exhibits ordering of the "third" kind, the ditelluride, ordering of the "first" kind, and the diselenide, an arrangement which is intermediate between the two. The structures are discussed from the viewpoint of indirect exchange. (*PA*, 1959, #429)

1731. MAGNETIC MOMENTS AND APPARENT MOLECULAR FIELDS IN SOME RARE EARTH METALS AND COMPOUNDS
Henry, W. E.
***Journal of Applied Physics*, v. 29, no. 3, pp. 524–525, March 1958**

A study was made of the absolute magnetization of some rare-earth metals (gadolinium and cerium) and some compounds (ytterbium oxide, neodymium oxide, erbium oxide and yttrium iron garnet) as a function of magnetic fields up to 60,000 gauss and temperature down to 1.3°K. The saturation magnetization of ferromagnetic gadolinium is 7.05 ± 0.10 Bohr magneton per atom of gadolinium and its molecular field is 1.3 megagauss. The average magnetization of cerium is only 0.17 Bohr magneton per atom of cerium even at 1.3°K and 60,000 gauss. It is ferrimagnetic with an estimated antiferromagnetic molecular field of one-half megagauss. Ytterbium sesquioxide has an antiferromagnetic molecular field of about 35,000 gauss and becomes antiferromagnetic at about 3°K in zero field. Yttrium iron garnet was studied and the saturation magnetization was determined at 100°K and in the helium range. The saturation magnetization is 0.83 at 1.3°K as compared with 1.25 Bohr magnetons per atom of iron in gamma iron (III) oxide studied previously. A ballistic method was used for measuring the magnetic moment and the calibration was made using metallic iron. (*PA*, 1958, #8911)

1732. LOW-TEMPERATURE MAGNETIC STUDIES OF URANIUM HYDRIDE, URANIUM DEUTERIDE, AND URANIUM DIOXIDE
Henry, W. E.
***The Physical Review*, v. 109, no. 6, pp. 1976–1980, March 15, 1958**

A study of magnetization as a function of temperature and magnetic field was carried out for the above compounds at temperatures from 300°K to 1.3°K and in magnetic fields from 60,000 gauss down to zero field. The apparent saturation magnetization for the samples of beta-uranium hydride used is 1.18 ± 0.03 Bohr magnetons per atom of uranium and for one sample of uranium deuteride is 0.98 ± 0.03 Bohr magneton per atom of uranium. The magnetic moment of uranium dioxide, limited by what may be antiferromagnetic ordering, is about 0.025 Bohr magneton per atom of uranium at 35,000 gauss and 1.3°K. This result makes possible corrections for the moments of UH_3 and UD_3 on the basis of a known oxygen content or an estimate of the oxide impurity on the basis of apparent saturation. A high zero-field remanent magnetization (over 50% of the saturation magnetization for a spherical sample) is observed, attesting to the pronounced magnetic hardness of beta-uranium hydride. Analytic expressions have been worked out for magnetization as a function of temperature for zero magnetic field and 11,500 gauss, leading to a paramagnetic θ of 180°K and a ferromagnetic θ of 168°K. An estimate of 2×10^6 gauss is made for the molecular field in UO_2. (*PA*, 1958, #3229)

1733. THE MAGNETOCALORIC EFFECT OF MnAs
Meyer, A. J. P. and Taglang, P.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 246, no. 12, pp. 1820–1822, March 24, 1958 (in French)**

The curve relating ΔT with temperature shows a sharp minimum at 35°C, followed by a change in sign to positive values, and a further sudden decrease at 126°C back to negative values. The first temperature corresponds to a polymorphic transition from ferro- to antiferromagnetism, the second to the Néel. (*PA*, 1958, #4131)

1734. NEW MAGNETIC COMPOUNDS OF THE ILMENITE-TYPE STRUCTURE
Swoboda, T. J., Toole, R. C., and Vaughan, J. D.
***Journal of Physics and Chemistry of Solids*, v. 5, no. 4, pp. 293–298, 1958**

Two new ferromagnetic oxides, $CoMnO_3$ and $NiMnO_3$,

have been synthesized by reacting the appropriate binary oxides under hydrothermal conditions. These compounds have rhombohedral, ilmenite-type crystal structures, i.e. they are isomorphous with $FeTiO_3$ and are believed to be the first oxides with this structure reported to be ferromagnetic. The specific moment of each oxide is of the order of 14 c.g.s. units/g at room temperature. Intrinsic coercive forces as high as 9000 oersted for $CoMnO_3$ and 1240 oersted, for $NiMnO_3$ have been observed for samples of these oxides that have been severely cold worked. The magnetic properties of $CoMnO_3$ and $NiMnO_3$ indicate that they possess high magnetocrystalline anisotropies and that their direction of easy magnetization does not lie along the principal crystallographic symmetry axis but lies probably in the basal plane. (*PA*, 1959, #8290)

1735. MAGNETIC SUSCEPTIBILITY OF SINTERED ROD OF αMnS

Lindsay, R. and Banewicz, J. J.
***The Physical Review*, v. 110, no. 3, pp. 634–637, May 1, 1958**

Measurements of magnetic susceptibility by absolute Gouy method in range 90 to 550°K; data for sintered specimen of α-MnS give Ising–Bethe constants. $J/k = -100.5$ K and $C_M = 3.57$, which fit range between 175 and 550°K. (*EI*, 1958)

1736. NEUTRON DIFFRACTION STUDY OF MAGNETIC PROPERTIES OF $MnBr_2$

Wollan, E. O., Koehler, W. C., and Wilkinson, M. K.
***The Physical Review*, v. 110, no. 3, pp. 638–646, May 1, 1958**

Single-crystal neutron diffraction measurements of antiferromagnetic structure of $MnBr_2$ at temperatures down to 1.35°K with magnetic fields up to 13 kilo-oersted applied; in absence of field, structure had hexagonal symmetry associated with formation of antiferromagnetic structure domains; magnetic ordering transition was found to be of first-order type. (*EI*, 1958)

1737. ORIGIN OF THE MAGNETIC ANISOTROPY ENERGY OF ANTIFERROMAGNETIC Cr_2O_3

Tachiki, M. and Nagamiya, T.
***Journal of the Physical Society of Japan*, v. 13, no. 5, pp. 452–455, May 1958**

The magnetic anisotropy constant of Cr_2O_3 arising from the dipolar interactions among the chromic ions is calculated to be -0.059 cm^{-1} per ion at absolute zero, and the magnetic anisotropy constant due to the crystalline field combined with the spin-orbit coupling is estimated from the fine-structure coupling constant of ruby and compared with that deduced from the antiferromagnetic resonance experiment by Dayhoff. The value from ruby is too large. The temperature dependence of the anisotropy constant and that of the antiferromagnetic resonance frequency at zero field are discussed. (*PA*, 1958, #8109)

1738. ANTIFERROMAGNETISM OF $CuF_2 \cdot 2H_2O$ AND MnF_3

Bozorth, R. M. and Nielsen, J. W.
***The Physical Review*, v. 110, no. 4, pp. 879–880, May 15, 1958**

The molar susceptibility, χ_m, of $CuF_2 \cdot 2H_2O$ was measured from $T = 1.3$ to 260°K. It is antiferromagnetic with a Néel point of $\theta_N = 26$°K. Above $T = \theta_N$ the Curie–Weiss law, $\chi_m = C_m/(T - \theta_p)$, is obeyed with $\theta_p = -37$°K and $\mu_{eff} = 1.9$. Data for MnF_3 also show antiferromagnetism with $\theta_N = 47°$, and with $C_m = 3.10$, $\theta_p = 8°$, and $\mu_{eff} = 5.0$ above the Néel point. (*PA*, 1958, #5115)

1739. MAGNETIC STRUCTURES OF MnO, FeO, CoO, AND NiO

Roth, W. L.
***The Physical Review*, v. 110, no. 6, pp. 1333–1341, June 15, 1958**

The antiferromagnetic arrangement of moments in MnO, FeO, CoO, and NiO was investigated by powder neutron diffraction. The results for the four oxides are consistent with a structure in which the magnetic moments are arrayed in ferromagnetic sheets parallel to (111) planes, and the direction of magnetization in neighboring planes is antiparallel. The observation of diffuse neutron scattering limits the precision with which the magnetization direction can be specified. If the diffuse intensity is included with the Bragg scattering, the direction of magnetization in MnO and NiO lies within the (111) plane; for CoO, the preferred direction is [117], intermediate to the (111) plane and the tetragonal axis. The magnetic axis in FeO is perpendicular to the ferromagnetic sheet. (*PA*, 1959, #444)

1740. OXIDES OF 3*d* TRANSITION METALS
Morin, F. J.
***Bell System Technical Journal*, v. 37, no. 4, pp. 1047–1084, July 1958**

Magnetic, electrical and optical properties of 3_d metal oxides are examined for clues to energy band structure; tentative energy band scheme is proposed for oxides of scandium, titanium and vanadium which suggest that nonbonding 3_d orbitals of neighboring cations overlap sufficiently to form 3_d conduction band; 3_d orbitals do not overlap in oxides of remaining 3_d metals. 47 ref. (*EI*, 1958)

1741. MULTISPIN AXIS STRUCTURES FOR ANTIFERROMAGNETS
Roth, W. L.
***The Physical Review*, v. 111, no. 3, pp. 772–781, August 1, 1958**

Neutron diffraction intensities were computed for antiferromagnetic spin arrangements in the rocksalt-type structure. If the spin directions in the unit cell occur at relative angles other than 0 or 180 deg, the neutron scattering from powder specimens does not lead to a unique solution of the spin arrangement. A unique solution can be obtained from neutron scattering by a single-domain crystal. Neutron diffraction from crystals of nickel oxide shows that in all crystals examined, either the magnetic moments were parallel to more than one direction in the crystal, or antiferromagnetic domains were present. The results can be quantitatively accounted for by assuming the crystal consisted of domains with a common magnetic axis. (*PA*, 1959, #2502)

1742. AN INTERPRETATION OF THE MAGNETIC PROPERTIES OF THE PEROVSKITE-TYPE MIXED CRYSTALS $La_{1-x}Sr_xCoO_{3-\lambda}$
Goodenough, J. B.
***Journal of Physics and Chemistry of Solids*, v. 6, no. 2–3, pp. 287–297, August 1958**

It is pointed out that trivalent cobalt with an octrahedral coordination of oxygen ions has a low-spin and a high-spin state of comparable energy. The anomalous magnetic properties of the perovskite-type mixed crystals $La_{1-x}Sr_xCoO_{3-\lambda}$ are interpreted in the light of this fact. It is assumed that the tetravalent cobalt ion is always in the low-spin state in this system. It is shown how the geometry of the perovskite-type lattice lends itself to the formation of two sublattices, each consisting of a set of (111) planes, in one of which the cobalt ions are predominantly in a high-spin state and in the other in a low-spin state. Experiments indicate that the magnetic interaction between trivalent cobalt ions in the high-spin state is antiferromagnetic, whereas the interaction between the low-spin tetravalent cobalt ions and the high-spin trivalent cobalt ions is ferromagnetic. These interactions are considered in relation to modified superexchange and the semicovalent-exchange models. The ferromagnetic $Co^{3+} - Co^{IV}$ interaction permits a sharp distinction to be made between the two, although there is always some ambiguity in qualitative models. Further, the ferromagnetic interaction can be understood without recourse to Zener's double-exchange mechanism. (*PA*, 1959, #8292)

1743. CRYSTAL STRUCTURE AND FERRIMAGNETISM IN $NiMnO_3$ AND $CoMnO_3$
Cloud, W. H.
***The Physical Review*, v. 111, no. 4, pp. 1046–1049, August 15, 1958**

X-ray diffraction studies of individual crystals of $NiMnO_3$ and $CoMnO_3$ show that these compounds have the structure of ilmenite (space group R3). The crystals have a plate-like crystal habit with the threefold symmetry axis perpendicular to the faces of the platelet. Positions of atoms within the unit cell have been determined by comparing calculated structure factors with those obtained from X-ray powder patterns. There are two Ni–O–Mn configurations that appear to be favorable to a magnetic superchange interaction, and these are sufficient to extend magnetic ordering in three dimensions. (*PA*, 1959, #3640)

1744. FERRIMAGNETIC RESONANCE IN $NiMnO_3$
Jarrett, H. S. and Waring, R. K.
***The Physical Review*, v. 111, no. 5, pp. 1223–1226, September 1, 1958**

Ferrimagnetic resonance in single crystals of hexagonal $NiMnO_3$ has shown that the magnetic anisotropy is axial and the easy direction of magnetization lies in the basal plane. The magnetic anisotropy field $2K/M$ equals 5.2×10^4 gauss, corresponding to an anisotropy energy of 2.6×10^6 ergs/cm^3. Resonance could not be observed at any orientation in single crystals of the isomorphous compound $CoMnO_3$. (*PA*, 1959, #2499)

1745. SOME OPTICAL AND MAGNETIC PROPERTIES OF IRRADIATED LiF
Bate, R. T. and Heer, C. V.
***Journal of Physics and Chemistry of Solids*, v. 7, no. 1, pp. 14–21, October 1958**

The optical oscillator strength of the F-band in LiF is determined as $f_L = 0.82$ from combined optical and magnetic measurements on X-irradiated and neutron-irradiated samples. The number of F-centers formed in LiF as a function of neutron dosage was measured over a broad range of dosage by either optical or magnetic techniques. The formation of F-centers saturates in the vicinity of 8×10^{19} centers/cm^3; and saturation occurs for neutron dosages considerably smaller than those required for saturation of vacancies and interstitials. Experimental evidence is presented to indicate that F-centers are separated by more than six lattice units in the most densely colored samples. (*PA*, 1959, #7953)

1746. X-RAY CRYSTALLOGRAPHIC INVESTIGATION OF THE THERMAL EXPANSION COEFFICIENT OF THE ANTIFERROMAGNETIC COMPOUND MnTe
Grazhdankina, N. P. and Gurfel', D. I.
***Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki*, v. 35, no. 4(10), pp. 907–910, 1958 (in Russian)**

The variation of the crystal lattice parameters of manganese telluride (MnTe) in the vicinity of the antiferromagnetic transformation point was investigated using X-ray diffraction techniques. A suggestion concerning the magnetic structure of MnTe is made on basis of the data obtained. The Néel point temperature, $T = 310°K$ was determined from the anomalous variation of the thermal expansion coefficient and an estimate of the dependence of T on omnidirectional pressure was made. (*PA*, 1959, #2265)

1747. THE ANTIFERROMAGNETISM OF $CuCl_2 \cdot 2H_2O$
Marshall, W.
***Journal of Physics and Chemistry of Solids*, v. 7, no. 2–3, pp. 159–164, November 1958**

A simple explanation is given of the unusual behavior of $CuCl_2 \cdot 2H_2O$, which has a Néel temperature of 4.33°K but a broad maximum in the magnetic susceptibility at about 4.8°K. The explanation is based upon the fact that in $CuCl_2 \cdot 2H_2O$ the strongest interaction exists only in linear chains, and hence it is not as effective in determining the long-range order as it is in determining the short-range order. (*PA*, 1959, #3649)

1748. EVIDENCE FOR ANTIFERROMAGNETISM IN $Cu_3(CO_3)_2(OH)_2$ [MINERAL AZURITE]
Spence, R. D. and Ewing, R. D.
***The Physical Review*, v. 112, no. 5, pp. 1544–1545, December 1, 1958**

Proton resonance was used to study the magnetic behavior of this mineral. Below 30°K the temperature dependence of the splitting of the proton resonance lines by the copper ions shows strong exchange effects. At 1.86°K a transition takes place and the resonance pattern below the transition indicates an antiferromagnetic state. (*PA*, 1959, #2504)

1749. ANTIFERROMAGNETISM OF $CuF_2 \cdot 2H_2O$
Verma, G. S. and Tokunaga, K.
***The Physical Review*, v. 112, no. 5, pp. 1521–1522, December 1, 1958**

The perpendicular and parallel magnetic susceptibilities were calculated on the basis of Nakamura's theory. The computed values of molar susceptibility for the same compound have been compared with the recent measurements of Bozorth and Nielsen and are found to be in good agreement. (*PA*, 1959, #2503)

1750. MAGNETIC PROPERTIES OF SPIN-FREE TRANSITION SERIES COMPLEXES
Figgis, B. N.
***Nature*, v. 182, pp. 1568–1570, December 6, 1958**

A review of the literature on the ground states of d electrons in spin-free transition series complexes together with calculations of the d^n configurations where these are not otherwise available. Ligand fields are classified as strong, medium or weak and the magnetic properties of all the d^n configurations are outlined for medium and weak fields. The information is presented graphically and is discussed in relation to the interpretation of the variation of magnetic moment with temperature. (*PA*, 1959, #3633)

1751. CRYSTALLOGRAPHIC AND MAGNETIC PROPERTIES OF SEVERAL SPINELS CONTAINING TRIVALENT MANGANESE JA-1044

Wickham, D. G. and Croft, W. J.
***Journal of Physics and Chemistry of Solids*, v. 7, no. 4, pp. 351–360, December 1958**

Many useful ferrimagnetic oxides which crystallize with the spinel structure contain several transition metals, each of which can exist in two or more possible oxidation states. A specific formulation for many such materials is very difficult. An approach to this problem, in some cases, can be made through crystallographic studies. The tetragonal distortion from cubic symmetry exhibited by several spinels containing manganese has been attributed to characteristic properties of Mn^{3+} ions occupying the octahedral positions in the lattice. Several new compositional systems containing manganese and crystallizing with the spinel structure have been prepared and studied crystallographically and magnetically. The following solid-solution systems were chosen because they appeared to present a minimum of ambiguity in composition and in the distribution of cations among tetrahedral and octahedral positions: $Zn_xGe_{1-x}Mn_2O_4$, $Zn_xGe_{1-x}Co_{2-2x}Mn_{2x}O_4$, and $Zn_xLi_{1-x}Mn_2O_4$. The tetragonal distortions from cubic symmetry observed for these systems can be accounted for by assuming that the octahedral sites are occupied by more than a critical fraction, 60–65 per cent, of Mn^{3+} ions. A complete range of solid solutions in the system $Co_{3-x}Mn_xO_4$ was prepared and formulae assigned to the basis of this rule. The configuration, for values of x between 0 and 2, appears to be $Co^{2+}[Co^{3+}_{2-x}Mn^{3+}_x]O_4$. The observed magnetic properties (saturation magnetization at 4.3°K and Curie temperatures) can be interpreted in terms of this configuration. The magnetization measured for cubic materials is the result of the Néel-type magnetic coupling between Co^{2+} ions on tetrahedral sites and Mn^{3+} ions on octahedral sites. Tetragonal materials apparently have a more complex magnetic structure. The configuration of $Co_{3-x}Mn_xO_4$ for values of x between 2 and 3 appears to be $Co^{2+}_{3-x}Mn^{2+}_{x-2}[Mn^{3+}_2]O_4$. The crystal lattice constants, saturation magnetization (4.3°K) and Curie temperatures are given for a number of materials, including $GeMn_2O_4$, $LiMn_2O_4$, Co_3O_4, $MnCo_2O_4$ and Mn_3O_4. (*PA*, 1959, #8323)

1752. AN ISOTOPE EFFECT IN ANTIFERROMAGNETISM AT LOW TEMPERATURES

Daniels, J. M.
***Canadian Journal of Physics*, v. 37, no. 1, pp. 75–77, January 1959**

It is pointed out that the antiferromagnetic properties of hydrated salts at low temperatures are greatly influenced by the isotopic composition of the paramagnetic ions. This is so because of the hyperfine coupling between unpaired electrons and the nuclear spins of paramagnetic ions may be much larger than the coupling between individual ions. For the case of $K_3InCl_6 \cdot 2H_2O$ containing Mo^{5+} as an impurity it is calculated by a second-order perturbation method that the anisotropy field at absolute zero is 160 g larger for the odd molybdenum isotopes than for the even ones. For the case of $Sm(C_2H_5SO_4)_3 \cdot 9H_2O$ the hyperfine interaction of the odd isotopes of samarium is estimated to be the dominant feature of the antiferromagnetic state. The examples quoted have isotropic g-factors and are thus not representative of magnetic substances generally. Significant differences in antiferromagnetic properties in materials containing different isotopes are also predicted for the general case. (*PA*, 1959, #8324)

1753. INTERPRETATION OF THE LAW OF MAGNETIZATION OF THE ION Yb^{+++} IN THE GARNET-TYPE GALLATE

Ayant, Y. and Thomas, J.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 248, no. 3, pp. 387–389, January 19, 1959 (in French)**

The spin Hamiltonian for the ion in a cubic field is diagonalized and the magnetization at low temperatures calculated from a consideration of the two lowest energy levels. The calculated variation of the magnetization with H/T is in good agreement with observation. (*PA*, 1959, #7151)

1754. SOME COMMENTS ON THE ANOMALOUS MAGNETIC BEHAVIOR OF CERTAIN Ni(II) COMPLEXES

Ballhausen, C. J. and Liehr, A. D.
***Journal of the American Chemical Society*, v. 81, no. 3, pp. 538–542, February 5, 1959**

The magnetic and spectral properties of tetra-coordinated Ni(II) complexes are discussed in the light of the modern theory of ligand fields. It is pointed out that for such Ni(II) complexes there exist both strong experimental evidence and convincing theoretical arguments against: (a) the existence of dsp^2 bonding, and (b) the existence in solutions and melts of planar-tetrahedral conformational equilibria. Equations governing the magnetic susceptibility of partially paramagnetic planar Ni(II) systems are derived and their usefulness in determining the singlet-triplet energy separation is underlined. Some conjectures concerning the nature of the famous Lifschitz salts of nickel are presented and an interesting analogy between these compounds and the recently characterized copper alkanoates is noted. (*PA*, 1959, #3632)

1755. MAGNETIC SUSCEPTIBILITY OF MANGANESE SESQUIOXIDE AT TEMPERATURES FROM 4 TO 700°K
Meisenheimer, R. G. and Cook, D. L.
***Journal of Chemical Physics*, v. 30, no. 2, pp. 605–606, February 1959**

Manganese sesquioxide is shown to be an antiferromagnetic material with a Curie point of about 80°K, following the Curie–Weiss law above 300°K. Results are briefly compared with previously recorded data. (*PA*, 1959, #7172)

1756. MAGNETIC PROPERTIES OF THE SYSTEM $Ni_{(1-x)}Li_xO$ BETWEEN 80 AND 300°K
Perakis, N., Wucher, J., and Parravano, G.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 248, no. 16, pp. 2306–2308, April 20, 1959 (in French)**

Measurements on materials of composition $x = 0.2$ and 0.3 showed that below 230–250°K the susceptibility depends on the magnetic field strength and increases rapidly with decreasing temperature, except for an inflection at ~95°K. Results depend on the history of the specimen. Ferrimagnetism apparently increases as x increases from 0 to 0.5, and not merely over the range $x = 0.3$ to 0.5, as previously found. (*PA*, 1959, #8285)

1757. NEUTRON DIFFRACTION INVESTIGATIONS OF MAGNETIC PHENOMENA IN CRYSTALLINE COMPOUNDS
Wilkinson, M. K.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 278S–279S, April 1959**

A summary is presented of a paper which discussed neutron diffraction applications and illustrated recent techniques with investigations on anhydrous dibromides and dichlorides of Fe, Co, and Mn.

1758. SYMMETRY OF MAGNETIC STRUCTURES
Corliss, L. M. and Hastings, J. M.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) p. 279S, April 1959**

A brief account is given of work done at Brookhaven National Laboratory on space group methods of magnetic structure studies. The method has been applied to $CuFeS_2$ and to CrN; however, the work is only mentioned in the Journal Supplement.

VIII. MAGNETIC PROPERTIES OF NON-METALLIC MATERIALS

1759. INTERACTION OF TWO CONSTITUENTS IN FERROMAGNETIC MATERIALS SHOWING REVERSE THERMO-REMANENT MAGNETISM
Nagata, T. and Uyeda, S.
Letter in *Nature*, v. 175, pp. 35–36, January 1, 1955

A continuation of earlier work on the magnetic properties of igneous rocks. The reversal phenomenon is believed to be due to the effect of the intimate interaction of the two ferromagnetic constituents A and B having different Curie points. For the Haruna dacites the two constituents are found in fact to interpenetrate closely, the interpenetrating particles being in the form of narrow, probably single domain strips. For dacites from Asio and Towada the thermo-remanent magnetization is not reverse and the interaction between constituents is weaker. (*PA*, 1955, #3884)

1760. OSCILLATORY HALL EFFECT, MAGNETORESISTANCE AND MAGNETIC SUSCEPTIBILITY OF A GRAPHITE SINGLE CRYSTAL
Berlincourt, T. G. and Steele, M. C.
***The Physical Review*, v. 98, no. 4, pp. 956–961, May 15, 1955**

The Hall coefficient, magnetoresistance, and magnetic susceptibility of a graphite single crystal have been measured at liquid helium temperatures and in magnetic fields up to 25 kilogauss. All three phenomena are periodic functions of reciprocal field and exhibit the same period for like orientations of the crystal axes with respect to the magnetic field. The phases, however, are different. Where possible, experiment and theory have been compared. (*PA*, 1955, #7191)

1761. MAGNETIC SUSCEPTIBILITY AND FREE ENERGY OF GRAPHITE BROMIDE
Henning, G. R. and McClelland, J. D.
***Journal of Chemical Physics*, v. 23, no. 8, pp. 1431–1435, August 1955**

The magnetic susceptibility of graphite bromide residue compounds has been measured by a Faraday method. The addition of bromine decreased the diamagnetism of graphite. Fair agreement was obtained between the measured diamagnetism and values calculated by assuming an undistorted graphite band structure depleted in electrons due to the dissociation and ionization of two out of eleven bromine molecules. It has also been shown that the transfer of electrons from the graphite bands to bromine can account for the observed pressure dependence of the graphite bromine equilibrium. (*PA*, 1955, #8917)

1762. THEORY OF THE MAGNETIC SUSCEPTIBILITY OF GRAPHITE
Hove, J. E.
***The Physical Review*, v. 100, no. 2, pp. 645–649, October 15, 1955**

The theory of the magnetic susceptibility of graphite is presented in terms of a three-dimensional Wallace electron energy-band structure. The experimentally observed variation with temperature is explained in a satisfactory manner, provided the interplane resonance integral occurring in the band approximation is given a value of about 0.5 ev. This is about five times larger than the previously used estimate and implies that a two-dimensional band approximation may be invalid in many cases. The in-plane resonance integral is obtained by fitting the variation, with electron concentration, of the electrical resistivity of a graphite–bisulphate residue compound. In this way a value of 1.63 ev for this integral is obtained. It might be noted that these values enabled a better fit of the resistivity over the entire range of bisulphatization than could be obtained by a two-dimensional theory. On the other hand, the value thus obtained for the actual magnitude of the susceptibility is lower than that observed by a factor of about 40. The (room-temperature) variation of the susceptibility of bromine graphite is then analyzed on the basis of the above theory, using the indicated values of the constants. In this way, a value is obtained for the percentage of the bromine which is ionized. This is found to be weakly dependent on the amount of bromine, varying between 18% at 0.3 atomic percent bromine to 13% at 0.8 atomic percent bromine. The experimental value has been found to vary slightly around 18%. This agreement is very good and indicates that the theory is valid in explaining relative variations of the susceptibility, even though there is difficulty in predicting the absolute magnitude. The latter is the only serious discrepancy found in the present work and has not yet been explained. (*PA*, 1956, #1358)

1763. FLEXIBLE FERROMAGNETIC PLASTICS MATERIALS
Davis, W. J.
***Electrical Manufacturing*, v. 57, no. 3, pp. 131–133, March 1956**

Flexible form permits maximum utilization of inherent magnetic properties of these materials and thus design of highly efficient components, including delay lines, transformers, inductors, and electromagnetic shielding; properties and applications reviewed and rigid core formulations discussed. (*EI*, 1956)

1764. MAGNETIC SUSCEPTIBILITY OF CARBONS AND POLYCRYSTALLINE GRAPHITES. II
Pinnick, H. T. and Kiive, P.
***The Physical Review*, v. 102, no. 1, pp. 58–64, April 1, 1956**

The change in magnetic susceptibility of carbons of varying crystallite sizes resulting from a shift of the Fermi level has been studied by investigating residue compounds of carbons with bisulphate ions. The susceptibility decreases monotonically with the concentration of the ions and the relative decrease is progressively larger for larger crystallites. As a result, instead of the plateau

in susceptibility in the case of untreated carbons extending from diameters of 150 Å to sizes greater than 1500 Å, one finds a maximum in susceptibility at about 200 Å diameter for carbons with a finite (not too small) ion concentration. The temperature dependence of susceptibility for both untreated carbons and residue compounds has also been studied over the temperature range from 80°K to 1300°K. The susceptibilities of the untreated carbons all decrease at higher temperatures and tend towards a temperature-independent limit at low temperatures. For small crystallites, the rapid decrease begins at higher ambient temperature, and the low-temperature limit is smaller. The plateau in susceptibility as a function of crystallite size is present for all ambient temperatures, but the beginning of the plateau shifts somewhat to smaller crystallite size for higher ambient temperatures. A qualitative discussion is given which leads to the conclusion that the Landau-Peierls theory is inadequate to explain all the experimental findings if the simplified band model deduced from other electronic properties of carbon is used.(*PA*, 1956, #3840)

1765. ERHOEHUNG DES SCHMELZPUNKTES FESTER KOERPER IN MAGNETISCHEN KRAEFTEFELD
Meincke, H.
***Schweitzer Archiv*, v. 22, no. 5, pp. 163–168, May 1956**

Increase of melting point of solids in magnetic field; if distance between electrodes is so short that point of cathode projects into anode flame, growth of carbon mushroom at cathode occurs; explanation given of formation of graphite mushrooms in carbon arc at about 6000 °K under oxygen cover; crystals obtained in process have increased diamagnetism. (*EI*, 1956)

1766. MAGNETIC SUSCEPTIBILITY OF NEUTRON-DAMAGED GRAPHITE
Hove, J. E. and McClelland, J. D.
***Journal of Chemical Physics*, v. 26, no. 5, pp. 1028–1030, May 1957**

Previous work on the magnetic susceptibility of graphite as it is affected by temperature and bromination is extended to include effects of neutron irradiation at about room temperature. Data taken at both room temperature and liquid nitrogen temperature are analyzed and yield consistent values for the number of electrons trapped out by damage effects, thus further establishing the validity of the theory. The trapping rate of electrons, with neutron exposure, is found to be slightly nonlinear and a fair fit of the empirical curve is: Number of trapped electrons per carbon atom $= 1.4 \times 10^{-4} t^{2/3}$ where t is the flux. This two-thirds power dependence cannot be taken too literally, since neither the quantity nor quality of the data is sufficiently good. Data are also given for the buildup of paramagnetic centres as damage increases. (*PA*, 1957, #7223)

1767. MAGNETIC SUSCEPTIBILITY OF NEUTRON-IRRADIATED QUARTZ
Stevens, D. K., Sturm, W. J., and Silsbee, R. H.
***Journal of Applied Physics*, v. 29, no. 1, pp. 66–68, January 1958**

Measurements are reported of the magnetic susceptibility of neutron irradiated quartz as a function of irradiation time. The results are interpreted in terms of the density of centers produced by the irradiation and are compared with optical and X-ray studies of neutron damaged quartz.

IX. THE USE OF MAGNETIC MATERIALS IN INSTRUMENTATION

A. Films, Thin Layers, Particles, Whiskers and Wires

1768. COMPARISON OF METALS AND FERRITES FOR HIGH-SPEED PULSE OPERATION
Brown, D. R., Buck, D. A., and Menyuk, N.
***Transactions of the American Institute of Electrical Engineers*, v. 73, Part 1, no. 16, pp. 631–635, January 1955**

Use of metals and ferrites with rectangular hysteresis loops in magnetic amplifiers, switching networks, and data storage systems; relative merits of metals and ferrites

indicate that ultra-thin metal ribbon cores are better for stepping registers and switching circuits; ferrite cores are better for coincident current memories. (*EI*, 1955)

1769. MAGNETIC MATERIALS FOR DIGITAL COMPUTER COMPONENTS—2. MAGNETIC CHARACTERISTICS OF ULTRA-THIN MOLYBDENUM-PERMALLOY CORES
Menyuk, N.
***Journal of Applied Physics*, v. 26, no. 6, pp. 692–697, June 1955**

Measurements of flux reversal time as function of applied magnetic field for ⅛, ¼, ½ and 1-mil 4–79 molybdenum-permalloy tape cores from − 196 to 270°C; from these measurements, switching coefficient is found permitting separation of spin relaxation and eddy-current contributions to switching delay; these studied individually vs temperature. (*EI*, 1955)

1770. REMANENCE CURVE OF SINGLE-DOMAIN FERROMAGNETIC PARTICLES. APPLICATION TO THE COATINGS OF SOUND-RECORDING TAPES
Wohlfarth, E. P.
***Research Correspondence*, v. 8, no. 8, pp. S42–S44, August 1955**

Gives results of calculations of a curve relating the reduced remanent magnetization I_R/I_0 with a reduced field for an assembly of randomly orientated particles having uniaxial anisotropy. Application is made to γ-Fe_2O_3 powders used as tape coatings, using the data given by Osmond. (*PA*, 1955, #8896)

1771. RESEARCH AND DEVELOPMENT ON MAGNETIC FILMS (Period covered: May 16–August 31, 1955)
Doherty, J. T.
Servomechanisms, Inc., Western Division, El Segundo, Calif.
AF 33(616)-3039, Scientific R-1, August 1955 (ASTIA AD-70,990)

1772. FERROMAGNETIC COMPUTER CORES
Devenny, C. F., Jr. and Thompson, L. G.
***Tele-Tech & Electronic Industries*, v. 14, no. 9, pp. 58–59, 84, 86, 88, 90, 92, 94, September 1955**

Application of magnetic cores or BIMAG elements to complex data processing systems, based on work at Burroughs Research Center; rectangular hysteresis-loop ferromagnetic core characteristics which pertain to 4–79 permalloy and 48% Ni–Fe alloy metal tape cores consisting of number of wraps of ⅛ to 1 mil thick metal tape wound on ceramic bobbin. (*EI*, 1956)

1773. MAGNETIC WRITING ON THIN FILMS OF MnBi
Williams, H. J., Sherwood, R. C., Foster, F. G., and Kelley, E. M.
***Journal of Applied Physics*, v. 28, no. 10, pp. 1181–1184, October 1957**

A study was made of the domain structure of thin films (~ 1000Å) of MnBi and their capability of storing information magnetically. It is estimated that a million bits of information could be written on 1 cm^2 of film. The information can be read out optically by utilizing the Faraday effect. The films have a uniaxial direction of easy magnetization normal to their surfaces and retain their magnetization after saturation along this direction in spite of the large demagnetizing factor. When magnetized in this manner, a high optical contrast is obtained between the writing and the background. (*PA*, 1958, #8126)

1774. TRAPPED-FLUX SUPERCONDUCTING MEMORY
Crowe, J. W.
***I.B.M. Journal of Research and Development*, v. 1, no. 4, pp. 295–303, October 1957**

Electronic computer memory cell based on action of trapped flux in superconductors; operating characteristics for fast and slow rise times of driving current; switching speeds are about 0.01 μsec, 100 times faster than ferrite core memories; cell is constructed by evaporation of lead film on insulating substrate; structural detail. (*EI*, 1957)

1775. ANALYSIS OF OPERATION OF PERSISTENT-SUPERCURRENT MEMORY CELL
Garwin, R. L.
***I.B.M. Journal of Research and Development*, v. 1, no. 4, pp. 304–308, October 1957**

Theoretical model for thin-film persistent-supercurrent memory cell for isothermal operation; for single cell, memory cycle time of 5 mμsec is shown possible; time variation of loop current for various drive pulses is derived. (*EI*, 1958)

1776. SOLID-STATE RESEARCH
Massachusetts Institute of Technology, Lincoln Lab., Lexington, Groups 24, 35, 37, 63, and 310
AF 19(122)-458, QPR, November 1, 1957
(ASTIA AD-110,024)

Following projects are being investigated: semiconductor device design; chemistry of germanium, indium, gallium; metallurgy of germanium, gallium antimonide, indium antimonide; band structure of solids; microwave and ferrite applications; microwave and magnetic properties of matter (solid-state maser and ferromagnetic resonance); inorganic chemistry and crystallography of magnetic materials; thin magnetic films; transistors; and memory display panels. This is one of a series of reports.

1777. DESIGN ADVANCES FROM MAGNETISM RESEARCH
Arrott, W.
***Electrical Manufacturing*, v. 61, no. 1, pp. 86–100, 274, January 1958**

Recent developments in soft magnetic alloys for power applications, permanent magnetic design, thin magnetic films and other elements for computer memory devices; ferrites, garnets, microwave techniques and magneto-optics. Abstracts of papers at AIEE Conference on "Magnetism and Magnetic Materials," November 18–21, 1957 in Washington, D. C. (*EI*, 1958)

1778. MAGNETIC DIGITAL TECHNIQUES, REPORT ON A GENERAL RESEARCH PROJECT–1957
Scarbrough, A. D. and Nyberg, J. J.
Ramo-Wooldridge Corp., Los Angeles, Calif., Digital Control Dept.,
General Research Program-E, January 15, 1958

The general research program during 1957 which has been a basic study of the problems of storing and processing information by the use of magnetic techniques, is reviewed. Particular attention has been paid to the problems arising from the environmental conditions typical of airborne applications, including shock, vibration, and wide temperature range. This paper reports progress on the investigations of digital circuits using ferrite memory cores and thin films.

1779. MOTION PICTURES OF MAGNETIC WRITING ON THIN FILMS OF MnBi
Williams, H. J. and Sherwood, R. C.
***Journal of Applied Physics*, v. 29, no. 3, p. 296, March 1958**

1780. NEW CONCEPT IN LARGE-SIZE MEMORY ARRAYS–THE TWISTOR
Bobeck, A. H.
***Journal of Applied Physics*, v. 29, no. 3, pp 485–486, March 1958**

Three methods have been developed for storing information in a coincident-current manner on magnetic wire. The resulting memory cells have been collectively named the "twistor." Two of these methods utilize the strain sensitivity of magnetic materials and are based on the century-old Wertheim or Wiedemann effects; the third utilizes the favorable geometry of a wire.

The effect of an applied torsion on a magnetic wire is to shift the preferred direction of magnetization into a helical path inclined at an angle of 45 deg with respect to the axis. The coincidence of a circular and longitudinal magnetic field inserts information into this wire in the form of a polarized helical magnetization. In addition, the magnetic wire itself may be used as a sensing means with resultant favorable increase in available signal since the lines of flux wrap the magnetic wire many times.

An experimental transistor-driven 320-bit twistor array has been built. The possibility of applying weaving techniques to future arrays makes the twistor approach appear economically attractive.

1781. ORIENTATION STUDY OF ULTRA-THIN MOLYBDENUM PERMALLOY TAPE
Koh, P. K.
***Journal of Applied Physics*, v. 29, no. 4, pp. 636–657, April 1958**

As square loop material, ultra-thin submil molybdenum permalloy tape is most important for switch core and coincident-current memory applications for binary circuits and for complex digital computer components; quantitative pole density stereograms of 111, 220, 200, and 113 poles of ⅛ mil molybdenum permalloy tape were developed in order to establish its cold rolled deformation and annealed textures. (*EI*, 1958)

1782. NONDESTRUCTIVE MEMORY EMPLOYING A DOMAIN ORIENTED STEEL WIRE
Gianola, U. F.
***Journal of Applied Physics*, v. 29, no. 5, pp. 849–853, May 1958**

A magnetic memory can be interrogated nondestructively by applying a perturbing field normal to the direction of remanent magnetization, and, at the same time, observing the sign of the reversible flux change. However, there may be a considerable irreversible flux change during the first few interrogations following magnetization. This irreversible component can be reduced by introducing magnetic anisotropy in a direction parallel to the direction of magnetization which is used to store binary information. The characteristics of the ideal memory are analyzed by means of domain theory. In an experimental memory a steel wire under tension was used for the memory material. A small solenoid was used to magnetize the wire locally and also to observe the flux change which was produced by an interrogative current pulsed through the wire itself. The general predictions of the theory were confirmed by experiment. Interrogation is nondestructive and is completed in less than 1 μsec. The output is proportional to the square of the wire current, and discrimination is a matter of observing its polarity. A single bit can be written into a memory array by a coincidence of a wire current and a solenoid current. The wire current can be the same as that used for interrogation. A number of bits can be carried on one wire and interrogated simultaneously. The factors affecting the design of a memory array are discussed.

1783. CURIE-POINT WRITING ON MAGNETIC FILMS
Mayer, L.
***Journal of Applied Physics*, v. 29, no. 6, p. 1003, June 1958**

1784. A MEMORY PLANE TEST UNIT FOR NIKE–ZEUS PERMANENT STORE TWISTOR MEMORIES
Pratt, W. R.
Bell Telephone Laboratories, Inc., New York, N. Y.
MM-58-4434-10, August 23, 1958

This memorandum presents a memory test set design which will test 32 word (24 bits per word) permanent twistor memory planes. Block, logic, and timing diagrams are included.

1785. MAGNETIC WRITING WITH AN ELECTRON BEAM
Mayer, L.
***Journal of Applied Physics*, v. 29, no. 10, pp. 1454–1456, October 1958**

Experimental evidence is presented that magnetic writing with an electron beam is possible. The method is based on Curie-point writing which permits local reversal of the direction of magnetization in suitable premagnetized magnetic films by temporarily elevating the temperature above the Curie point. By utilizing the dissipation energy of a focused electron beam for this purpose, quite well-defined traces of reversed magnetization could be recorded on MnBi films. The traces were erasable magnetically. Writing speeds corresponding to $3 \cdot 10^4$ bits/sec and information densities corresponding to 10^5 bits/cm^2 could be achieved in these first experiments. Considerably higher writing speeds and some increase in information density should be feasible.

By means of an electron mirror micrograph of the electronically recorded magnetic trace, evidence is presented which shows that, in addition to read-in with an electron beam, electronic read-out of the magnetically stored information is also possible.

Electronic writing of magnetic half-tone images by controlling the size of the spots of reversed magnetization appears to be feasible also.

1786. DIE MAGNETISCHEN EIGENSCHAFTEN DUENNER SCHICHTEN
Mayer, H.
***Metalloberflaeche*, v. 12, no. 9, pp. 257–262, September 1958 (see also English abstract in *Engineers' Digest*, v. 19, no. 11, pp. 487–489, November 1958)**

Magnetic properties of thin layers: ferromagnetic properties show increasing and very characteristic changes, as thickness of layer is diminished below critical point, and in certain cases, can disappear altogether; application of such thin magnetic layers in electronic computers given as example. (*EI*, 1958)

1787. "TWISTOR" SHIFT REGISTER
***Electromechanical Design*, v. 3, no. 1, p. 8, January 1959**

A reversible, diodeless shift register using a single magnetic wire as the memory—which stores pulses when subjected to a magnetizing field—will be cheaper to build than conventional shift registers. (*C and A*, 1959)

1788. MILLIMICROSECOND MAGNETIC GATING AND STORAGE ELEMENT
Meier, D. A.
***Journal of Applied Physics*, v. 30, pp. 122–123, January 1959**

A round glass rod is chemically plated with Ag, and then electrodeposited with Fe–Ni film. The element has an almost square saturation loop.

1789. MEMORY STUDY AND DEVELOPMENT PROGRAM ECPX 0005 FINAL REPORT
International Business Machines Corp., New York, N.Y., February 1, 1959

Research is reported in the following areas: evaporated metal film memory development; utilization of thin magnetic films as memory elements; cryogenic evaluation; and surveillance and liaison program.

1790. MICROWAVE RESONANCE IN THIN MAGNETIC FILMS
Tannenvald, P. E. and Seavey, M. H., Jr.
***Journal de physique et le Radium*, v. 20, p. 323, 1959**

1791. SUMMARIZED PROCEEDINGS OF A CONFERENCE ON SOLID-STATE MEMORY AND SWITCHING DEVICES–LONDON, SEPTEMBER 1958
***British Journal of Applied Physics*, v. 10, pp. 153–158, April 1959**

Thin magnetic films are included.

1792. PARAMETRIC EXCITATION IN PERMALLOY FILMS
Soohoo, R. F.
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
Solid State Quarterly Progress Report, April 15, 1959

1793. OPERATING CHARACTERISTICS OF A THIN FILM MEMORY
Raffel, J. I.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 60S–61S, April 1959**

An experimental prototype memory with 32 ten-bit words has been designed, built and tested. Circular spots 1/16 in. in diameter and about 600Å thick are used. These are evaporated on two pieces of glass each comprising a 16 × 16 spot array. Extension to sizes of the order of 1000 words is planned using these techniques.

1794. COINCIDENT-CURRENT NONDESTRUCTIVE READOUT FROM THIN MAGNETIC FILMS
Oakland, L. J. and Rossing, T. D.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 54S–55S, April 1959**

By using cores which consist of two vacuum-deposited ferromagnetic films, it is possible to build memory arrays from which data can be read out nondestructively by use of coincident-current selection. Three different devices are described; good signal to noise has been achieved with each of these.

1795. MILLIMICROSECOND MAGNETIC SWITCHING AND STORAGE ELEMENT
Meier, D. A.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 45S–46S, April 1959**

The magnetic element used for performing the logical switching and storage functions consists of a silver-coated glass rod upon which is electroplated a Fe–Ni alloy several thousand angstroms thick. Use of the magnetic rod in a coincident-current memory, and as a multi-input logical switch, is detailed.

1796. REVERSIBLE, DIODELESS, TWISTOR SHIFT REGISTER
Bobeck, A. H. and Fischer, R. F.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 43S–44S, April 1959**

The design uses interaction effects which exist between magnetized regions on a magnetic wire. A single magnetic wire is required for a complete register. Information is stored as magnetically polarized zones which can be moved along the wire by a five-phase pulse source. A several hundred kilocycle bit rate should be possible.

1797. RECENT ADVANCES IN MAGNETIC DEVICES FOR COMPUTERS
Looney, D. H.
***Journal of Applied Physics*, v. 30, no. 4 (Supplement) pp. 38S–42S, April 1959**

Some of the newer magnetic elements which may replace ferrite toroids in memory matrices are ferrites in sheets and multiaperture devices, and ferromagnetic materials in the form of thin films and wrapped wire.

1798. THIN MAGNETIC FILMS FOR DIGITAL COMPUTER MEMORIES
Smith, D. O.
***Electronics*, v. 32, no. 26, p. 44, June 26, 1959**

Tiny dots consisting of magnetic alloys can be deposited on planes and cylinders in the hardware of the computer, providing for high speed memories with large capacities. The tiny magnetic films can also be manufactured economically. Two tables are given, the first showing present and probable properties of ferrite cores and planar magnetic films, the second, a comparison of planar and cylindrical magnetic films. (*C and A*, 1958)

1799. INFORMATION PROCESSING QUARTERLY PROGRESS REPORT
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington
AF 19(604)-5200, AFCRC TN-59-1009, June 15, 1959

The TX-2 computer, a high-speed, large-memory, flexible machine with unique input-output features has begun to see some experimental use. A magnetic thin-film memory has been operating successfully in the Laboratory and will be tested further as a functional element of TX-2. The psychology of man-machine communication is also discussed. This is one of a series of reports.

1800. FIRST SUCCESSFUL OPERATION OF A PRACTICAL MAGNETIC FILM MEMORY
Kessler, J. A.
***Computers and Automation*, v. 8, no. 10, pp. 1, 6, October 1959**

1801. DEPOSITED MAGNETIC FILMS AS LOGIC ELEMENTS
Frank, A., Marette, G., and Parsegyan, B. (Remington Rand Univac, St. Paul, Minn.) 1959

Paper presented at the Eastern Joint Computer Conference, Boston, Massachusetts, December 1–3, 1959.

1802. MOLECULAR SCIENCE AND ENGINEERING
von Hippel, A.
Technology Press and John Wiley and Sons, New York, N. Y., 1959
("Thin Films for Digital Computers", by D. O. Smith, appears as Chapter 20, Part 2.)

(See also references: 1804, 1807, 1809, 1812, 1820, 1823, 1825, 1828, 1829, 1836, 1846, 1848, 1852, 1868, 1869, 1870, 1873, 1881, 1889, 1890, 1891, 1892, 1893, 1894, 1896, 1910, 1914, and 1915.)

B. General

1803. RADIO-FREQUENCY NONDESTRUCTIVE READOUT FOR MAGNETIC-CORE MEMORIES
Widrow, B.
***IRE Transactions of Professional Group on Electronic Computers*, v. EC-3, no. 4, pp. 12–15, December 1954**

Method of reading information nondestructively from two- and three-dimensional magnetic core digital computer memories in several microseconds by exciting selected cores with r.f. currents; method of generating beat frequency signal whose phase may take on two values corresponding to 0 and 1 information states of core. (*EI*, 1955)

1804. CALCULATION OF MAGNETIC FIELD IN FERROMAGNETIC LAYER OF MAGNETIC DRUM
Karlqvist, O.
***Tekniska Hogskolans—Handlingau (Transactions of the Royal Institute of Technology, Stockholm)* No. 86, 1954**

Reference made to magnetic drum used to store information coming from electronic computer or telephone dial; study of variation of field with permeability, airgap, layer thickness and other factors; layer is assumed to be spinel material for which permeability is low; results enabling analysis of field effects from permeability and geometric shape of recording head. (*EI*, 1955)

1805. MAGNETIC MATERIALS FOR DIGITAL-COMPUTER COMPONENTS—I. A THEORY OF FLUX REVERSAL IN POLYCRYSTALLINE FERROMAGNETICS
Menyuk, N. and Goodenough, J. B.
***Journal of Applied Physics*, v. 26, no. 1, pp. 8–18, January 1955**

Proposal that magnetization reversal in ferro- and ferri-magnetic materials is primarily due to nucleation and growth of 180-deg Bloch walls; origin of domains of reverse magnetization; growth is determined by study of elastic and frictional forces which retard motion of their 180-deg Bloch wall boundaries; model explains output voltage wave. (*EI*, 1955)

1806. IMPUL'SNOE PEREMAGNICHIVANIE SERDECHNIKOV S PRYRAMOUGOL'NOY PETLEY GISTEREZISA
Rozenblat, M. A.
***Elektrichestvo*, no. 1, pp. 24–28, January 1955**

Impulsive remagnetization of ferromagnetic cores with rectangular hysteresis loops; applicability in connection with relays for remote control or automatic control installation. (*EI*, 1955)

1807. RECORDING DATA ON MAGNETIC TAPE
Fisher, L. L.
***Radio and Electronic Engineering*, v. 24, no. 3, pp. 18–20, 37–38, March 1955**

For digital computers, magnetic tape provides auxiliary high capacity low access time memory, permitting storage of tables, subroutines and programming; for analog computers, magnetic tape recording can be used as function storage device and for other purposes; how multiplexing techniques are utilized in recording large amounts of digital and analog data with minimum of tape; merits of various pulse systems. (*EI*, 1955)

1808. LOGICAL AND CONTROL FUNCTIONS PERFORMED WITH MAGNETIC CORES
Guterman, S., Kodis, R. D., and Ruhman, S.
***Proceedings of the IRE*, v. 43, no. 3, pp. 291–298, March 1955**

Application to digital computers of magnetic core having square hysteresis loop; technique for performing logical functions is based upon "single line" shift register; method utilizes inherent storage and amplification capabilities of cores to make possible an all-core-manipulative organ; vacuum tubes are only used for shift pulse sources. (*EI*, 1955)

1809. NEW FERRITE-CORE MEMORY USES PULSE TRANSFORMERS
Papian, W. N.
***Electronics*, v. 28, no. 3, pp. 194–197, March 1955**

Arrangement for high speed parallel electronic digital computers which require large memories allowing rapid access to registers; use of ferrite "doughnuts" only 80 mils OD to store coded information in $64 \times 64 \times 17$ magnetic core memory; improved circuit techniques which give increased capacity while employing considerably fewer tube cathodes; balanced linear pulse transformers step up memory signal. (*EI*, 1955)

1810. HIGH-SPEED PERMANENT STORAGE DEVICE
Wier, J. M.
***IRE Transactions on Electronic Computers*, v. EC-4, no. 1, pp. 16–20, March 1955**

Device utilizes large magnetic core matrix switch, of type described by Rajchman, in conjunction with storage system used with Bell Computer, Model VI, to obtain permanent storage capacities up to about one million bits. (*EI*, 1955)

1811. "MEMORY" SYSTEMS IN ELECTRONIC COMPUTERS
Coombs, A. W. H.
***Communications and Electronics*, London, v. 2, no. 3, pp. 60–64, March 1955**

Main features of analog and digital computers and requirements of latter as to data storage; essentials of storage devices and distinctions between different types such as "muttering" systems, "delay line" stores, magnetostriction and electric delay lines, "scribbling" systems and filing systems. (*EI*, 1955)

1812. MULTIPLE COINCIDENT MAGNETIC STORAGE SYSTEMS

Minnick, R. C. and Ashenhurst, R. L.
***Journal of Applied Physics*, v. 26, no. 5, pp. 575–579, May 1955**

In existing magnetic matrix storage systems given location is selected by applying to two intersecting wires current equivalent to one half of selecting field; this situation is generalized so that any core is selected by energizing p wires each with current equivalent to I/p of selecting field; advantages gained; storage matrix in which cores are toroids etched from continuous magnetic sheet. (*EI*, 1955)

1813. "MNEMOTRON" MEMORY IS NOW IN OPERATION

***Midwest Engineer*, v. 8, no. 1, pp. 7–9, June 1955**

Features of ferrite core memory installed in RAND Corp. electronic computer; memory consists of 170,000 ferrite cores and associated circuits; information stored will remain stored permanently if desired; finding stored item takes 8 millionths of sec; speed of unit is approximately 70,000 words per sec; other characteristics, and mode of operation. (*EI*, 1955)

1814. TRANSISTOR DIGITAL FAST MULTIPLIER WITH MAGNETOSTRICTIVE STORAGE

Chaplin, G. B., Hayes, R. E., and Owens, A. R.
***Proceedings of the Institution of Electrical Engineers*, v. 102, Part B *(Radio and Electronic Engineering)*, no. 4, pp. 412–425, July 1955**

Multiplier uses transistors throughout; operating at basic frequency of 125 kc, multiplier computes product of two 32-digit serial numbers in about 4 ms; digits of multiplier are taken in pairs instead of singly; it is concluded that transistors at present available are well suited to computer circuits. (*EI*, 1955)

1815. SYNCHRONIZING MAGNETIC DRUM STORAGE SPEED

Bivans, E. W.
***Electronics*, v. 28, no. 8, pp. 140–141, August 1955**

System in which magnetic drum storage system of digital computer is synchronized with acoustical delay line system by time difference discriminator circuit that controls drum speed through servo system; accuracy is plus or minus 0.5 μsec with 10 percent line voltage variation; control circuit of drum synchronizer. (*EI*, 1955)

1816. SERIES-TUBE CORE MEMORY

Otis, E. J.
Air Research and Development Command, Cambridge Research Center, Bedford, Mass.
AFCRC-TR-55-116, September 1955
OTS: PB-121,558

One of the problems in using magnetic cores for permanent high-speed storage is that of selecting the few cores representing a storage register and then providing the high current necessary for reading out or writing information into this register. The solution presented here requires a diode to be used with each core. The resulting core memory achieves a random access time of two μsec. A theoretical analysis and synthesis procedure is given for the series-tube-driving circuit on which this solution is based. Experimental results obtained from the operation of sixteen single-bit registers with the series-tube selection are also given.

1817. LOGICAL READING SYSTEM FOR NON-RETURN-TO-ZERO MAGNETIC RECORDING

Hoagland, A. S.
***IRE Transactions on Electronic Computers*, v. EC-4, no. 3, pp. 93–95, September 1955**

Nonreturn to zero (NRZ) method for magnetic recording of computer binary information which saturates surface in continuous fashion, one sense of saturation being used for "1" and opposite sense of saturation for "0"; system for reading NRZ digital data which utilizes inherent characteristic of readback signal waveform to effect logical correction. (*EI*, 1955)

1818. MAGNETIC ELEMENTS IN ARITHMETIC AND CONTROL CIRCUITS

Auerbach, I. L. and Disson, S. B.
***Electrical Engineering*, v. 74, no. 9, pp. 766–770, September 1955**

Characteristics of square loop ferromagnetic cores and basic circuits from which logical elements can be formed are described and several typical applications discussed;

future applications expected to expand beyond electronic computers to include fields of industrial control and communication. (*EI*, 1955)

1819. UNIVAC: ELECTRONIC COMPUTING SYSTEM
Rumbles, A. R.
***Sperryscope*, v. 13, no. 10, 3rd Quarter, pp. 4–7, 1955**

Elements of electronic data processing systems; converting and storing of information; Univac II with magnetic core storage; automatic programming; Univac Scientific; Univac File-Computer; Univac 120 and Univac 60. (*EI*, 1955)

1820. HIGH DENSITY RECORDING FOR DIGITAL COMPUTERS
***Tele-Tech & Electronic Industries*, v. 14, no. 11, pp. 90–91, 137–138, November 1955 (see also *Electrical Manufacturing*, v. 56, no. 5, pp. 153, 290, November 1955)**

Method for closely packing digital pulses on magnetic tape developed by National Bureau of Standards, which achieves densities in range of 500 to 700 pulses/in.; such high density storage can greatly reduce problem solution time by providing more rapid access to information recorded on external magnetic tape units; use with SEAC computer. (*EI*, 1956)

1821. FERRITE-CORE MEMORY IS FAST AND RELIABLE
Alexander, M. A., Rosenberg, M., and Stuart-Williams, R.
***Electronics*, v. 29, no. 2, pp. 158–161, February 1956**

Matrix wiring and pulse switching circuits which enhance reliability of 168,960-core memory for RAND JOHNNIAC computer; memory uses 4096 × 40 storage cores and 128 × 40 switch cores; reading time is 4.5 μsec, write time 10 μsec; mean error-free operating time exceeds 35 hr; operation of various circuits; schematic diagrams of complete memory and driver circuits. (*EI*, 1956)

1822. BROADBANDING FERRITE MICROWAVE ISOLATORS (Presented at the IRE Convention in New York, March 21, 1956)
Vartanian, P. H., Melchor, J. L., and Ayres, W. P.
Sylvania Electric Products, Inc., Electronics Defense Laboratory, Mountain View, Calif., Report EDL-M65 (Technical Memo)
March 15, 1956

1823. ON DEPOSITED CORE MATRIX
Remington Rand Univac, New York
DA-49-170-sc-1662 (2d), PX 72004-5, Progress Report No. 5, May 1956

1824. SQUARE HYSTERESIS LOOP FERRITES IN SYSTEM MgO–MnO–Fe_2O_3
Albers-Schonberg, E.
***The American Ceramic Society Bulletin*, v. 35, no. 7, pp. 276–279, July 1956**

Ferrites were developed and successfully adopted as storage cells of magnetic memory systems in electronic computers; magnetic materials of this type can be switched back and forth between two states of magnetization with extremely high speed. (*EI*, 1956)

1825. DYNAMAX—NEW CRYSTAL AND DOMAIN-ORIENTED MAGNETIC CORE MATERIAL
Howe, G. H.
***Electrical Engineering*, v. 75, no. 8, pp. 702–704, August 1956**

High permeability material, developed in form of thin tape for torodial cores, has dynamic characteristics superior to those of any rectangular hysteresis-loop materials commercially available today; most promising applications are in magnetic amplifiers and, possibly, in special transformers. (*EI*, 1956)

1826. THE NOISES OF CYCLIC REVERSAL OF MAGNETIZATION OF FERROMAGNETICS
Bunkin, F. V.
***Zhurnal Tekhnicheskoi Fiziki*, v. 26, no. 8, pp. 1790–1798, 1956 (in Russian)**

A theoretical paper in which the e.m.f. included in a coil as a result of reversal of magnetization of the ferromagnetic core is considered as a random superposition of

elementary perturbations. The author discusses the correlation functions and the spectrum intensity of noises due to reversal of magnetization which enables calculation to be made of the particular noises of various coils with ferromagnetic cores, chokes, transformers, magnetic amplifiers, etc. The case of the signal-to-noise ratio of the output of a transformer is considered more fully. (*PA*, 1957, #2431)

1827. A DIGITAL CIRCUIT TECHNIQUE USING JUNCTION TRANSISTORS AND MAGNETIC CORES

Perry, G. H., Hoffman, G. R., et al.
Ministry of Supply, Radar Research Establishment, Great Britain
TN-591, September 1956
(ASTIA AD-116,900)

Fundamental requirements of digital circuits are considered. It is shown that a combination of a magnetic core, as a memory, and a transistor as a gate to transfer the contents of one memory to another similar memory, can form a simple circuit element, capable of replacing some of the more conventional digital circuits. Details are given of some circuits that have been developed for use in a digital data transmission system including a pulse separator, binary counter, and certain gates. Advantages and limitations are discussed.

1828. NOISE IN MAGNETIC RECORDING TAPES

Howling, D. H.
***Journal of the Acoustical Society of America*, v. 28, no. 5, pp. 977–987, September 1956**

A theoretical and experimental investigation is made into the mechanism of noise in magnetic media as used in magnetic recording.

1829. MAGNETIC DATA RECORDING THEORY: HEAD DESIGN

Hoagland, A. S.
***Transactions of the American Institute of Electrical Engineers*, v. 75, Part 1 (Communication and Electronics) no. 27, pp. 506–512, November 1956**

Analysis of process of magnetic recording of digital data is presented from which qualitative design concepts are developed and their usefulness demonstrated, both in evaluation of magnetic head structures and in their design for high density storage; pertinence to development of IBM 350 magnetic disk storage file. (*EI*, 1957)

1830. HARNESSING FERRITES FOR ELECTRONICS

Katz, H. W. and Mullen, E. B.
***General Electric Review*, v. 59, no. 6, pp. 40–45, November 1956**

Metallic and ferrite materials are compared by superimposing their respective low-frequency magnetization curves; conventional and specialized application of ferrites; examples indicate some of uses for ferrites in electronic circuits. (*EI*, 1957)

1831. HIGH SPEED COINCIDENCE-FLUX MAGNETIC STORAGE PRINCIPLES

Hunter, L. P. and Bauer, E. W.
***Journal of Applied Physics*, v. 27, no. 11, pp. 1257–1261, November 1956**

In usual systems, specific storage element is selected by applying to two or more intersecting wires, currents of magnitudes whose sum will produce magnetic field sufficient to switch element and such that any one of selecting currents alone will not switch; improved system in which coincident summation of magnetic flux causes element to switch, and magnitudes of currents inducing flux are not critical.

1832. SMALLER MEMORY DEVICES DEVELOPED BY THE DAVID SARNOFF RESEARCH CENTER

***Product Engineering*, v. 28, no. 1, p. 210, January 1957**

1833. PROGRESS IN FERRITE MATERIALS

***Electronic & Radio Engineer*, v. 34, no. 2, pp. 56–61, February 1957**

How new-found properties of ferrites have greatly increased range of applications: "square loop" ferrites, by virtue of their ability to store binary coded information, have applications in computers and allied devices and in automatic telephony; use as direct selection store; use as variable magnetic coupling device; microwave and other applications. (*EI*, 1957)

1841. FERRITE MICROWAVE DETECTOR

Jaffe, D., Cacheris, J. C., et al.
Diamond Ordnance Fuze Laboratories, Washington, D. C.
TR-457, May 1, 1957 (ASTIA AD-131,965)

Second-order terms in alternating components are usually neglected in investigating the behavior of the magnetic moments of unbalanced electron spins in ferromagnetic materials in an rf field. Here, it is shown that retention of some of these terms for one component of the magnetization predicts the possibility of using ferrites to detect an amplitude modulated microwave signal. The demodulated envelope could be used to magnetostrict a thin ferrite rod, the vibration of which can be observed by means of a polarized $BaTiO_3$ ceramic rod. Results of such an experiment agree with theory. Factors for improved performance are mentioned.

1842. FERRITES AT MICROWAVES

Allin, P. E. V.
Electronic Engineering, v. 29, no. 352, pp. 292–296, June 1957

Principles of some of non-reciprocal microwave ferrite devices now becoming available; gyromagnetic properties of ferrites; applications of ferrites as cylindrical and as rectangular waveguide components; gyrators and other applications. (*EI*, 1957)

1843. ANALYSIS OF CIRCUITS WITH MULTIPLE-HOLE MAGNETIC CORES

Onyshevych, L. S.
Massachusetts Institute of Technology, Research Laboratory of Electronics, Cambridge,
TR-328, July 9, 1957

Multiple-hole magnetic cores, also called transfluxors, which have been developed recently, promise to be very useful in computer, control, and other logical circuitry. They are ferrite cores, with square hysteresis loops, of various complicated geometries. In this report, a workable analysis procedure for circuits that contain transfluxors is developed. It is based on the square waveshape approximation. This analysis forms a basis for a design procedure. Sample circuits were designed and tested, and the results were found to be within 10 percent of the predicted values.

1844. THE APPLICATION OF SQUARE-LOOP FERRITE MATERIAL IN DATA-PROCESSING SYSTEMS

Wright, E. P. G.
Proceedings of the Institution of Electrical Engineers, Paper 2234R, v. 104B, Supplement no. 7, pp. 502–511, 523–525, July 1957

One application takes the form of buffers for modifying the speed or mode of presentation of data; a second concerns counters, distributors and scalers. It is shown that magnetic material can be used to replace electromagnetic switches, meters and relays and electronic triggers, counters and gates. (*PA*, 1957, #1407)

1845. MAGNETIC PROPERTIES AND ASSOCIATED MICROSTRUCTURE OF ZINC-BEARING SQUARE-LOOP FERRITES

Palmer, G. G., Johnson, R. W., and Schultz, R. E.
The American Ceramic Society Journal, v. 40, no. 8, pp. 256–262, August 1957

Zinc oxide added to obtain lower coercive force and higher magnetic saturation induction than usual for commercial square loop ferrites; Curie temperatures, hysteresis loops, initial permeabilities, magnetization curves, and switching times; grain structure and etch-pit density; work in connection with use of ferrites as switching cores in memory matrix of digital computers. (*EI*, 1957)

1846. DATA HANDLING DEVICES

Institution of Radio Engineers, 1957 IRE Wescon Convention Record, v. 1, Part 4, pp. 205–230, 1957

The following subjects were covered: "Magnacard New Concept in Data Handling," R. M. Hayes and J. Wiener; "Magnacard—Mechanical Handling Techniques," A. M. Nelson, H. M. Stern, and L. R. Wilson; "Magnacard Magnetic Recording Studies," J. Burkig and L. E. Justice; "Very High Speed Punched Paper Tape Reader," A. M. Angel; and "Air-Floating Disk Magnetic Memory Unit," W. A. Farrand. The convention was held in San Francisco, August 20–23, 1957. (*EI*, 1958)

1847. SOME NEW ELECTRICAL AND MAGNETIC CERAMICS

Campbell, G.
Journal of Scientific Instruments, v. 34, no. 9, pp. 337–348, September 1957

1834. LES FERRITES FERROMAGNETIQUES
Maugard, G.
***Onde électrique*, v. 37, no. 360, pp. 248–258, March 1957**

Ferromagnetic ferrites: survey of industrial processing of ferrite materials; characteristics and application of "soft" magnetic materials and "hard" ferrites; application of some types of ferrites in microwave circuits, where they provide solution in unidirectional system circuitry. (*EI*, 1957)

1835. FERRORESONANT CIRCUITS FOR DIGITAL COMPUTERS
Newport, C. B. and Bell, D. A.
***Institution of Radio Engineers*, Paper 424, March 13, 1957 (Also in *Journal of British Institution of Radio Engineers*, v. 17, no. 11, pp. 619–630, November 1957)**

The characteristics of the ferroresonant circuit are analyzed and conditions for bistability obtained. Problems of high frequency operation are considered and the composition and configuration of suitable ferrites discussed. A carrier frequency of 1 Mc seems to be the present limit. Practical circuits are presented for a shift register, 3-stage binary counter and 2-input logical adder.

1836. HIGH-SPEED DATA PROCESSING SYSTEM
Klein, M. L., Rush, R. B., and Morgan, H. C.
***Electronic Engineering*, v. 29, no. 350, pp. 158–163, April 1957**

Details of digital data system which holds up to 4,800,000 18-bit words on magnetic tape; these data are obtained from 100 input analog signals at rate of 10,000 words/sec; information is recorded digitally on tape along with source identification and time; tape can be played back through system into two IBM 727 tape units and is compatible with IBM EDPM 704; system accuracy to 0.1 percent. (*EI*, 1957)

1837. CERTAIN PROPERTIES OF FERRITES
Galt, J. K.
***Bell Laboratories Record*, v. 35, no. 4, pp. 126–130, April 1957**

Discussion of peculiar characteristics of ferrites and their applications in standard components of communication technology; examples of ferrite components used in Bell system. (*EI*, 1957)

1838. EINIGE CHARAKTERISTISCHE FUNKTIONSGRUPPEN DATENVERARBEITENDER SYSTEME
Zschekel, H.
***Elektronische Rundschau*, v. 11, no. 4, pp. 100–101, April 1957**

Characteristic functional groups of data-processing systems; description of electric coordinator effecting input and output magnitude coordination by plug connections; multiplicator unit using multiplication elements, and magnetic storage drum by Standard Elektrik AG. (*EI*, 1958)

1839. TEMPERATURE CHARACTERISTICS OF TRANSFLUXOR
Abbott, H. W. and Suran, J. J.
***IRE Transactions on Electron Devices*, v. ED-4, no. 2, pp. 113–119, April 1957**

Determination of temperature characteristics of transfluxors, i.e., of high-remanence multi-holed ferrite cores which may be used as combined memory–ac gate; investigation, over ambient temperature range from −60 to 140°C, of behavior of static magnetic properties of core and of variation of ac properties, which are related to gating function of transfluxor. (*EI*, 1957)

1840. 32,000-WORD MAGNETIC-CORE MEMORY
Foss, E. and Partridge, R. S.
***IBM Journal of Research and Development*, v. 1, no. 2, pp. 103–109, April 1957**

Development of IBM 738 magnetic-core storage unit; discussion of associated engineering problems, including electrical and mechanical arrangement for packaging over 1,000,000 cores and their circuits; description of driver circuits and sense amplifier. (*EI*, 1957)

These materials have been conveniently classified as insulator, conductor, ferroelectric and ferromagnetic ceramics. The functions of insulator and of conductor ceramics are readily understood and the underlying theory of conduction is briefly outlined. The ferroelectric and ferromagnetic classes are less widely appreciated: the analogies and the differences in these groups are discussed. The wide range of applications for these materials is indicated and some ceramics of particular interest to the electrical engineer and physicist are described more fully. These include ferroelectrics based on barium titanate for ceramic capacitors, piezoelectric transducers, dielectric amplifiers and memory devices. Other important ceramics are ferromagnetics based on soft magnetic ferrites for radio and television components, very-high-frequency applications, magnetostrictive transducers, microwave components and memory devices together with ferromagnetics based on hard magnetic ferrites. Electronic devices and equipments of the future may use "solid" circuits made from various ceramic materials inert to moisture and capable of operating at relatively elevated temperatures. (*PA*, 1957, #9155)

1848. MAGNETIC TAPE STORE FOR PEGASUS
Braunholtz, T. G. H. and Hogg, D.
***Electronic Engineering*, v. 29, no. 356, pp. 484–489, October 1957**

Data on engineering and system design of tape store attached to Ferranti, Ltd. Pegasus computer; application of tape store; tape mechanisms; magnetic tape; layout of information on tape; reading and writing heads and circuits; method of control; reliability and built-in checks. (*EI*, 1958)

1849. RECORDING OF DIGITAL INFORMATION ON MAGNETIC DRUMS
Hunter, D. G. N. and Ridler, D. S.
***Electronic Engineering*, v. 29, no. 356, pp. 490–496, October 1957**

Discussion of methods of representing binary digital information on magnetic drums, with regard to reliability, and cost and technical merits; phase modulation and pulse methods; advances in components and in circuit techniques which reduce disadvantage of telegraph method over phase modulation method. (*EI*, 1958)

1850. SWITCHING TIME OF FERRITES WITH RECTANGULAR HYSTERESIS LOOP
van der Heide, H., Bruijning, H. G., and Wijn, H. P. J.
***Philips Technical Review*, v. 18, no. 11, pp. 336–346, 1956–1957**

Method for measuring, as function of time, reversal of magnetization caused by sudden application of magnetic field to ferrite cores with rectangular hysteresis loop, used as "memory" elements in electronic computers. (*EI*, 1957)

1851. SURVEY OF SQUARE-LOOP MAGNETIC MATERIALS
Legg, V. E.
***IRE Transactions on Component Parts*, v. CP-4, no. 4, pp. 106–109, December 1957**

Magnetic and electrical properties of square-loop materials for applications in cores for magnetic amplifiers, pulse modulators, and memory and switching coils; preeminence of 50–50 nickel–iron for magnetic amplifier applications can be challenged only by new alloys such as Super mendur; material with lower saturation for fast-switching coils, and ferrites in memory arrays. (*EI*, 1958)

1852. MILLIONS OF TINY FERRITE MEMORY CORES
***Computers and Automation*, v. 7, no. 2, p. 17; v. 7, no. 2B, p. 15, February 1958**

1853. MEASUREMENT OF THE PROPERTIES OF VARIOUS FERRITES USED IN MAGNETICALLY TUNED RESONANT CIRCUITS IN THE 2.5–45 Mc/sec REGION
Lombardini, P. P., Schwartz, R. F., and Doviak, R. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 395–396, March 1958**

An investigation was conducted directed toward securing data for choosing the best ferrite to be used in the Penn–Princeton 3 Bev high-intensity proton synchrotron now being built at Princeton University. The ferrite samples tested were from American and European manufacturers and were in the form of small rings 2 in. or less in diameter. Measurements were required of μ and Q under

varying magnetic bias, at various r.f. flux levels, in the band frequencies 2.5 to 45 Mc. At the beginning of this research no clear method existed for a proper choice of ferrite, and generally speaking the manufacturers' data were inadequate. Therefore a novel technique of measurement was devised, and an effort was made to establish a minimum number of parameters for defining ferrite properties for this application. The present paper includes a description of the techniques used and a resume of the results obtained.

1854. BEHAVIOR OF THE TE MODES IN FERRITE LOADED RECTANGULAR WAVEGUIDE IN THE REGION OF FERRIMAGNETIC RESONANCE

Crowe, W. J.

***Journal of Applied Physics*, v. 29, no. 3, pp. 397–398, March 1958**

A computation is described which reveals the exact values of the propagation constants of the TE modes in rectangular waveguide loaded with a transversely magnetized ferrite slab over a frequency interval which includes resonance. Magnetic losses are included in the analysis. It is shown that the way in which the modes link through resonance depends upon the value of the magnetic damping parameter, and further that they generally link in such a way that an interference between two or more modes will occur.

1855. APPRAISAL OF PERMANENT MAGNET MATERIALS FOR MAGNETIC FOCUSING OF ELECTRON BEAMS

Glass, M. S.

***Journal of Applied Physics*, v. 29, no. 3, pp. 403–404, March 1958**

In the magnetic focusing of electron beams there is a growing need for permanent magnets of higher coercive force than those which are easily obtainable. Special techniques in the design of compact tubular magnets for strong focusing fields enable the use of magnet materials of relatively low remanence. The low remanence of some materials suitable for this use has limited their general use and this has probably retarded their final development. There is a good potential demand for these materials for electron beam focusing which should stimulate increased development effort.

1856. PERFORMANCE OF PERMANENT MAGNETS AT ELEVATED TEMPERATURES

Roberts, W. H.

***Journal of Applied Physics*, v. 29, no. 3, pp. 405–407, March 1958**

The objective of this investigation was to determine the effect of temperature up to 600°C and vibration on the performance of Alnico V and Alnico VI magnets. Data are presented on the effect of cycling stability, coefficient of remanence, extended exposure to elevated temperature and vibration.

The results of this investigation show that the use of Alnico V and Alnico VI in most instrument and control applications is feasible up to 500°C. However, a considerable loss in properties should be expected if the temperature exceeds 500°C.

1857. FACTORS LIMITING A MAGNETIC SUSPENSION SYSTEM

Breazeale, J. B., McIlwraith, C. G., and Dacus, E. N.

***Journal of Applied Physics*, v. 29, no. 3, pp. 414–415, March 1958**

A magnetic suspension apparatus is reported which is capable of operating in any attitude in space, or under reasonable accelerations in any direction. The device may be used as a low friction bearing or as a force-measuring balance. Limitations of both of these useful properties exist because of physical and magnetic properties of the materials used. These limitations are discussed and their order of magnitude reported for several common magnetic materials. As a low-friction bearing, hysteresis torques as low as 3×10^{-5} dyne-cm, and eddy current torques as low as 9×10^{-7} dyne-cm per radian/sec are reported. As a force-measuring balance hysteresis errors and deviations from linearity of as little as 0.1% of full-scale force may be obtained. The maximum force under which support can be maintained, is about five times the weight of ferromagnetic material in the supported object. Displacement of the supported object under an applied force can be made as small as 10^{-6} cm/dyne.

1858. ORIGIN AND USE OF INSTABILITIES IN FERROMAGNETIC RESONANCE

Suhl, H.

***Journal of Applied Physics*, v. 29, no. 3, pp. 416–421, March 1958**

An outline is presented of the behavior of ferromagnetic materials in large high-frequency fields. It is shown that, because of the collective behavior of the electronic spins, instabilities set in beyond a certain critical field amplitude. Finally, the application of such effects to the construction of ferromagnetic amplifiers is discussed. (*PA*, 1958, #8869)

1859. SOLID-STATE MICROWAVE AMPLIFIER AND OSCILLATOR USING FERRITE
Weiss, M. T.
***Journal of Applied Physics*, v. 29, no. 3, p. 421, March 1958**

1860. NEW TYPE OF FERROMAGNETIC AMPLIFIER
Hogan, C. L., Jepsen, R. L., and Vartanian, P. H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 422–423, March 1958**

A simple physical explanation is given of the mechanism of microwave amplification by coupling local oscillator energy to signal energy as proposed by Suhl.

1861. SWITCHING PROPERTIES OF PERMALLOY CORES OF VARYING COERCIVITY
Rossing, T. D. and Korkowski, V. J.
***Journal of Applied Physics*, v. 29, no. 3, pp. 479–480, March 1958**

In attempting to develop a 4–79 molybdenum permalloy core for use in a memory with nondestructive readout, studies have been made of switching properties of permalloy tape cores with coercivities ranging from 0.1–1.0 oersted, corresponding to heat treatments over a temperature range of 300–900°C. The switching time of a core can be shortened by means of auxiliary field pulses which help to nucleate domains of reverse magnetization, but have little effect on their rate of propagation. In general, auxiliary field pulses applied perpendicular to the direction of remanent magnetization are more effective than those applied antiparallel to it provided the latter are not large enough to cause switching by themselves. The timing of the auxiliary pulses is important. Many of the cores have a "preferred" direction presumably caused by small domains of extremely high coercivity. The experimental results are interpreted in the light of domain wall motion theory.

1862. OPERATING RANGE OF A MEMORY USING TWO FERRITE PLATE APERTURES PER BIT
Kaufman, M. M. and Newhouse, V. L.
***Journal of Applied Physics*, v. 29, no. 3, pp. 487–488, March 1958**

In order to make use of all the structural and economical advantages which apertured ferrite plates may offer to a magnetic memory, techniques were developed to compensate for the nonuniformity from hole to hole found in experimental plates. An analysis is presented which indicates that storage of information using two holes per bit and allowing both holes to switch increases the operating range of a ferrite plate memory to a point where it is possible to drive it with a ferrite plate switch. A switch-driven ferrite plate memory has been operated successfully in the laboratory and confirms the results of the analysis.

1863. RECENT ADVANCES IN THE DESIGN OF HIGH-FIELD dc SOLENOID MAGNETS
Kolm, H. H.
***Journal of Applied Physics*, v. 29, no. 3, pp. 489–491, March 1958**

The art of dc solenoid design is re-examined with the objective of maximizing magnetic field at the expense of volume and homogeneity, while providing axial access at the largest feasible angular aperture. Solenoids of this type would provide higher fields for the investigation of cyclotron resonance and magneto-optical effects in thin specimens at far infrared frequencies where limitations of source intensity and detector sensitivity require large aperture optics and preclude the use of pulsed magnets. Heat-transfer experiments indicate that under conditions of nucleate boiling it is possible to transfer heat across a copper–water interface at more than ten times the rate of 200 w/cm^2 which served as the basis for Bitter's design some twenty years ago. Transfer rates of 2500 w/cm^2 were achieved in a 0.010 × 0.20-in. rectangular flow channel and at a copper temperature of only 114°C. Two modified Bitter solenoids and a new, tape-wound wide-aperture solenoid were designed to dissipate the maximum power of 1700 kw supplied by Professor Bitter's generator at MIT through a considerably reduced transfer area and thus provide higher fields in smaller volumes. The design and preliminary performance data are described.

1864. TRANSPARENT FERROMAGNETIC LIGHT MODULATOR USING YTTRIUM IRON GARNET

Porter, C. S., Spencer, E. G., and LeCraw, R. C.
***Journal of Applied Physics*, v. 29, no. 3, pp. 495–496, March 1958**

A method of preparation of yttrium iron garnet crystals from Y_2O_3 and Fe_2O_3, using PbO as a solvent, is described. The transmission spectrum from 0.5 to 16 μ of ground and polished slabs cut from the crystals shows strong absorption at wavelengths shorter than 0.7 μ; other absorptions occur at 0.89, 5.7, 7.8, 8.6, 10.9, 11.6, and 14 μ. Faraday rotation brought about by spontaneous magnetization normal to the slab can be applied to the design of light modulators. Three of these are described and the construction and operation of one is discussed. It is an axially ac magnetized slab, passing polarized tungsten light to an analyzer 45 deg out of the plane of polarization.

1865. DESIGN OF OPTIMUM INDUCTORS USING MAGNETICALLY HARD FERRITES IN COMBINATION WITH MAGNETICALLY SOFT MATERIALS

Ludwig, J. T.
***Journal of Applied Physics*, v. 29, no. 3, pp. 497–499, March 1958**

A new method is developed for the optimum design of inductors carrying unsymmetrical currents and having magnetically soft ferromagnetic cores biased with magnetically hard gaps. Techniques are given for obtaining designs to meet those specifications for which the optimum design has no air gap, and those specifications imposing limits on the maximum induction.

1866. PULSE GENERATOR BASED ON HIGH SHOCK DEMAGNETIZATION OF FERROMAGNETIC MATERIAL

Kulterman, R. W., Neilson, F. W., and Benedick, W. B.
***Journal of Applied Physics*, v. 29, no. 3, pp. 500–501, March 1958**

The shock wave from a pellet of high explosive is passed without attenuation through one leg of a closed ferromagnetic core which has been previously magnetized. The shock wave demagnetizes the core, reducing the flux from the remanent value to zero. This change in flux generates a voltage in any winding wound on the core. Idealized calculations indicate that the voltage pulse generated in this manner will be a square wave with amplitude, in volts, given by $e_g = NB_{R}vw$, and a pulse width, in seconds, given by $T = s/v$, where N is the number of turns, B_R the remanent magnetization (webers/m^2) and v is the shock velocity (m/sec). It is also assumed that the core has a rectangular cross section, w being the width of the core (m) in the direction perpendicular to B_R and v, and s being the thickness of the core (m) in the direction parallel to v.

Experimental tests have produced output pulses with an amplitude of 6400 v/turn meter of w where the length of the pulse was in fair agreement with the known shock velocity of the material used. At the present time it is believed that the operation of the device can be explained by a transducer mechanism which converts some of the energy of the shock wave into electrical energy.

1867. HIGH-RESOLUTION MAGNETIC RECORDING STRUCTURES

Hoagland, A. S.
***IBM Journal of Research and Development*, v. 2, no. 2, pp. 91–104, April 1958**

Design concepts for several magnetic recording heads for computer applications: comparision of conventional ring-type head with probe and wire-grid structures; methods of providing high resolution; application of probe-type unit for high-density vertical magnetic recording. (*EI*, 1958)

1868. PULSE TIME DISPLACEMENT IN HIGH-DENSITY MAGNETIC TAPE

Skov, R. A.
***IBM Journal of Research and Development*, v. 2, no. 2, pp. 130–141, April 1958**

Analysis of intertrack pulse time displacement in magnetic tapes for digital computers: measurement techniques for evaluation of pulse time displacement; analysis of various components of time displacement; reduction of skew and pulse crowding to permit increased bit density. (*EI*, 1958)

1869. ELECTRON MIRROR MICROSCOPY OF [MAGNETIC] PATTERNS RECORDED ON MAGNETIC TAPE
Mayer, L.
***Journal of Applied Physics*, v. 29, no. 4, pp. 658–660, April 1958**

Experimental evidence is presented demonstrating that electron mirror microscopy can provide micrographs of patterns written on magnetic tapes. Successful utilization of the principle of electron mirror microscopy for depiction of magnetic patterns on magnetic tapes may have general significance with respect to magnetic memory systems. The high resolving power of the electron mirror microscope and the fact that it is an electronic device suggests further experimentation aimed at an all-electronic, fast-reading magnetic memory system with large storage capacity. (*PA*, 1958, #8912)

1870. TERMINAL PROPERTIES OF MAGNETIC CORES
Chen, T. C. and Papoulis, A.
***Proceedings of the IRE*, v. 46, no. 5, Part 1, pp. 839–849, May 1958**

Reversal of magnetization of cores with rectangular hysteresis loop is investigated; for materials whose thickness is more than one thousandth of an inch, switching is determined from static loop and solution of appropriate field problem; for thinner materials, terminal properties of cores can be obtained from their dynamic step response; application to components used in computers. (*EI*, 1958)

1871. RECHTECKFERRITE UND DIE PRUEFUNG IHRER SPEICHEREIGENSCHAFTEN
Heck, C. and Reiner, H.
***Nachrichtentechnische Zeitschrift*, v. 11, no. 7, pp. 360–369, July 1958**

Square loop ferrites and tests of their storage properties; discussion of macroscopically anisotropic material with square hysteresis loop, suited particularly for use as ring cores for rapid storage devices, because of their high specific resistance; specification properties of material and shape of storage cores; test methods. (*EI*, 1958)

1872. MAGNETIC CORE SWITCH DEVELOPMENT PROGRAM
Remington Rand Univac, New York, AF 33(616)-2326, Items 1 and 8 Project RRU-2052, July 1958 (ASTIA AD–107, 907)

The development of logical circuits based on magnetic switch cores is described.

1873. EFFECT OF A TRANSVERSE FIELD ON SWITCHING RATES OF MAGNETIC MEMORY CORES
Rossing, T. D. and Rubens, S. M.
***Journal of Applied Physics*, v. 29, no. 8, pp. 1245–1247, August 1958**

A ferromagnetic material having a rectangular hysteresis loop can be magnetized much easier if a magnetic field is applied tranverse to the direction of remanence at the same time the remagnetizing pulse is applied. This effect, which has been observed in cores of ferrite, rolled permalloy and vacuum-deposited alloys, is shown to be compatible with the existing theories of domain wall motion. It forms the basis of an improved method of writing into magnetic memory cores in a digital computer.

1874. A LINE PRINTER MEMORY UTILIZING MAGNETIC CORES
Goda, B., Markowitz, S., and Jacobi, E.
***Computers and Automation*, v. 7, no. 8, pp. 12–13, August 1958**

1875. FERRITES FOR HIGH-POWER R-F TUNING
Lombardini, P. P. and Schwartz, R. F.
***Electrical Manufacturing*, v. 62, no. 2, pp. 60–71, August 1958**

Evaluation of commercially available ferrites for power tuning application in 2.5 to 30 Mc range; magnetic permeability and Q for samples as function of frequency, r.f. flux and temperature; dielectric constant and Q_B as function of frequency and electric field intensity; recommendations for future data to be supplied by ferrite manufacturers. (*EI*, 1958)

1876. END-FIRED MEMORY USES FERRITE PLATES
Newhouse, V. L., Kornfield, N. R., and Kaufman, M. M.
Electronics, v. 31, no. 41, pp. 100–103, October 10, 1958

Arrangement in which magnetic flux is induced around holes in ferrite plates to store and switch digital information; plate properties can vary considerably from hole to hole without affecting memory accuracy; end-fired ferrite plate memory operation is explained and transistor drive and regeneration circuits described. (*EI*, 1958)

1877. A MAGNETIC-DRUM STORE FOR ANALOGUE COMPUTING
Douce, J. L. and West, J. C.
Proceedings of the Institution of Electrical Engineers, Part B, v. 105, pp. 577–580, November 1958

The drum is usable for generating nonlinear functions and as a delay network.

1878. CONTROL APPARATUS FOR A SERIAL DRUM MEMORY
Kamat, D. S.
Electronic Engineering, v. 30, pp. 634–639, November 1958

Equipment is considered for obtaining design data for fast track switching on a serial magnetic drum storage device.

1879. AN ELECTRICAL MULTIPLIER UTILIZING THE HALL EFFECT IN INDIUM ARSENIDE
Chasmer, R. P. and Cohen, E.
Electronic Engineering, v. 30, pp. 661–664, November 1958

An InAs Hall plate is mounted in the gap in a ferrite core.

1880. MULTIPLICATION BY SEMICONDUCTORS
Hilsum, C.
Electronic Engineering, v. 30, pp. 664–666, November 1958

Multipliers use the Hall effect in semiconductors. The application of the magnetoresistive effect is outlined.

1881. THE STORAGE AND PROCESSING OF DIGITAL DATA ON MAGNETIC TAPE
Willis, D. W.
Transactions of the Society of Instrument Technology, v. 10, pp. 182–189, December 1958

1882. FLUX-CONTROLLING-TYPE ADDER
Kuroyanagi, N.
Reports of the Electrical Communication Laboratory, Japan, v. 6, pp. 468–475, December 1958

Magnetic cores are used to control switching.

1883. A TRACK SWITCHING SYSTEM FOR A MAGNETIC DRUM MEMORY
Majunder, D. D.
Electronic Engineering, v. 30, pp. 702–705, December 1958

1884. A MAGNETIC CORE PARALLEL ADDER
Chen, M.
IRE Transactions on Electronic Computers, v. EC-7, no. 4, p. 262, December 1958

An extension of early methods of analysis of binary computer units, produces a logical design which uses magnetic core elements without the usual time limitations. (*C and A*, 1959)

1885. A HIGH-SPEED LOGIC SYSTEM USING MAGNETIC ELEMENTS AND CONNECTING WIRE ONLY
Crane, H. D.
Proceedings of the IRE, v. 47, no. 1, pp. 63–73, January 1959

By the use of geometric variation in the magnetic core toroidal structure, new logic design freedom is achieved. Logic functions may be formed directly within a Multiaperture Device (MAD), and these elements may also be simply interconnected to perform logical functions, such as one output controlling several inputs. (*C and A*, 1959)

1886. THE LADDIC—A MAGNETIC DEVICE FOR PERFORMING LOGIC

Gianola, U. F. and Crowley, T. H.
***Bell System Technical Journal*, v. 38, pp. 45–72, January 1959**

A ladderlike structure of rectangular-hysteresis-loop ferrite is used. Magnetic paths are flux-limited. Any Boolean function of n variables can be produced.

1887. SWITCHING TIMES OF A SQUARE-LOOP FERRITE

Vautier, R. and Marais, A.
***Comptes rendus hebdomadaires des séances de l'académie des sciences*, Paris, v. 248, no. 5, pp. 660–663, February 1959 (in French)**

These were measured for symmetrically and asymmetrically applied fields, and the threshold fields related to the coercive force. (*PA*, 1959, #8313)

1888. MAGNETIC DRUM PROVIDES ANALOG TIME DELAY

Daniels, H. L. and Sampson, D. K.
***Electronics*, v. 32, no. 6, p. 44, February 6, 1959**

A relatively uncomplicated drum recording system has been developed to make analog simulations in designing continuous-processing systems, which provide a time delay. In a highly stable system, applicable also to tape, precision of 0.1 percent is exceeded, between recorded and played-back low-frequency analog voltages. (*C and A*, 1959)

1889. TAPE RECORDING SYSTEM SPEEDS DATA PROCESSING

Way, D. W.
***Electronics*, v. 32, no. 6, p. 56, February 6, 1959**

The use of a technique for recording pulse duration and a 31-channel block format give large information content, while minimizing "dead space" and effect from tape skew, plus the ability to re-record on individual blocks. These unique uses of magnetic tape enable a data-processing system to handle information at a rate of 40,000 alpha-numeric characters per second. (*C and A*, 1959)

1890. THE DIGITAL TAPE RECORDER

Kezer, C.
***Instruments and Control Systems*, v. 32, no. 3, p. 389, March 1959**

The characteristics of the "digital" magnetic tape recorder differ greatly from those of the analog recorder. These differences are mentioned, while the digital recorder is discussed in greater detail. (*C and A*, 1959)

1891. MAGNETIC TAPE SYSTEM FOR ANALOG, PDM, OR FM

Fetty, K.
***Instruments and Control Systems*, v. 32, no. 3, p. 392, March 1959**

A versatile tape system handles analog, PDM, and FM signals. It is designed for use where high-speed acquisition of large amounts of data is required. The description of the system includes amplifiers, power supplies, and auxiliary equipment. (*C and A*, 1959)

1892. DIGITAL-RECORDING MAGNETIC HEADS

Hurley, W. F.
***Instruments and Control Systems*, v. 32, no. 3, p. 394, March 1959**

The magnetic head in a tape recording instrument serves three functions: (1) it records electric signals on magnetic tape; (2) it reads information on magnetic tape and converts it into electric signals; (3) it serves as an eraser, wiping out old information so that the tape may be reused. A survey of magnetic heads for digital tape systems is given. (*C and A*, 1959)

1893. MAGNETIC HEAD READS TAPE AT ZERO SPEED

Anderson, M. E.
***Electronics*, v. 32, no. 10, p. 58, March 6, 1959**

A system which permits information playback at extremely slow speeds, so that the highest frequency component is within the limited bandwidth of a pen recorder. Original data is recorded at high tape speeds, but "played back" at speeds including zero inches per second, with no deterioration in the signal-to-noise ratio. (*C and A*, 1959)

1894. DIGITAL MEMORY SYSTEM KEEPS CIRCUITS SIMPLE
Chen, T. C. and Stram, O. B.
Electronics, v. 32, no. 11, p. 130, March 13, 1959

A magnetic memory, which uses a flat-surfaced aluminum disk capable of storing from 50 to 100 words, is now used in small, low-cost digital computers. A description of its performance is given. (*C and A*, 1959)

1895. A NEW HIGH-SPEED DIGITAL TECHNIQUE FOR COMPUTER USE
Eldridge, D.
Proceedings of the Institution of Electrical Engineers, Part B, v. 106, pp. 229–239, March 1959

Square-loop ferrite cores and transistors are used.

1896. MAGNETICS FOR COMPUTERS—A SURVEY OF THE STATE OF THE ART
Rajchman, J. A.
RCA Review, v. 20, pp. 92–135, March 1959

A review is presented of magnetic materials applied to storage and switching devices.

1897. MILLIMICROSECOND SWITCHING PROPERTIES OF FERRITE COMPUTER ELEMENTS
Shevel, W. L., Jr.
Journal of Applied Physics, v. 30, no. 4 (Supplement) pp. 47S–48S, April 1959

The switching properties of square loop ferrites are considered. Three mechanisms, wall motion, incoherent rotation, and coherent rotation, are proposed as being responsible for the process of flux reversal.

1898. EVALUATION OF NEW HIGH-SPEED MAGNETIC FERRITE SYSTEM FOR USE IN COMPUTER COMPONENTS
Eichbaum, B. R.
Journal of Applied Physics, v. 30, no. 4 (Supplement) pp. 49S–52S, April 1959

The $CdO \cdot MnO \cdot Fe_2O_3$ system has been studied. Properties are discussed, and the use of these materials in fast switching multipath elements and matrix switch cores is described.

1899. STUDY OF THE RESIDUAL STATES OF FERRITE CORES IN COMPUTER MEMORY OPERATION
Overn, W. M. and Korkowski, V. J.
Journal of Applied Physics, v. 30, no. 4 (Supplement) pp. 52S–53S, April 1959

1900. REVERSIBLE COMPONENT OF MAGNETIZATION
McKay, R. W.
Journal of Applied Physics, v. 30, no. 4 (Supplement) pp. 56S–57S, April 1959

A method of nondestructive sensing of a ferrite-core memory has been suggested which depends on the variation of the reversible component of magnetization with the state of the core. The effects of finite core-wall thickness and of flux-leakage are discussed. Measurements are reported for two types of cores.

1901. INHIBITED FLUX—A NEW MODE OF OPERATION OF THE THREE-HOLE MEMORY CORE
Baldwin, J. A., Jr. and Rogers, J. L.
Journal of Applied Physics, v. 30, no. 4 (Supplement) pp. 58S–59S, April 1959

A new method of operation of the three-hole memory core has been developed. As is the case with the coincident-flux scheme developed by IBM, read and write times may be made very short. However, by using single-line drive rather than coincident current only one conductor need pass through each hole. A description is given of a small memory array which uses this method.

1902. EXPERIMENTAL STUDY OF THE MODIFIED SEMISTATIC FERRITE AMPLIFIER
Whirry, W. L. and Wang, F. B.

Journal of Applied Physics, v. 30, no. 4
(Supplement) pp. 150S–151S, April 1959

A ferromagnetic parametric amplifier operating at 5930 Mc is described.

1903. LOW-GROSS GYROMAGNETIC COUPLING THROUGH SINGLE CRYSTAL GARNETS
DeGrasse, R. W.
Journal of Applied Physics, v. 30, no. 4
(Supplement) pp. 155S–156S, April 1959

Methods are described for synthesizing filters and gyrators using strong coupling of a small volume of ferrimagnetic material to an electromagnetic circuit. The small volume of material is treated as a lumped element resonator, and it is shown that energy can be coupled through this resonator with low loss. The synthesis leads to the realization of small tunable filters, compact circulators and isolators, as well as practical realization of solid state TR cells.

1904. TRANSISTORS AND CORES IN COUNTING CIRCUITS
Rozner, F. and Pengelly, P.
Electronic Engineering, v. 31, pp. 272–274, May 1959

1905. A MEDIUM POWER FERRIMAGNETIC MICROWAVE LIMITER
Skomal, E. N. and Medina, M. A.
Proceedings of the IRE, v. 47, no. 5, pp. 1000–1001, May 1959

1906. MAGNETIC MATRIX STORES
Cole, W. A.
Wireless World, v. 65, pp. 279–283, June 1959

Ferrites with rectangular hysteresis loops, as computer storage systems, are reviewed.

1907. A TORSIONAL MAGNETOSTRICTIVE DELAY LINE
Rothbart, A.
Proceedings of the IRE, v. 47, no. 6, pp. 1153–1154, June 1959

1908. MAGNETIC CORE CIRCUITS FOR DIGITAL APPLICATIONS
Auerbach, I. L.
Automatic Control, v. 11, no. 2, p. 48, August 1959

Bistable magnetic cores, one of the prime component types for digital applications, can perform most of the functions of digital-data processing systems, including storage, delay, control and logical operations. This article discusses present applications of magnetic core circuits. (*C and A*, 1959)

1909. GENERAL-PURPOSE SUBROUTINES FOR THE IBM 650 MAGNETIC DRUM DATA-PROCESSING MACHINE WITH ATTACHMENTS
Huff, V. N., Turner, D. N., and Reese, O. W.
National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio
TN D-68, October 1959

A set of routines has been designed for use with the IBM 650 Magnetic Drum Data-Processing Machine equipped with floating decimal arithmetic, immediate access storage, and indexing accumulators. These routines occupy 528 storage locations. They are intended for general-purpose use on engineering calculations. They include five transcendental functions and square root along with input-output routines and a console-controlled trace.

1910. A NEW MAGNETIC DEVICE FOR MEMORY AND LOGIC
Computers and Automation, v. 8, no. 11, pp. 9–10, November 1959

1911. DIGITAL MAGNETIC CIRCUITS; THEORY, ELECTRICAL DESIGN, AND LOGICAL DESIGN
Burroughs Corporation Report, 1959
Nonr-2145(00)
(ASTIA AD-215,789)

This paper contains three sections of the report on Digital Magnetic Circuits. Included are: Part II–Parallel Magnetic Pulse Amplifiers (design procedures and representative digital applications are described); Part III–Delay Parallel Magnetic Pulse Amplifiers (differs from

data of Part II in that adjacent delay PMA'S may be read simultaneously); and Part IV—Series Magnetic Pulse Amplifiers (design procedures and representative digital applications are described).

1912. SOLID STATE MAGNETIC AND DIELECTRIC DEVICES
Chynoweth, W. R., et al.
Katz, H. W., Editor
John Wiley and Sons, Inc., New York, N.Y., 1959

1913. THE THEORY AND DESIGN OF MAGNETIC AMPLIFIERS
Frost-Smith, E. H.
John Wiley and Sons, Inc., New York, N.Y., 1959

1914. AN ADVANCED MAGNETIC TAPE SYSTEM FOR DATA PROCESSING
Lawrance, R. B. (Minneapolis-Honeywell Regulator Co., Minn.) 1959

Paper presented at the Eastern Joint Computer Conference, Boston, Mass., December 1–3, 1959.

1915. A HIGH SPEED, SMALL SIZE MAGNETIC DRUM MEMORY UNIT FOR ULTRA SMALL DIGITAL COMPUTERS
Howard, R. A., May, M., Miller, G., and Shifrin, G. (Ramo-Wooldridge Corp., Los Angeles, Calif.) 1959

Paper presented at the Eastern Joint Computer Conference, Boston, Mass., December 1–3, 1959.

AUTHOR INDEX

Author	Abstract
Abbott, H. W.	1,839
Abe, H.	1,018
Abe, T.	849
Abels, V. R.	12
	733
Abragam, A.	11
Abrahams, E.	156
Abrikosov, A. A.	311
	419
Ackermann, F. W.	573
	836
Ackermann, W.	792
Adachi, K.	1,689
Adams, C. Q.	13
	1,203
Adams, E.	6
Aden, A. L.	1,013
	1,031
	1,038
Agashe, V. V.	1,610
Aharoni, A.	314
	370
	1,614
Ahern, S. A.	1,455
Aiyama, Y.	1,033
	1,144
	1,186
Akhiezer, A. I.	409
Akimoto, S.	1,157
	1,174
Akulov, N. S.	100
	158
	211
	1,413
	1,494
Albers-Schonberg, E.	1,824
Albert, P. A.	6
	13
	678
	890
Alberts, L.	909
	928
Alekseevskii, N. E.	12
	1,500
Aléonard, R.	1,043
	1,061
	1,162
Alers, G. A.	1,601
Alers, P. B.	1,514
Alexander, M. A.	1,821
Alley, R. E., Jr.	490
	1,293
Allin, P. E. V.	9
	1,842
Altman, A. B.	828
	829
Altshuler, S. A.	12
Amanuma, T.	1,030
Amar, H.	13
	42
	684
	685
Amatuni, A. Ts.	195
	267
	1,688
Ament, W. S.	132
Ananthanarayanan, N. I.	3
Anderson, E. E.	1,298
Anderson, J. C.	820
	1,604
Anderson, M. E.	1,893
Anderson, P. W.	13
	175
	191
	198
	222
	254
	1,007
	1,068
	1,670
Andrä, W.	501
	715
	783
	1,353
	1,423
	1,433
	1,445
Andrianova, I. A.	633
Andrus, J.	979
Angel, A. M.	1,846
Angelakos, D. J.	1,082
Anolick, E. S.	6
	13
	896
Antik, I.	64
Aoyagi, K.	1,437
Appel, J.	1,444
Archer, M. S.	1,616
Argyres, P. N.	137
Arnott, R. J.	13
	1,729
Arrott, A.	3
	6
	13
	343
	434
	561
	580
	601
	888
	898
	901
	1,387
	1,472
	1,594
	1,712
Arrott, W.	1,777
Artman, J. O.	6
	13
	258
	455
	539
	541
	1,026
	1,082
	1,089
	1,217
Asanuma, M.	734
	769
	858
Asch, G.	1,535
	1,591
Aseeva, L. I.	12
Ashenhurst, R. L.	1,812
Askochenskii, A. A.	1,194
Astrov, D. N.	1,701
Auerbach, I. L.	1,818
	1,908
Ault, L. A.	1,082
Ayant, Y.	1,753
Ayres, W. P.	1,013
	1,038
	1,048
	1,822
Azovtsev, V. K.	12
	509
Bacon, G. E.	1,509
Bader, F., et al.	193
Bady, I.	13
Bagguley, D. M. S.	743
Baldwin, J. A.	1,901
Balint, A. T.	6
Ballhausen, C. J.	1,754
Baltzer, P. K.	3
	13
	337
	1,218
	1,288
Bambrough, B.	10
Banewicz, J. J.	1,607
	1,735
Banks, E.	13
	1,126
	1,195
	1,247
	1,728
Baranova, N. A.	108
Barbier, J. C.	1,043
	1,061
	1,162
	1,462
Barnett, S. J.	76
Barrett, C. S.	94
Baryakhtar, V. G.	409
Bate, I. G.	1,309
Bate, R. T.	1,745
Bates, L. F.	8
	12
	87
	519
	521
	768
	775
	777
	778
	781
	795
	872
	1,005
	1,087
	1,172
	1,232
	1,246
	1,375
	1,406
	1,507
	1,570
	1,579
	1,589
Baudet, J.	362
Bauer, E. W.	1,831
Bazhanova, N. V.	863
Bean, C. P.	3
	6
	12
	24
	26
	27
	224
	236
	453
	603
	729
	1,223
	1,368
	1,473
Beck, F. J.	806
Becker, C. H.	1,114
Becker, J. J.	6
	13
	859
	933
	1,332
	1,339
	1,541
	1,545
Becker, R.	56
	72
	471
Bednár, J.	718
	758
Behrendt, D. R.	1,495
	1,536

Author	Abstract
Behringer, R. E.	51
	695
Beisswenger, H.	516
Beitel, F. P., Jr.	930
Beljers, H. G.	1,002
Bell, D. A.	1,835
Bell, R. O.	436
	627
Bell, W. E.	6
Belov, K.	1,477
	1,478
Belov, K. P.	12
	271
	796
Belson, H. S.	13
	1,201
	1,220
Benedick, W. B.	13
	1,866
Benoit, J.	526
	1,008
	1,071
Bents, U. H.	1,694
Berdyshev, A. A.	345
Berger, J. A.	1,624
Berghout, C. W.	626
Bergmann, W. H.	805
Bergstein, A.	1,108
Berk, A. D.	275
	278
	947
	1,082
Berkowitz, A. E.	6
	13
	462
	812
	1,331
Berlincourt, T. G.	1,400
	1,760
Bernstein, F.	594
Berstein, H.	1,551
Bertaut, E. F.	13
	1,725
Bertaut, F.	8
	1,044
	1,081
	1,135
	1,231
	1,237
Berteau, F.	12
Berteaud, A. J.	1,261
	1,263
Bethe, H.	62
Beun, J. A.	1,638
	1,646
Bhimasankaram, V. L. S.	760
Bickford, L. R., Jr.	8
	13
	1,020
	1,086
	1,166
Bickford, L.R., Jr. (Cont'd)	1,171
	1,216
Biedermann, E.	814
	1,434
Biorci, G.	316
	371
	374
	517
Birks, J. B.	8
	243
	1,023
Birss, R. R.	1,524
Bitler, W. R.	799
Bittel, H.	192
Bitter, F.	57
	67
	550
Bivans, E. W.	1,815
Bizette, H.	1,056
	1,080
	1,153
	1,629
	1,632
	1,635
	1,640
	1,677
	1,718
Blackman, L. C. F.	1,012
	1,039
	1,113
	1,301
Blackman, M.	582
	1,142
	1,453
	1,510
	1,517
	1,525
	1,557
	1,564
Blades, J. D.	841
Blank, H.	1,441
Blank, J. M.	3
Bleaney, B. I.	266
Bloch, F.	55
	58
	136
Bloembergen, N.	6
	250
	1,082
Blois, M. S., Jr.	637
Blomberg, H.	913
Bloom, M.	11
Blum, S. L.	1,137
Bobeck, A. H.	13
	1,780
	1,796
Bodewig, C.	1,378
Boehm, M. J.	1,046
Bogoliubov, N. N.	12
Bohlmann, M. A.	931
Bohringer, E.	1,417
Bolfa, J.	1,009
Bolger, B.	1,636
Bolshova, K. M.	12
Bömmel, H. E.	3
Bonch-Bruevich, V. L.	12
	353
Bonn, T. H.	6
	594
Boothby, O. L.	13
	1,486
	1,546
Bordier, D.	731
Boronski, S.	9
Borovik, E. S.	4
Borovik-Romanov, A. S.	1,653
	1,672
	1,676
	1,695
	1,701
	1,708
Bose, A.	12
Bosman, A. J.	867
Both, E.	3
Bowen, L. O.	854
Bowers, K. D.	150
Bowers, R.	1,410
	1,438
	1,522
	1,588
Boyet, H.	1,129
Bozorth, R. M.	6
	92
	473
	484
	530
	708
	709
	782
	1,024
	1,027
	1,075
	1,165
	1,239
	1,264
	1,350
	1,363
	1,531
	1,738
Brackmann, J.	1,025
Bradfield, G.	10
Bradley, E. M.	698
Bradley, F.	1,268
Braginski, A.	1,124
Brailsford, F.	201
	486
Brandt, N. B.	12
	1,580
Braun, P. B.	8
	1,134
	1,146
	1,713
Braun, U. F. (See Brown, W. F., Jr.)	1,493
Braunholtz, T. G. H.	1,848
Breazeale, J. B.	13
	1,857
Breitenhuber, L.	554
Brenner, R.	165
	177
	1,518
Brissonneau, P.	13
	559
	822
	884
	920
Brockhouse, B. N.	1,251
	1,482
Brockman, F. G.	1,240
Brommer, P. E.	867
Brooks, H.	3
	74
Brophy, J. J.	13
	897
Brouwer, G.	180
Brown, D. R.	1,768
Brown, F.	997
	1,003
Brown, H. A.	176
	252
Brown, H. H., Jr.	550
Brown, J. R.	13
Brown, W. F., Jr.	13
	36
	37
	73
	77
	384
	967
	975
	1,439
	1,493
Brownlow, J. M.	8
	13
	1,086
	1,171
	1,204
	1,216
Brož, J.	443
	718
	758
	761
	1,108
Bruijning, H. G.	1,850
Brukhatov, N. L.	12
Buck, D. A.	1,768
Buckley, S. E.	10
Buehler, W. J.	807
Buessem, W. R.	7
Buinov, N. N.	12
Bulatova, L. V.	1,520
	1,521
Bullock, B. W.	1,289
Bunge, H. J.	819
Bunkin, F. V.	237
	1,826

Author	Abstract
Burbank, R. D.	938
Burger, J. P.	1,529
Burgess, F. R.	574
Burgess, J. H.	1,082
Burk, D. L.	3
Burkig, J.	1,846
Burstein, E.	1,474
Butters, R. G.	1,396
Bykovskii, Yu. A.	12
	1,481
Byrnes, W. S.	13
Cable, J. W.	1,274
Cacheris, J. C.	3
	13
	965
	1,082
Cacheris, J. C.	1,841
Cahen, L.	1,106
Cain, A. L.	10
Calhoun, B. A.	3
	13
	1,161
	1,211
	1,283
	1,296
Callaby, D. R.	611
	907
Callaway, J.	753
Callen, H. B.	3
	13
	378
	395
Campbell, G.	10
	1,847
Campbell, R. B.	6
Carlin, H. J.	9
Carlson, E. R.	1,082
Carman, E. H.	641
Carr, W. J., Jr.	3
	13
	341
	1,539
	1,549
Carter, A. E.	8
	1,133
Carter, W. S.	1,675
Castelliz, L.	1,376
Cetlin, B. B.	1,024
Chaplin, G. B.	1,814
Charru, A.	1,074
Chasmer, R. P.	1,879
Chechernikov, V. I.	12
	1,258
	1,358
	1,420
	1,511
Chen, C. W.	916
Chen, M.	1,884
Chen, T. C.	1,870
	1,894
Chernikova, L. A.	12
Chevallier, R.	1,009
Chiba, S.	1,069
Chikazumi, S.	13
	766
	794
	800
	868
	889
Childress, J. D.	3
Childs, B. G.	1,483
Chiron, B.	8
Chizh, L. D.	1,555
Christensen, B.	3
Christoffel, D. A.	8
	872
	956
	1,087
	1,172
Chu, K.	469
Chubb, T. A.	535
Chynoweth, A. G.	602
	1,224
Chynoweth, W. R.	1,912
Clark, C. A.	1,457
	1,556
Clark, G. W.	668
Clark, J. J.	3
	870
Clarke, R. W.	10
Clarricoats, P. J. B.	9
	244
Clegg, A. G.	747
	860
	904
Cleland, J. W.	1,409
Clogston, A. M.	13
	198
	254
	388
	1,010
Cloud, W. H.	1,743
Clow, H.	872
	1,246
Cofta, H.	217
Cohen, E.	1,879
Cohen, J.	1,461
	1,463
	1,468
Cohen, M. H.	164
	1,641
Coldwell-Horsfall, R. A.	173
Cole, R. W.	13
	647
	893
Cole, W. A.	1,906
Coleman, R. P.	6
Coleman, R. V.	13
	664
	665
	680
	693
Coles, B. R.	3
	799
	1,387
	1,472
Collins, L. E.	1,306
Colombani, A.	442
	448
	1,329
	1,335
	1,340
Combrisson, J.	11
Conard, G. P.	3
	648
	764
	1,372
Conard, G. P., II	1,596
Conger, R. L.	6
	32
	44
	452
	636
Conrad, E. E.	449
Constantinescu, F.	1,189
Conte, R.	538
Cook, D. L.	1,755
Cooke, A. H.	1,621
	1,631
Coombs, A. W. H.	1,811
Cooper, B. R.	1,256
Cooter, I. C.	6
Cooter, I. L.	545
	608
Corcoran, R.	3
Coren, R.	1,323
Corenzwit, E.	932
	1,575
	1,585
Corliss, L.	1,682
Corliss, L. M.	13
	1,067
	1,269
	1,730
	1,758
Corner, W. D.	1,373
	1,587
Craik, D. J.	450
	584
	610
	1,232
	1,246
	1,275
Crane, H. D.	1,885
Crangle, J.	882
	1,385
	1,496
Crawford, J. H., Jr.	1,391
	1,409
Crawford, R. G.	13
Crittenden, E. C., Jr.	441
	1,304
	1,313
Croft, G. T.	505
Croft, W. J.	13
	1,290
	1,721
	1,727
	1,751
Crowe, J. W.	1,774
Crowe, W. J.	13
	1,854
Crowley, T. H.	1,886
Crump, L. R.	577
Czerlinsky, E.	776
Czerlinsky, E. R.	3
	6
Czofta, G.	12
Dabbs, J. W. T.	185
	500
Dacus, E. N.	13
	1,857
Dana, H.	366
Danan, H.	372
	780
	875
	876
Dancy, W. H., Jr.	1,289
Danielian, A.	1,691
Daniels, H. L.	1,888
Daniels, J. M.	1,752
Darby, J. K.	913
Date, M.	116
	1,678
	1,720
Davis, C. M., Jr.	13
	784
	834
	1,203
	1,249
	1,597
Davis, J. L.	1,022
Davis, P. F.	260
	263
	816
	872
Davis, W. J.	1,763
Dayhoff, E. S.	13
	380
	1,696
de Andres Sanz, M. P.	571
De Bitetto, D. J.	1,240
DeBlois, R. W.	13
	383
	681
	683
	691
de Gennes, P. G.	255
	256
	410
	1,241
	1,582
DeGrasse, R. W.	1,903
de Greve, L.	1,379
Degtyarev, I. F.	917

Author	Abstract
Dehors, R.	531
de Jong, J. J.	13
Dekker, A. J.	1,566
De Klerk, D.	1,638
	1,646
Dempsey, E.	194
Denes, P.	12
Denisov, P. P.	851
	852
de Nobel, J.	809
Derry, R.	9
Deschamps, A.	1,231
Detert, K.	614
Devenny, C. F., Jr.	1,772
de Vos, K. J.	813
Dhillon, J. S.	1,381
Diakov, G. P.	12
Dickinson, S. K.	6
Dietz, R. E.	1,344
Dietze, H. D.	283
	1,527
Dillon, J. F., Jr.	13
	624
	968
	971
	974
	1,029
	1,105
	1,252
	1,254
	1,277
Dingle, R. B.	97
	98
	487
	488
Disson, S. B.	1,818
Dixit, K. R.	1,610
Dmitrenko, I. M.	4
	983
	1,452
	1,504
	1,565
Doctor, N. J.	449
Doherty, J. T.	444
	1,771
Domb, C.	207
	212
	307
Dombrovskaya, T. N.	12
	503
	525
	551
Donahoe, F. J.	6
	505
Donnay, G.	1,269
Donnay, J. D. H.	1,269
Donovan, B.	820
	1,604
Dorey, P. F.	10
Dorf, A.	7
Dorfman, J.	470
	12
Dorfman, Ya. G.	365
Doring, W.	72
Douce, J. L.	1,877
Doviak, R. J.	13
	1,209
	1,853
Dranz, J.	581
Drechsel, W.	1,611
Drewes, G. W. J.	1,661
Dreyfus, B.	160
	184
	1,051
Drigo, A.	16
Drokin, A. I.	12
	1,401
Drozdov, N. G.	1,177
Drozhzhina, V. I.	12
Duchateau, W.	1,379
	1,448
	1,479
Duffus, H. J.	1,621
Duncan, B. J.	1,054
Dunmur, I. W.	1,509
Dunn, C. G.	3
Dupré, A.	1,307
Du Pré, F. K.	999
	1,240
Durand, E.	147
Dutta Roy, S. K.	520
	1,665
Dwight, K.	13
	1,257
	1,291
Dyakov, G. P.	219
	321
Dylgerov, V. D.	12
Dyson, F. J.	223
	225
Dzyaloshinskiĭ, I. E.	310
	328
	419
	1,714
Dzyaloshinsky, I.	394
Earl, H. E., Jr.	624
	1,277
Earnshaw, A.	850
Eckert, O.	10
Economos, G.	1,028
	1,035
	1,253
Edelman, F. H.	697
Edwards, A.	563
Egghart, H.	962
Eich, A. M.	6
Eichbaum, B. R.	1,898
Eischen, G.	1,096
Eisele, J. A.	118
Eisenstein, J. C.	1,722
Ekstein, H.	25
Elcock, E. W.	1,620
Eldridge, D.	10
	1,895
Elkina, T. A.	12
Elliott, J. F.	1,411
Elliott, N.	3
	13
	1,269
	1,618
	1,682
	1,704
	1,730
Ellis, W. C.	13
	1,519
	1,543
Elmore, W. C.	474
	475
Elpatevskaya, O. D.	1,608
Elschner, B.	642
Emerson, W. H.	8
	1,085
Enander, B. N.	1,082
Enz, C. P.	11
Enz, U.	1,184
	1,242
Epstein, D. J.	6
	13
	1,205
	1,297
Erickson, R. A.	500
Ericson, M.	1,241
Ershov, R. W.	111
Eschenfelder, A. H.	13
	1,206
Eskowitz, A.	1,149
Essig, F. C.	32
	44
	452
Esveldt, C. J.	10
Evans, H.	3
Ewing, R. D.	1,748
Fabrikov, V. A.	1,169
Fahlenbrach, H.	717
	742
	752
	790
	791
	798
	836
	874
Fakidov, I. G.	12
Falk, R. B.	13
	677
Fallot, M.	705
Farrand, W. A.	1,846
Farrar, R. T.	13
	1,210
Fast, J. F.	10
	1,037
	1,154
Fay, G. E.	1,082
Fedorov, F. I.	234
	281
	300
Feigina, F. J.	871
Feldtkeller, R.	634
Fell, E. A.	1,556
Ferebee, S. F.	784
	834
	1,249
	1,597
Ferguson, E. T.	13
	842
	885
Ferguson, G. A., Jr.	1,265
Ferro, A.	11
	374
	832
	835
Fetty, K.	1,891
Feynman, R. P.	1,084
Fiedler, H. C.	13
	892
Field, W. G.	6
Fieschi, R.	138
Figgis, B. N.	850
	1,750
Firsov, Yu. A.	1,703
Fischell, R. E.	3
	609
Fischer, J.	216
	1,311
Fischer, R. F.	1,796
Fisher, J. C.	433
Fisher, L. L.	1,807
Fisher, M. E.	423
	428
	432
Flanders, P.	943
Flanders, P. J.	6
	13
	1,331
	1,392
Fletcher, G. C.	1,405
Fletcher, P. C.	436
	627
Foerster, F.	504
	510
Foëx, G.	589
Foëx, M.	1,633
Fokker, A. D.	71
Folen, V. J.	8
	13
	1,085
	1,215
Fomenko, L. A.	12
	980
	1,041
	1,099
	1,193
Foner, S.	6
	13
	542
	759
	785
	1,217
	1,699

Author	Abstract
Forestier, H.	1,096
Forra, F.	12
Forrat, F.	13
	1,044
	1,081
	1,725
Foss, E.	1,840
Foster, F. G.	173
Foster, K.	6
	13
	679
	869
Fowler, C. A., Jr.	451
	492
	494
	639
	650
	651
	713
	714
Fox, A. G.	9
Fox, M.	1,578
Frackiewicz, B.	13
	1,205
	1,297
Fraczek, K.	1,124
Fraczek, T.	1,124
Fradkin, B. M.	213
Frait, Z.	357
	560
	823
Francombe, M. H.	1,078
Frank, A.	1,801
Frank, D.	238
Franklin, A. D.	943
Franklin, P. J.	449
Frazer, B. C.	1,262
Freeman, M. W.	3
	6
	13
	888
Frei, E. H.	6
	303
	314
	622
	1,614
Frendil, J.	470
Fresh, D. L.	1,082
Frey, J.	1,025
Fridman, L. A.	12
Friedberg, S. A.	3
Friedel, J.	181
	257
Frings, W.	597
Frischmann, P. G.	3
	13
	892
Fritz, J. F.	870
Frost-Smith, E. H.	1,913
Frumkin, A. L.	1,177
Fryer, E. M.	451
	492
	494
	639
	650
	651
	713
	714
Fujimura, T.	1,053
Fujiwara, K.	262
Fukuoka, N.	1,654
Fukuroi, T.	1,512
Fullam, E. F.	690
Fuller, H. W.	467
	703
Fulop, W.	595
Funatogawa, Z.	1,369
Gaidukov, Yu. P.	1,500
Gale, G. O.	630
Galkina, O. S.	12
	13
Gall, D. C.	540
Galperin, F. M.	12
	273
	983
Galt, J. K.	8
	978
	979
	988
	1,001
	1,019
	1,024
	1,837
Garber, M.	1,659
	1,660
	1,661
Garcia, S. J.	514
Garde, L.	531
Gardner, F. S.	3
Garifianov, N. S.	12
Garwin, R. L.	1,775
Gaume-Mahn, F.	1,393
Geist, D.	1,530
Gelbukh, L. A.	375
	569
Geller, S.	13
	1,207
	1,225
	1,233
Gemperle, R.	788
Gengnagel, H.	10
	653
	873
	879
Gerlach, W.	581
Germer, L. H.	1,347
Gerritsen, H. J.	1,636
	1,637
	1,659
	1,660
	1,661
Gertsenshtein, M. E.	353
Geschwind, S.	1,029
Geyger, W. A.	547
Gianola, U. F.	1,782
	1,886
Giansoldati, A.	1,352
	1,377
Gielessen, J.	1,416
	1,553
Gieseke, W.	1,107
Gilbert, T. L.	3
Gilleo, M. A.	13
	1,070
	1,207
	1,225
	1,285
Gillette, P. R.	13
	47
	52
	369
Gingrich, N. S.	1,490
Girgis, R. K.	1,627
Giron, V. S.	1,278
Giulotto, L.	11
Glass, M. S.	13
	1,855
Glass, S. J.	45
Glazer, A. A.	866
Glover, W. G.	10
Goda, B.	1,874
Godfrey, R. M.	9
Goetz, H.	1,383
Gold, L.	13
	386
Goldman, A.	1,598
Goldman, J. E.	3
	6
	561
	1,049
	1,387
	1,472
	1,712
Gondo, Y.	712
Goodenough, J. B.	3
	6
	10
	13
	19
	113
	464
	675
	1,430
	1,721
	1,727
	1,729
	1,742
	1,805
Gordon, D. A.	618
Gordon, D. I.	609
Gordon, I.	1,064
Goriaga, A. N.	12
Goronina, K. A.	633
Gorter, C. J.	11
	12
	115
	206
	287
	566
	589
	809
	1,636
	1,638
	1,643
	1,646
Gorter, E. W.	8
	10
	188
	990
	994
	1,136
	1,489
Gould, H. L. B.	6
Gould, J. E.	771
Gourary, B. S.	1,110
Goureaux, G.	1,329
	1,335
	1,340
Gow, K. V.	1,382
Grachev, A. A.	633
Graenicher, H.	11
Graffi, D.	106
Graham, C. D., Jr.	6
	13
	171
	570
	590
	681
	691
	856
	922
	926
	934
	1,541
	1,603
Grannis, F. H.	1,668
Gravel, C. L.	997
	1,003
Grazhdankina, N. P.	12
	1,715
	1,746
Greenwald, S.	1,657
Greifer, A. P.	1,290
Greiner, C.	635
	654
Grenoble, H. E.	13
	892
Gresky, A. T.	367
	430
Griest, A. J.	648
Griffel, M.	3
Griffith, J. S.	414

Author	Abstract
Griffiths, P. M.	584
	610
	1,232
	1,246
	1,275
Grimes, D. M.	6
	13
	121
	992
	1,208
Grimmond, R.	10
Gruen, D. M.	1,645
	1,664
Grünbaum, E.	1,453
	1,517
	1,525
	1,557
	1,564
Gugan, D.	914
	1,586
Guggenheim, E. A.	66
Guillaud, C.	8
	951
	1,058
	1,060
	1,140
	1,348
Guiot-Guillain, G.	1,016
	1,096
Gurevich, V. L.	421
Gurfel, D. I.	1,746
Gusev, A. A.	12
	109
	141
	159
Gushchina, Z. M.	1,169
Guterman, S.	1,808
Guy, J.	362
Gyorgy, E. M.	6
	13
	277
	329
	390
	437
Haanstra, H. B.	13
Haas, P. H.	532
Hahlbohm, H. D.	534
Hahn, R.	1,568
Haigh, D.	1,192
Haigh, G.	582
	1,123
	1,142
	1,156
Haken, W.	1,282
Hale, M. E.	467
	703
Hall, E. O.	773
	1,480
Hall, R. C.	6
	764
Hall, R. C. (Cont'd)	847
	865
	902
	924
	937
Hallgren, D. S.	690
Hamilton, W. C.	418
	1,065
Hammond, P.	202
	714
	786
Handler, P.	1,684
Haneman, D.	149
Hansen, J. R.	3
Hansen, W. N.	3
Hardeman, G. E. G.	1,644
Harrington, J. V.	350
	360
Harrington, R. D.	7
	532
	1,272
Harris, M. J.	913
Harris, W. P.	6
	545
	608
Harrison, S. E.	3
	8
	13
	1,076
	1,201
	1,220
	1,235
Hart, A.	775
	795
	912
Harvey, A. F.	9
	244
Haseda, T.	1,720
Hasegawa, H.	3
	175
Hass, M.	1,265
Hastings, J. M.	13
	1,067
	1,269
	1,682
	1,730
	1,758
Haszko, S. E.	1,279
Hayashi, I.	1,018
Hayes, A. G.	9
	244
Hayes, R. E.	1,814
Hayes, R. M.	1,846
Haynes, M. K.	13
	385
Healy, D. W., Jr.	1,132
Heavens, O. S.	1,306
Heck, C.	1,250
	1,871
Hedgcock, F. T.	1,415
Hedgcock, F. T. (Cont'd)	1,459
	1,466
	1,492
Hedwig, P.	285
	903
Heer, C. V.	1,745
Heidenreich, R. D.	830
	938
	939
	1,040
Heikes, R. R.	6
	1,390
	1,506
	1,642
	1,692
Heimke, G.	1,267
Heine, V.	233
Heister, W.	1,178
	1,286
Hellenthal, W.	1,334
Heller, G. S.	1,082
Helms, H. H.	834
Henning, G. R.	605
	1,761
Henning, W.	1,576
Henry, W. E.	3
	6
	13
	1,046
	1,255
	1,294
	1,544
	1,595
	1,731
	1,732
Henry, W. G.	1,424
	1,425
Hermann, P. K.	746
Herpin, A.	255
	1,081
	1,160
	1,241
Herring, C.	93
	95
Herzfeld, C. M.	113
Hesselbach, H.	726
Hibbard, W. R., Jr.	3
	13
	892
Hihara, T.	1,090
	1,145
Hillert, M.	1,303
Hilsum, C.	617
	1,880
Hipskind, G. S.	1,021
Hirahara, E.	1,090
	1,145
	1,271
Hirakawa, K.	1,163
Hirone, T.	989
Hirone, T. (Cont'd)	1,069
	1,456
	1,693
	1,689
Hoagland, A. S.	1,817
	1,829
	1,867
Hoarau, J.	1,649
Hoare, F. E.	1,515
Hodgin, D. M.	7
Hoffman, G. R.	1,827
Hoffman, P. O.	1,159
Hoffman, R. W.	6
	694
	699
	1,304
	1,313
Hofmann, J. A.	247
Hogan, C. I.	6
	13
	1,082
	1,151
	1,185
	1,187
	1,281
	1,716
	1,860
Hogg, D.	1,848
Holden, A. N.	1,068
	1,670
Holtzman, A. H.	1,596
Holzmüller, W.	232
Honda, H.	704
Hopper, H. G.	979
Hora, O.	1,167
Hoselitz, K.	489
Hoskins, R.	723
Houdremont, E.	717
	740
Hove, J. E.	1,762
	1,766
Howard, R. A.	1,915
Howe, G. H.	3
	1,825
Howe, L.	1,488
Howling, D. H.	549
	1,828
Hrianca, J.	911
	1,577
Hrivnak, L.	208
Hubbard, W. M.	6
Huber, E. E., Jr.	13
	675
Hudimac, A. A.	441
Huet, P.	1,340
Huff, V. N.	1,909
Humphrey, F. B.	13
	277
	437
	670
Humphreys, B. L.	9
Hunt, G. H.	1,373

Author	Abstract
Hunter, D. G. N.	1,849
Hunter, L. P.	1,831
Hurd, R. A.	973
Hurley, W. F.	1,892
Hutchinson, F.	1,587
Hutchison, C. A., Jr.	1,684
Ianus, R. I.	12
Iida, S.	1,033
	1,144
	1,186
Iliushenko, V. L. (see Ilyushenko)	12
Illenberger, A.	1,342
Ilyushenko, V. L. (see Iliushenko)	1,401
Inoue, S.	1,357
Isaac, E. D.	1,589
Ishikawa, Y.	1,062
	1,157
	1,174
	1,280
Ishmukhametov, B. K.	985
Isihara, A.	338
Itskovich, F. I.	261
Ivanovskii, V. I.	12
	826
	827
	839
	851
	852
Ivlev, V. F.	12
	1,426
	1,548
Iwanaga, K.	1,018
Iwata, H.	868
Izyumov, Yu. A.	305
	345
	1,581
Jaccarino, V.	1,029
Jackson, R. C.	908
Jackson, W.	8
	1,191
Jacobi, E.	1,874
Jacobs, I. S.	3
	6
	13
	27
	453
	613
	660
	1,223
	1,464
	1,491
	1,590
Jacrot, B.	1,241
Jaffe, D.	1,841
Jahn, H.	880
Janssen, K.	755
Janusz, T. P.	1,692
Janzekovic, J.	117
Jarrett, H. S.	1,744
Jaumot, F. E. Jr.	812
Jeans, J. H.	60
Jellinghaus, W.	265
	755
Jensen, H.	1,305
Jepsen, R. L.	13
	1,860
Johannin-Gilles, A.	196
Johnson, C. E., Jr.	13
	967
	975
Johnson, F. M.	1,679
Johnson, R. A.	1,132
Johnston, R. W.	1,845
Johnston, W. D.	1,692
Jones, E. R. W.	1,556
Jones, G.	3
Jones, G. R.	1,082
Jones, R. M.	6
	13
	899
Jones, R. V.	13
	1,214
Jones, V. A.	10
Jongenburger, P.	626
Jonker, G. H.	6
	8
	1,134
	1,146
	1,673
Joussot-Dubien, J.	529
Judd, B. R.	1,652
Jung, P. E. L.	8
	9
Juretschke, H. J.	1,323
	1,460
Justice, L. E.	1,846
Juza, R.	1,667
Kaczér, J.	12
	30
	40
	48
	373
	748
	788
Kagan, W.	1,140
	1,141
Kaganov, M. I.	347
	351
	405
	465
Kalashnikov, A. G.	536
Kales, M. L.	1,082
Kamat, D. S.	1,878
Kambersky, V.	1,336
Kamigaichi, T.	1,090
Kanai, Y.	1,397
Kanamori, J.	182
Kanamori, J. (Cont'd)	1,663
Kanavina, N. G.	12
	503
Kandaurova, G. S.	12
	1,321
	1,322
	1,325
	1,326
	1,520
	1,521
Kandler, J.	1,700
Kaplan, A.	13
Kaplan, T. A.	363
Karantassis, T.	1,655
Karasik, V. R.	1,672
Karayianis, N.	13
	379
	604
	1,082
Karchagina, E. V.	1,183
Karlqvist, O.	1,804
Kartashev, V. P.	12
Karttunen, P. J.	913
Kasper, J. S.	1,419
	1,538
Kasteleijn, P. W.	210
	214
	215
Kastler, A.	11
Kasuya, T.	123
	125
	231
	241
Katz, H. W.	1,830
Kaufman, M. M.	13
	1,862
	1,876
Kaufmann, A. R.	3
	6
	1,526
	1,666
Kaya, S.	704
	1,345
	1,346
Kedesdy, H. H.	13
	1,097
	1,158
	1,728
Keffer, F.	118
	164
	190
	524
	1,641
	1,706
Keller, J. B.	117
Kelley, E. M.	1,773
Kelly, J. M., Jr.	3
	587
Kendig, P. M.	499
Kerr, J.	763
	945
Kersten, M.	70
	75
	167
	249
	1,443
	1,449
	1,503
Kessler, J. A.	1,800
Kezer, C.	1,890
Kholodenko, L.	480
Khutsishvili, G. R.	145
Kiive, P.	1,764
Kikoin, I. K.	12
	1,481
Kikuchi, R.	31
	396
	434
	1,594
Kikuchi, Y.	843
Kingston, R. H.	668
Kip, A. F.	12
Kirenskii, L. V.	12
	917
	1,426
Kirko, I. M.	416
Kittel, C.	11
	15
	17
	88
	89
	91
	93
	204
	286
	399
	404
	485
	518
	711
	1,439
Kittl, E.	3
Klann, A.	1,707
	1,709
	1,710
Klatte, G.	507
Klein, M. J.	18
	45
	1,836
Klinger, M. I.	325
Klokholm, E.	6
	1,392
Knappwost, A.	162
	512
	1,342
	1,380
Kneller, E.	50
	814
	1,434
	1,568
Knight, W. D.	1,439
Knorr, T. G.	694

Author	Abstract
Knorr, T. G. (Cont'd)	699
Knox, K.	1,233
Koch, A. J. J.	6
Koch, K. M.	265
	515
	596
Kodis, R. D.	1,808
Koehler, W. C.	1,274
	1,647
	1,736
Koh, P. K.	13
	686
	1,781
Kohn, W.	406
Kojima, H.	1,228
Kojima, M.	1,680
Kolachevskii, N. N.	633
Kolesnikov, A. P.	1,436
Kolm, H. H.	6
	13
	1,863
Komar, A. P.	4
	1,104
Komarova, M. L.	12
Kondo, J.	1,719
Kondo, K.	107
Kondoh, H.	1,006
	1,654
Kondorskiĭ, E.	1,337
Kondorskiĭ, E. I.	9
	12
	221
	274
	921
Kondorsky, E.	13
	68
Kooi, C. F.	1,302
Koolhof, R. A.	10
Kooy, C.	972
Korchovei, A.	358
Korenblit, L. L.	1,436
Korkowski, V. J.	13
	1,861
	1,899
Korman, M. M.	1,082
Kornetzki, M.	253
	725
	1,025
Kornfield, N. R.	1,876
Kosevich, A. M.	4
	29
	163
	327
Kostina, T. I.	12
Kostryukova, M. O.	1,617
Kotelnikov, N. V.	655
	689
Kotlyar, B. I.	1,418
Kouvel, J. S.	6
	13
	41

Author	Abstract
Kouvel, J. S. (Cont'd)	570
	1,541
	1,603
Kovalev, N. B.	564
Kozlowski, L.	831
Kozyrev, B. M.	12
Kramer, A.	948
Kramer, V.	1,239
Kranz, J.	493
	952
	1,378
	1,611
Kreines, N. M.	1,653
	1,672
	1,708
Kriessman, C. J.	3
	8
	13
	1,076
	1,201
	1,220
	1,235
	1,287
	1,384
Krinchik, G. S.	12
	100
	1,475
	1,476
Krivko, N. I.	1,104
	1,245
Kronenberg, K. J.	13
	716
	886
	887
	931
	953
	1,079
Kronqvist, E.	1,370
Krupička, S.	1,092
	1,108
	1,117
	1,148
Kubo, R.	11
	12
	135
	290
Kubota, B.	1,014
Kubyschkina, T.	64
Kudryavtsev, V. D.	1,169
Kulterman, R. W.	13
	1,866
Kumagai, H.	1,018
Kurbatov, L. V.	12
	1,243
Kuroyanagi, N.	1,882
Kurti, N.	11
	292
	1,599
Kushima, I.	1,030
Kussman, A.	54
	209

Author	Abstract
Kussman, A. (Cont'd)	631
	797
	1,389
	1,412
Kuwahara, I. K.	631
Kvasnikov, I. A.	220
	301
	322
La Blanchetais, C. H.	1,360
	1,450
	1,619
Lăbuşcă, E.	1,189
Lamarsh, J. R.	817
Landau, L.	65
Lange, H.	513
Lange, N.	1,303
Lanzi, G.	11
Larach, S.	1,626
Laurila, E.	21
Laverick, E.	9
Lawrance, R. B.	1,914
Lawrence, P. E.	613
Lax, B.	1,011
	1,082
Lax, M.	144
	402
Lazarev, B. G.	1,452
	1,504
	1,565
Leach, S. J.	1,375
	1,406
Leavitt, W. Z.	6
LeCraw, R. C.	6
	13
	969
	1,000
	1,072
	1,082
	1,128
	1,200
	1,212
	1,226
	1,864
Lednev, I. A.	12
	1,103
Lee, E. W.	151
	415
	611
	736
	907
	908
	923
Lee, M. D.	607
Leech, J. W.	1,047
	1,656
Legg, V. E.	1,851
Legvold, S.	1,411
	1,495
	1,536
	1,537

Author	Abstract
Legvold, S. (Cont'd)	1,562
	1,573
Leipfinger, H.	1,554
Lemanceau, B.	529
Lengyel, B. A.	947
Lever, R. C.	13
	677
Levi, F. P.	702
Levine, D. B.	413
Levitas, A.	402
Lewin, L.	9
Lewis, B.	422
Lewis, H. W.	1,068
	1,670
Lewis, J.	850
Lewis, W. B.	1,704
Li, Y. Y.	3
	1,050
	1,648
Libsch, J. F.	3
	648
	764
	1,372
Liehr, A. D.	1,754
Lifshits, I. M.	4
	29
	163
Lifshitz, E.	65
	706
Lihl, F.	751
	765
	821
	837
Lilley, B.	90
Lin, S. T.	3
	6
	1,299
	1,526
	1,666
Lindsay, R.	1,607
	1,735
Lipatova, V. A.	112
Lisgarten, N. D.	582
	1,142
Little, C. W., Jr.	6
Littmann, M. F.	3
	13
	678
Livingston, J. D.	1,339
Livshits, B. G.	12
Loasby, R. G.	1,375
	1,406
	1,571
	1,579
Lock, J. M.	1,497
	1,499
	1,501
	1,502
Loeb, A. L.	6
Loesche, A.	12
Lombardini, P. P.	13

Author	Abstract
Lombardini, P. P. (Con't)	1,209
	1,853
	1,875
Lomer, W. M.	368
Looney, D. H.	6
	1,797
Loriers, J.	1,179
	1,244
Lotgering, F. K.	1,077
	1,489
	1,674
Lothian, B. W.	915
Loudetté, P.	1,074
Love, W. F.	505
Lowde, R. D.	356
	793
Luborsky, F. E.	3
	6
	13
	459
	638
	640
	657
	660
	667
	676
	690
Ludewig, G.	7
Ludwig, J. T.	13
	1,865
Luteijn, A. I.	813
Luttinger, J. M.	176
Luzhinskaia, M. G.	12
	824
	825
	838
Lvov, V. S.	12
Lynch, A. C.	3
	5
	611
	855
Lynton, E. A.	1,574
Lyustrova, A. P.	112
MacBean, I. G.	9
McCaig, M.	544
	860
	861
	771
	904
McClelland, J. D.	1,761
	1,766
Macdonald, J. R.	235
MacDonald, D. K. C.	1,470
	461
	1,320
McDonald, K. L.	129
MacDonough, F. X.	13
McFarlane, J.	913
McGuire, T. R.	3
	998
	1,384
	1,668
McIlwraith, C. G.	13
	1,857
McKay, R. W.	1,900
McKim, F. R.	558
	1,683
MacMillan, R. A.	3
	6
McMillan, J. A.	625
McSkimin, W.	1,350
Maeda, S.	989
	1,456
	1,693
Majunder, D. D.	1,883
Malek, Z.	336
	407
	552
	833
Malm, J. G.	1,664
Manley, J. H.	339
Manuel, A. J.	1,047
	1,440
	1,656
Marais, A.	722
	1,284
	1,887
Marchand, A.	1,394
Marette, G.	1,801
Marfoure, S.	1,349
Markowitz, S.	1,874
Marshall, W.	11
	174
	178
	293
	368
	403
	568
	1,747
Martin, D. H.	777
	778
	781
	818
Martin, D. L.	6
	1,569
Martin, D. W.	121
	992
Martin, W. G.	1,612
Martius, U. M.	1,382
Marton, L.	483
Mash, D. I.	1,109
Mason, W. P.	1,362
Masumoto, H.	1,513
Masumoto, S.	1,357
Matcovich, T. J.	1,287
Mathieu, S.	1,009
Matsumae, S.	1,355
Matthias, B.	1,615
Matthias, B. T.	1,068
	1,531
	1,575
	1,585
	1,670
Matyás, M.	1,723
	1,724
Matz, S.	986
	1,032
Maugard, G.	1,834
Maxwell, L. R.	8
	993
May, M.	1,915
Mayer, F.	1,042
	1,175
Mayer, H.	1,786
Mayer, L.	628
	1,783
	1,785
	1,869
Maynard, C. A.	7
Mayo, J. W.	607
Medina, M. A.	13
	1,905
Meiboom, S.	11
Meier, D. A.	1,788
	1,795
Meiklejohn, W. H.	6
	13
	224
	629
	963
	1,473
Meincke, H.	1,765
Meinken, R. H.	6
Meisenheimer, R. G.	1,755
Melchor, J. L.	1,013
	1,031
	1,048
	1,822
Mellentin, K.	513
Mendelsohn, L. I.	3
	13
	459
	630
	640
	657
	895
Meneghetti, D.	1,467
Menyuk, N.	13
	19
	1,257
	1,291
	1,768
	1,769
	1,805
Mercereau, J. E.	13
	387
	1,084
	1,199
Meriel, P.	1,081
	1,160
	1,241
Merritt, F. R.	1,019
	1,024
Meyer, A. J. P.	1,366
	1,367
	1,432
	1,442
	1,485
	1,532
	1,535
	1,547
	1,733
Meyer, H. H.	836
Meyer, K.	142
	166
	238
	245
	330
	331
Meyer, L.	1,528
Mikhail, H.	1,627
Mikhaĭlovskiĭ, L. K.	1,094
Miles, P. A.	8
	1,133
	1,155
Miller, G.	1,915
Milligan, W. O.	1,606
Milne, P.	913
Minnick, R. C.	1,812
Míšek, K.	543
	1,317
	1,374
	1,395
Mitchell, A. H.	204
	280
Mitchell, D. W.	1,285
Mitchell, E. N.	13
	671
Mitkevich, A. V.	564
Mitui, T.	803
	1,408
Miyahara, S.	1,100
	1,408
Miyata, N.	1,351
	1,354
	1,369
Miyazaki, T.	929
Moeller, C. W.	1,705
Moĭzhes, B. Ya.	315
	1,484
Moller, C.	63
Molodtsova, L.	983
Molotilov, B. V.	12
Mones, A. H.	1,195
	1,247
Monforte, F. R.	13
	1,222
Monkewicz, A. A.	607
Montalenti, G.	11
	374
	832
	835
Moore, E. J.	408

Author	Abstract
Mooser, E.	3
Morgan, H. C.	1,836
Morgan, R. H. C.	10
Morin, F. J.	1,740
Moriya, T.	1,663
Morkowski, J.	1,563
Morozova, A. M.	871
Morris, A. L.	9
Morris, D. P.	1,447
	1,592
	1,593
Morrish, A. H.	36
	445
	944
	950
	954
	970
Morrison, C. A.	13
	379
	604
	1,082
Moser, H.	216
Moss, R. W.	1,302
Motizuki, K.	1,663
Mott, G.	9
Mueller, H. G.	506
	562
	819
	1,017
Mueller, K. A.	11
Muldawer, L.	943
Mullen, E. B.	1,082
	1,830
Murakami, M.	1,145
	1,271
Murray, A. M.	398
	431
Murray, R. B.	185
	1,650
	1,651
Murrin, F. J.	3
Muth, P.	562
Myers, W. R.	606
	1,396
	1,482
	1,488
	1,505
Nachman, J. F.	807
Nagai, O.	317
	359
Nagamiya, T.	135
	1,663
	1,737
Nagano, H.	1,639
Nagasaki, S.	1,693
Nagata, T.	1,759
Nagy, I.	949
Nakagawa, Y.	846
	1,451
Nakamichi, T.	1,533
Nakamura, T.	240
	1,622
Nakamura, Y.	721
	1,407
	1,550
Nakano, H.	133
Narasimhan, V.	727
Naschke, E.	526
	789
Nathans, R.	6
	8
	1,280
	1,602
Neale, F. E.	87
Néel, L.	11
	12
	22
	28
	80
	82
	127
	288
	304
	308
	392
	400
	438
	439
	472
	476
	477
	707
	1,428
	1,429
Neighbours, J. R.	1,601
Neilson, F. W.	13
	1,866
Nelson, A. M.	1,846
Nelson, C. E.	1,082
Nemarich, J.	13
	965
Nepremerov, N. N.	12
Nesbet, R. K.	397
Nesbitt, E. A.	3
	6
	767
	830
	932
	938
	939
	1,040
Nethercot, A. H., Jr.	1,679
Neurath, P. W.	3
	6
	856
Newhouse, V. L.	13
	1,862
	1,876
Newkirk, J. B.	1,612
Newmann, M. M.	1,570
Newport, C. B.	1,835
Nielsen, A.	1,305
Nielsen, J. W.	13
	1,738
Niessen, K. F.	152
	200
	229
	276
	323
	612
	935
Nilan, T. G.	3
	730
Nonnenmacher, W.	576
Nosova, R. S.	12
Nyberg, J. J.	1,778
Nyholm, R. S.	850
Nysiter, H. M.	620
Oakland, L. J.	1,794
Obraztsov, Yu. N.	315
O'Brien, M. C. M.	1,685
Ochsenfeld, R.	745
	749
Ogasawara, N.	960
Ogawa, S.	734
	769
	858
Oguchi, T.	143
Ohara, T.	849
Ohnishi, H.	1,100
Ohoyama, T.	43
Ohtsuka, T.	720
	1,365
Okazaki, C.	1,014
Okkes, R.	1,636
Olsen, K. M.	13
	900
Olson, C. D.	13
	669
Ono, K.	1,018
Ono, M.	845
Onyshkevych, L. S.	1,843
Oomura, T.	766
Orbach, R.	420
	429
Oriani, R. A.	1,572
Orlova, M. P.	1,676
	1,695
	1,701
Osborn, J. A.	478
Oshima, K.	13
	47
	52
	369
	1,639
Osmond, W. P.	8
	941
	1,101
	1,102
O'Sullivan, W.	1,706
Otis, E. J.	1,816
Otter, F. A., Jr.	1,392
Overmeyer, J.	13
	1,161
	1,211
	1,283
Overn, W. M.	1,899
Overton, W. C., Jr.	1,400
Owen, J.	150
	1,439
Owens, A. R.	1,814
Owens, C. D.	3
	1,082
Ozhigov, I. E.	12
Paches, Ya.	1,477
	1,478
Page, J. G.	10
Page, M. A.	514
Paine, T. O.	3
	6
	459
	638
	640
	657
Pakhomov, A. S.	221
	274
Pál, L.	12
	949
	1,421
Pallagi, D.	949
Palma, M. U.	591
Palma-Vittorelli, M. B.	591
Palmer, G. G.	1,845
Palumbo, D.	1,227
Panina, I. K.	271
	796
Pankey, T.	607
Papian, W. N.	1,809
Papoulis, A.	1,870
Pappis, J.	1,020
Parfenov, V. V.	12
Park, D.	996
	1,004
Parker, H. M.	1,289
Parker, R.	811
Parker, R. J.	13
	242
Parravano, G.	1,558
	1,658
	1,756
Parsegyan, B.	1,801
Partridge, R. S.	1,840
Paskin, A.	247
	284
Patel, S. T.	808
Paulevé, J.	13
	511
	1,015
	1,051
	1,119
	1,198
	1,176
	1,698

Author	Abstract
Paulus, M.	1,060
	1,180
Pauthenet, R.	8
	13
	1,055
	1,061
	1,093
	1,095
	1,135
	1,197
	1,231
	1,244
	1,278
	1,295
Pavlovic, D.	6
	13
	679
	869
Pawlek, F.	588
	746
	1,125
Paxton, W. S.	3
	730
Peelaers, W.	1,605
Penfold, J.	1,483
Pengelly, P.	1,904
Penoyer, R. F.	6
	8
	13
	1,086
	1,120
	1,166
	1,171
	1,216
	1,300
Perakis, N.	1,558
	1,628
	1,655
	1,658
	1,687
	1,756
Perekalina, T. M.	1,194
Perry, G. H.	1,827
Perthel, R.	1,445
Pescetti, D.	316
	371
	517
	1,462
Peters, J.	8
Pfeifer, H.	11
Phillips, J. H.	1,388
Picault, A.	529
Pickart, S. J.	8
	993
	1,280
	1,602
Picus, G. S.	1,474
Pigott, M. T.	3
	499
Pilat, I. M.	1,487
	1,555
Pil'shchikov, A. I.	161
	218
	228
	246
Pincus, P.	426
	429
Pinnick, H. T.	3
	1,764
Pipes, L. A.	239
Pippard, A. B.	1,516
Pippin, J. E.	1,151
	1,152
	1,185
	1,187
	1,281
	1,292
	1,716
Pizzo, M.	16
Plotkin, M.	6
Plume, Z. Y.	101
Podrezov, L. I.	12
Pohm, A. V.	13
	669
Poldervaart, L. J.	528
Polivanov, K. M.	981
	982
Pollack, S. R.	1,235
Pollentier, R.	1,605
Porter, C. S.	13
	449
	969
	1,200
	1,212
	1,864
Post, G. I.	1,598
Pothene, R.	12
Poulis, J. A.	528
Poulis, N. J.	1,644
Poulsen, A. S.	3
Powell, R. C.	532
Prache, P. M.	8
	33
	456
	556
Pratt, C. W., Jr.	13
	295
	342
	1,542
	1,623
Pratt, W. R.	1,784
Preston, J.	1,515
Preston, R. P.	1,447
Preston, R. R.	1,593
Prilezhaeva, I. N.	12
	509
Pruton, M.	698
Pry, R. H.	13
	603
	892
Pryce, M. H. L.	11
Puff, H.	1,667
Pugh, E. M.	930
	1,371
Pugh, E. W.	1,567
	1,583
Purcell, E. M.	11
Puzei, I. M.	12
Quartly, C. J.	10
Quigg, R. J.	1,372
Quivy, D.	391
Rado, G. T.	3
	8
	13
	132
	377
	1,085
	1,215
Raffel, J. I.	1,793
Rajchman, J. A.	1,896
Rao, B. S. R.	760
Rappeneau, T.	1,316
Rasmussen, A. L.	1,272
Rathenau, G. W.	13
	867
	883
	995
	1,037
Raub, E.	1,389
	1,412
Reekie, J.	1,431
Reese, O. W.	1,909
Regel, A. R.	1,608
Reggia, F.	1,000
	1,072
Reich, K. H.	523
	762
	779
	1,403
	1,427
Reichel, K.	558
	724
	746
	1,125
Reimer, L.	646
	659
	663
	666
	754
	1,315
	1,318
	1,324
	1,327
	1,333
Reiner, H.	1,871
Reinov, N. M.	1,115
Reljers, H. G.	1,190
Remeika, J. P.	977
	1,239
	1,273
	1,276
Renwick, W.	10
Reshetnikova, N. V.	12
Rhodes, B. L.	1,537
Rhodes, P.	11
	124
	128
Ribaud, G.	731
Richards, C. E.	3
	855
Richards, J. H.	10
Richardson, J. T.	1,606
Ridler, D. S.	10
	1,849
Rieder, G.	296
Rimbert, F.	957
	1,045
Rinder, W.	596
Rios, B. R.	1,649
Rivett-Carnac, A.	9
Robbrecht, G. G.	1,260
Roberts, B. W.	3
	6
	1,368
	1,419
	1,458
	1,506
Roberts, J.	9
Roberts, J. A.	7
Roberts, L. D.	185
	500
	1,650
Roberts, L. M.	1,502
Roberts, W. H.	13
	894
	1,856
Robins, D. A.	1,552
Robinson, A. C.	915
Robinson, A. E.	8
Robinson, R. D.	3
Rodbell, D. S.	3
	13
	24
	236
	729
	1,330
Rodi, V. E.	12
Rodrigue, G. P.	13
	1,150
	1,152
	1,187
	1,214
	1,716
Roebuck, D. S. P.	1,616
Roesler, U.	3
Rogers, J. L.	6
	1,424
	1,425
	1,901
Roi, N. A.	1,625
Rooksby, H. P.	1,078
Rose-Innes, A. C.	617
Rosenberg, M.	1,337
	1,821

Author	Abstract
Rosenstock, H. B.	535
Rossing, T. D.	13
	672
	1,794
	1,861
	1,873
Rossing, T. R.	13
Roth, W. L.	1,739
	1,741
Rothbart, A.	1,907
Rothenstein, B.	911
	1,577
Rothstein, J.	3
Rowen, J. H.	940
	955
Rowlands, G.	124
	128
	344
	914
Rozenblat, M. A.	1,806
Rozner, F.	1,904
Rozovskiĭ, M. I.	279
Rubens, S. M.	1,873
Rubinstein, H.	467
	703
Rüdorff, W.	1,700
Rudyak, V. M.	1,548
Ruediger, B. A.	906
Ruediger, O.	740
Ruhman, S.	1,808
Rumbles, A. R.	1,819
Rush, R. B.	1,836
Rushbrooke, G. S.	186
	336
Ruske, W.	1,338
Ryan, F. M.	1,567
Rytov, S. M.	20
Saito, H.	1,513
Saito, S.	1,680
Saito, Y.	1,512
Salkovitz, E. I.	1,294
	1,399
Sampson, D. K.	1,888
Sanders, R. M.	13
	463
	672
	692
Sandler, Y. L.	1,328
Sanyal, G. S.	12
Saraga, W.	10
Sato, H.	3
	13
	364
	382
	434
	898
	901
	1,594
	1,601
Sato, M.	1,414
Saunders, J. H.	1,057
Savchenko, M. K.	12
Savitski, M. J.	13
	891
Sawada, S.	1,062
Sawyer, B.	864
Say, M. G.	491
Sbitnikova, I. S.	12
	503
Scarbrough, A. D.	1,778
Schallerer, J. W.	7
Scharfman, H.	1,082
Scharnow, B.	54
Scheikl, O.	962
Schindler, A. I.	1,399
Schindler, M.	774
Schlömann, E.	6
	13
	1,202
	1,248
Schmeckenbecher, A.	7
Schmidbauer, O.	458
Schmitt, R. W.	1,464
	1,491
	1,590
Schnettler, F. J.	13
	1,222
Schofield, D.	1,309
Scholten, R. A.	1,098
Schreiber, F.	299
	804
Schrieffer, J. R.	38
Schuele, W. J.	462
Schultz, R. E.	1,845
Schulze, D.	645
Schulze, R.	735
Schwabe, E.	501
	1,121
Schwartz, N.	3
Schwartz, R. F.	13
	1,209
	1,853
	1,875
Schwartze, W.	1,446
Schweinler, H. C.	1,409
Schweitzer, L.	576
Schwink, C.	1,308
	1,609
Scott, E. J.	1,668
Scott, G. G.	13
	664
	665
	680
	693
	756
	802
	1,402
	1,465
Seavey, M. H., Jr.	13
	259
	268
	674
	696
	1,082
Seavey, M. H., Jr. (Cont'd)	
	1,790
Sedov, N. N.	551
Sedov, V. L.	921
Seidel, H.	1,082
	1,129
Seiden, J.	424
Seiwatz, H.	1,238
Sekizawa, H.	1,033
	1,144
	1,186
Selwood, P. W.	1,344
Semadeni, Z.	12
Senftle, F. E.	607
Sensiper, S.	1,082
Serin, B.	1,574
Serres, A.	1,628
	1,655
	1,658
	1,687
Sery, R. S.	6
	609
Shafer, M. W.	1,300
Shekun, L. Ia.	12
Shenker, H.	3
	1164
Shepstone, B. J.	909
	928
Sherry, N. P. R.	519
	1,005
	1,039
Sherwood, R. C.	6
	13
	457
	977
	1,273
	1,276
	1,319
	1,486
	1,519
	1,543
	1,773
	1,779
Shevel, W. L., Jr.	1,897
Shifrin, G.	1,915
Shiklosh, T.	221
Shimada, J.	1,018
Shimizu, M.	1,091
Shimomura, Y.	1,680
Shirakawa, Y.	849
	929
Shirane, G.	1,280
Shirkman, S.	622
Shishkov, A. G.	1,170
Shmarts, V. L.	346
Shmatov, V. T.	376
Shockley, W.	83
	709
	710
	711
Shoenberg, D.	12
	1,343
	1,381
Shramkov, E. G.	564
Shtol'ts, E. V.	12
	1,325
	1,326
	1,520
	1,521
Shtrikman, S.	6
	303
	314
	370
	1,614
Shubina, L. A.	12
	824
	825
Shull, C. G.	728
	801
	1,490
Shur, Ya. S.	12
	108
	733
	824
	825
	838
	866
	1,325
	1,326
	1,520
	1,521
Sidhu, S. S.	1,467
Silsbee, R. H.	1,767
Simpson, A. W.	521
	768
Singer, J.	13
	896
Singer, J. R.	469
	1,681
Singh, L.	324
Sirvetz, M. H.	13
	1,057
	1,213
Sivaramakrishnan, V.	1,686
Six, W.	10
Sixtus, K. J.	3
	61
	953
	1,079
Skelbelkin, V. I.	154
Skomal, E. N.	13
	1,905
Skov, R. A.	1,868
Skrotskii, G. V.	12
	376
	1,188
	1,243
Slonczewski, J. C.	13
	1,219
	1,236
Smart, J. S.	169
	197
Smeets, J. M. G.	13
Smel'makh, M. F.	1,115

Author	Abstract
Smirous, K.	718
	758
Smit, J.	11
	183
	354
	567
	1,002
Smith, C. G.	3
Smith, D.	13
Smith, D. O.	3
	6
	13
	46
	464
	537
	652
	673
	675
	682
	700
	1,059
	1,798
Smith, J. H.	1,509
	1,523
Smith, R. S.	18
Smith, W. V.	13
	1,161
	1,211
	1,283
Smits, L. J.	589
Smoluchowski, R.	864
Snieder, J.	1,131
	1,143
	1,182
	1,196
Sokolov, A. V.	148
Solomko, R. N.	154
Solt, I. H., Jr.	13
	387
	1,083
	1,199
Sommerfeld, A.	62
Sommerkorn, G.	836
	847
Sonder, E.	1,559
Sondheimer, E. H.	440
Soohoo, R. F.	1,792
Sorger, G.	634
Soutif-Guicherd, J.	13
	1,726
Špaček, L.	757
	772
Spedding, F. H.	1,411
	1,495
	1,536
	1,537
	1,562
	1,573
Spence, R. D.	1,748
Spencer, E. G.	6
	13
	969
	1,000
Spencer, E. G. (Cont'd)	1,072
	1,082
	1,128
	1,200
	1,212
	1,226
	1,864
Spivak, G. V.	12
	503
	509
	525
	551
Spry, W. J.	309
Squire, C. F.	1,361
Sriraman, S.	1,386
	1,560
	1,561
Srivastava, C. M.	9
Stacey, F. D.	425
	1,312
	1,404
Staeblein, H.	959
Standley, K. J.	8
	248
	1,403
Stanley, J. K.	6
Startseva, I. E.	12
Stauffer, L. H.	13
Stauss, H. E.	435
	598
	878
	927
	1,534
	1,584
Steele, M. C.	1,760
Steenland, M. J.	1,638
	1,646
Stephen, W.	705
	787
Stern, H. M.	1,846
Sternberk, J.	443
	761
	1,116
	1,118
Stevens, D. K.	1,391
	1,409
	1,559
	1,767
Stevens, J. R.	651
Stevens, K. W. H.	248
	306
	1,375
	1,675
	1,691
Stewart, K. H.	131
Stinson, D. C.	1,259
	1,302
Stoinskaia, E. E.	853
Stoner, E. C.	79
	85
	86
	482
Strachan, C.	398
	431
Street, R.	422
	773
	810
	1,388
	1,509
	1,523
	1,894
Strnat, K.	596
	1,471
Strough, R. I.	441
Strumwasser, E.	9
	1,082
Stuart-Williams, R.	1,821
Stuijts, A. L.	13
	925
	995
	1,221
Stull, J. L.	1,020
Sturm, W. J.	1,767
Suchet, J.	226
Suchkov, A. I.	987
Suchow, L.	961
Sucksmith, W.	349
	643
	815
	915
	1,309
	1,359
	1,455
Suda, P.	227
Sugihara, M.	862
Suhl, H.	13
	191
	198
	203
	254
	361
	942
	1,022
	1,082
	1,585
	1,858
Summergrad, R. N.	1,126
Sundaramma, K.	1,702
Suran, J. J.	1,839
Suzuki, K.	868
Swan, M. J.	616
Swanekamp, F. W.	1,127
	1,279
Swern, L.	1,054
Swoboda, T. J.	1,734
Sykes, M. F.	207
	212
	307
	423
	432
Syozi, I.	133
Tachikawa, K.	918
Tachiki, M.	1,737
Taglang, P.	1,366
	1,367
	1,442
	1,733
Takahashi, M.	1,513
Takaki, H.	548
	721
Takamura, J.	1,550
Takemoto, S.	1,234
Taketa, H.	240
	1,622
Taksar, I. M.	101
Taniguchi, S.	114
	1,063
	1,147
	1,437
Tannenwald, P. E.	13
	259
	268
	656
	668
	674
	676
	696
	1,026
	1,036
	1,082
	1,790
Taoka, T.	720
	1,365
	1,435
Tarama, K.	1,711
Tarnóczi, T.	1,421
Tarnotski, T.	12
Tatsumoto, E.	857
	881
Tauber, A.	13
	1,097
	1,158
	1,728
Tauer, K. J.	770
Taylor, A.	6
	13
	899
Tazaki, H.	1,090
Tchernikova, L. A.	13
Teale, R. W.	344
	1,469
Tebble, R. S.	189
	1,469
	1,578
Telesnin, R. V.	12
	1,103
	1,170
	1,183
Tenzer, R. K.	6
	13
	522
	886
	887
	953
	1,079

Author	Abstract
Teranishi, S.	1,711
ter Haar, D.	173
	194
Terrier, C.	1,080
	1,153
	1,677
	1,718
Tessman, J. R.	3
	122
Teunissen, P.	528
Theile, K. J.	792
Thiess, G. H.	1,292
Thoburn, W. C.	1,562
	1,573
Thomas, E. E.	13
	1,546
Thomas, J.	1,753
Thompson, E. D.	1,600
Thompson, J. C.	1,361
Thompson, J. E.	1,359
Thompson, L. G.	1,772
Tiablikov, S. V.	12
Tilden, E. F.	1,027
Tiller, C. O.	688
Tillieu, J.	326
	332
	362
Timofeev, B. B.	579
	844
Tino, Y.	744
	1,414
Tokunaga, K.	1,749
Tolmachev, V. V.	205
Tombs, N. C.	8
	1,088
	1,173
Tompkins, J. E.	13
Tompkins, R. E.	6
Tonge, D. G.	49
	460
Tonks, L.	61
Toole, R. C.	1,734
Torizuka, Y.	1,053
Torkar, K.	962
	1,383
Torrey, R. D.	594
Tosca, L.	11
Townes, C. H.	13
Tracy, R. A.	841
Trapp, R. H.	13
	527
	678
Tredgold, R. H.	119
Treuhaft, M. A.	1,082
Treves, D.	6
	303
	314
	622
Trishina, Z. D.	246
Trombe, F.	1,450
Troughton, G. H.	923
Trousil, Z.	718
Trousil, Z. (Cont'd)	758
Tsai, B.	1,056
	1,080
	1,153
	1,629
	1,632
	1,635
	1,640
	1,677
	1,718
Tseitlin, V. B.	1,420
Tsipis, S. M.	148
Tsubokawa, I.	1,456
	1,669
Tsuji, T.	548
Tsukernik, V. M.	313
	347
	351
	405
Tsuya, N.	13
	110
	381
	989
	1,112
	1,456
Tukalov, R. I.	12
Turkevich, J.	1,626
Turner, D. N.	1,909
Turov, E. A.	4
	12
	103
	130
	270
Tutovan, V.	621
Tyablikov, S. V.	195
	205
Uchida, E.	1,006
	1,630
	1,654
Uebersfeld, J.	508
Ukaji, I.	1,357
Unangst, D.	642
Urquhart, H. M. A.	1,049
Uryû, N.	104
	105
	1,671
Uyeda, S.	1,759
Vail, Iu. S.	12
Vainshtein, E. E.	1,418
Valeev, Kh. S.	1,177
Valenta, L.	12
	34
	35
	153
	168
van Daal, H. J.	867
Van Dang, N.	393
	401
	411
van den Berg, G. J.	809
van den Broek, H.	1,643
van der Burgt, C. M.	6
	10
	1,122
van der Heide, H.	10
	1,154
	1,850
van der Marel, L. C.	1,643
van Itterbeek, A.	1,314
	1,379
	1,448
	1,479
	1,605
van Kranendonk, J.	11
	134
	210
	214
	294
	355
van Oosterhout, G. W.	447
van Peski-Tinbergen, T.	12
	115
	206
Van Sant, O. J.	6
	840
Van Uitert, L. G.	3
	1,022
	1,034
	1,073
	1,082
	1,111
	1,127
	1,130
	1,279
Van Vleck, J. H.	6
	11
	59
	69
	78
	81
	99
	251
	289
	291
	355
	565
	1,082
	1,690
van Wolfe, R.	3
Vartanian, P. H.	13
	1,031
	1,038
	1,048
	1,822
	1,860
Vassiliev, A.	1,168
Vaughan, J. D.	1,734
Vautier, R.	282
	496
	1,066
	1,140
	1,141
Vautier, R. (Cont'd)	1,261
	1,263
	1,887
Veksler, A. Z.	139
	297
	298
Venkateswarlu, K.	1,386
	1,560
	1,561
Ventssel, V. A.	1,580
Verhaeghe, J. L.	1,260
Verkin, B. I.	4
	553
	1,452
	1,504
	1,565
Verma, G. S.	1,749
Vestrum, E. F., Jr.	1,208
Vicena, F.	120
	140
	187
Vickery, R. C.	1,707
	1,709
	1,710
Vigness, I.	454
Vilím, F.	533
	1,148
Villachon, A.	658
Villers, G.	951
	1,058
	1,179
	1,244
Vintera, J.	1,108
Vitol, V. G.	416
Vlasov, A. Ia.	12
Vlasov, K. B.	4
	12
	102
	130
	155
	312
	348
	985
Vlasov, V. V.	853
Vogler, G.	644
Voigt, F.	964
Voityshen, S. Yu.	1,555
Volkov, D. I.	12
	1,358
	1,420
	1,511
Volkov, Yu. D.	1,258
von Aulock, W.	940
	955
von Elfreide, M.	739
von Harlem, J.	157
von Haza-Radlitz, C.	1,282
von Hippel, A.	3
	1,155
	1,615
	1,802

Author	Abstract
von Kienlin, A.	334
	1,139
	1,18[illegible]
	1,230
	1,270
von Klitzing, K. H.	555
	739
	1,416
	1,553
Vonsovskiĭ, S. V.	4
	12
	102
	130
Voroshilov, V. P.	12
Vtiurin, N. I.	12
Waché, X.	1,016
Wachtel, E.	516
Wakeman, C. B.	806
Waldron, R. A.	9
	1,052
Walker, E. V.	3
	855
Walker, L. R.	13
	198
	254
	264
	600
Walsh, D. E.	1,075
	1,165
Walter, J. L.	13
	892
Walters, R. E. S.	6
Wang, F. B.	1,092
Wangsness, R. R.	146
	199
	412
	427
	1,149
Ward, C. E.	3
Waring, R. K.	1,744
Wasscher, J. D.	1,643
Watanabe, H.	1,138
	1,356
	1,693
Waterstrat, R. M.	1,538
Watkins, J.	5
	8
	1,088
	1,173
Watson, J. D.	540
Watson, J. H. L.	3
	6
	13
	888
Watt, L. A. K.	954
	970
Way, D. W.	1,889
Webb, C. E.	546
Weber, G. H.	995
Weber, H.	1,250
Webley, R. S.	701
Weertman, J. R.	3
	13
Weil, L.	481
	724
	1,310
	1,349
Weiner, D.	1,528
Weinstock, B.	1,664
Weisbaum, S.	3
Weiss, G. P.	13
	673
Weiss, J. A.	6
Weiss, M. T.	13
	1,007
	1,859
Weiss, P.	53
Weiss, P. R.	84
Weiss, R. J.	770
Weisz, R. S.	3
	991
Welch, A. J. E.	8
	1,133
Wells, F. H.	10
Wenckus, J. F.	6
Wendling, R.	1,558
Wenny, D. H.	6
	13
	900
	1,546
Wernick, J. H.	932
Wert, C.	763
	945
West, F. G.	13
	1,540
West, J. C.	1,877
Westphal, W. B.	1,155
Westrum, E. F., Jr.	13
Whirry, W. L.	1,902
Whitby, F. J.	1,616
White, J. G.	13
	1,218
White, R. L.	13
	387
	1,083
	1,199
Whitley, S.	1,631
Wickham, D. G.	13
	1,721
	1,727
	1,751
Widrow, B.	1,803
Wiener, G.	3
	13
	678
	723
Wiener, G. W.	6
	614
	1,624
Wiener, J.	1,846
Wier, J. M.	1,810
Wijn, H. P. J.	8
	10
Wijn, H. P. J. (Cont'd)	13
	925
	984
	1,134
	1,146
	1,154
	1,221
	1,850
Wilde, H.	179
	335
Wilkinson, M. K.	728
	801
	1,266
	1,274
	1,490
	1,736
	1,757
Williams, A. J.	6
	1,027
	1,165
Williams, H. J.	3
	6
	13
	457
	479
	709
	710
	711
	767
	977
	1,040
	1,075
	1,273
	1,276
	1,319
	1,486
	1,519
	1,543
	1,773
	1,779
Williams, I.	1,592
	1,593
Williams, M. O.	1,229
Willis, D. W.	10
	1,881
Wills, M. S.	9
Wilson, L. R.	1,846
Wilson, V. C.	3
Winterhoff, H.	746
Wohlfarth, E. P.	23
	49
	85
	96
	389
	446
	460
	482
	632
	848
	946
	966
Wohlfarth, E. P. (Cont'd)	1,662
	1,770
Wojtowicz, P. J.	1,288
	1,697
Wold, A.	13
	1,729
Wolf, W. P.	13
	340
	558
	572
	1,150
	1,214
	1,631
	1,683
	1,716
Wolff, C.	1,532
Wolfsberg, M.	3
Wollan, E. O.	905
	1,274
	1,647
	1,736
Wollenberger, J. H.	797
Wood, P. J.	186
	336
Woolley, J. C.	810
	1,388
Worn, D. K.	3
Wotruba, K.	12
	497
	502
	578
	632
	719
	1,454
Wright, E. P. G.	10
	1,844
Wucher, J.	1,422
	1,468
	1,529
	1,558
	1,633
	1,634
	1,658
	1,756
Wycklendt, D. A.	6
Yager, W. A.	1,019
	1,024
Yakovlev, E. N.	302
Yamada, O.	209
	534
	732
Yamaguchi, S.	586
	592
	593
	599
	687
	936
	958
	1,341
	1,613

Author	Abstract
Yamamoto, M.	114
	318
	1,063
	1,364
	1,398
	1,437
	1,533
Yamartino, E. J.	13
	677
Yamashita, J.	1,719
Yamashita, T.	857
Yao, Y. L.	1,431
Yokota, M.	170
Yosida, K.	135
	182
	1,498
Young, J. D.	6
Yousef, Y. L.	1,627
Yu, S. P.	445
	944
	950
Yuzuri, M.	1,693
Zachariasen, W. H.	1,575
Zaikova, V. A.	12
Zakharchenko, V. F.	12
Zaripov, M. M.	12
Zatsepin, N. N.	269
	272
	319
	320
	333
	495
Záveta, K.	649
	1,108
Zeender, J. R.	13
	1,202
Zega, B.	1,058
Zehler, V.	39
	661
	662
Zemsch, P.	765
Zener, C.	6
	126
Zilberman, G. E.	4
	261
	352
Zlotnik, H.	1,137
Zneimer, J. E.	13
	1,137
	1,213
Zschekel, H.	1,838
Zumbusch, W.	877
Zvereva, T. A.	246
Zyryanov, P. S.	1,188