MAGNETICS SOCIETY NEWSLETTER

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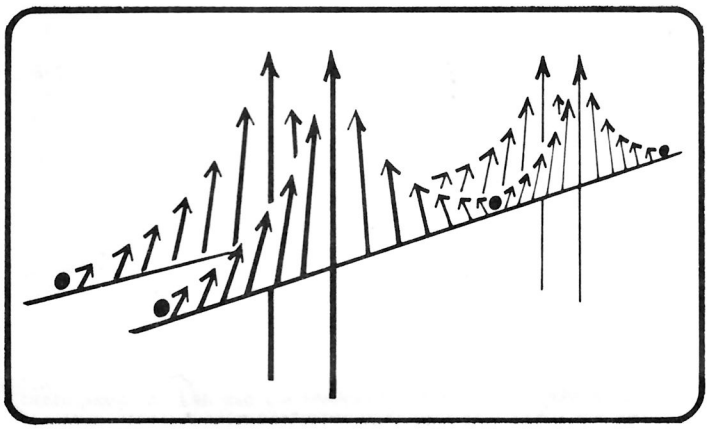
CARL E. PATTON, EDITOR • COLORADO STATE UNIVERSITY • DEPARTMENT OF PHYSICS • FORT COLLINS, COLO. 80521

20TH ANNUAL CONFERENCE MAGNETISM AND MAGNETIC MATERIALS SAN FRANCISCO, DECEMBER 3-6, 1974



The Twentieth Annual Conference on Magnetism and Magnetic Materials will be held at the Jack Tar Hotel in San Francisco, California, from Tuesday, December 3 through Friday, December 6, 1974. The purpose of this conference is to bring together scientists and engineers interested in all aspects of magnetism from basic research to applications. Accordingly, the Conference will cover all recent developments in magnetism and its associated technology. Those interested in any of the various branches of magnetism are invited to attend this Conference and to contribute to the technical sessions.

PROGRAM

The technical program will consist of symposia, invited and contributed papers in all branches of science and technology involving magnetism. Specific categories of interest are:

1. Material Synthesis and Characterization; New Materials.
2. Magnetism Order; Magnetic Structure.
3. Phase Transitions; Singlet-Ground-State Systems.
4. Critical Phemomena
5. Surface and Size Effects.
6. Amorphous and Disorder Effects.
7. Alloys; Dilute Alloy Effects.
8. Bands; Crystal Fields; Optics; Magneto-Optics.
9. Exchange; Covalency; Hyperfine Effects; Bonding.
10. Transport; Metal/Insulator Transitions; Tunneling.
11. Spin Waves; Relaxation Effects.
12. General Theory.
13. Hard Magnetic Materials.
14. Domains; Magnetostatics; Soft Magnetic Materials.
15. Microwave Devices and Materials.
16. Anisotropy and Magnetoelastic Effects.
17. Bubble Materials: Growth and Characterization.
18. Bubble Devices; Design, Fabrication, Measurements.
19. Recording; Memory Devices and Materials.
20. Other Applications.
21. Interdisciplinary and Other Subjects.

PAPERS

Contributed papers, falling broadly within the scope of this program, are solicited. Prospective authors should submit abstracts by August 16, 1974 to:

Dr. H. C. Wolfe, American Institute of Physics
335 East 45th Street, New York, N.Y. 10017

Papers will be selected on the basis of new technical information actually contained in the abstract. The abstract should state clearly the purpose and significance of the research in addition to the results actually obtained. Program committee: E. M. Gyorgy and R. E. Watson (Co-chairmen), and A. Arrott, R. B. Clover, R. E. Dietz, M. A. Gilleo, C. D. Graham, F. B. Hmphrey, T. A. Kitchens, G. H. Lander, F. E. Luborsky, A. H. Luther, J. E. Mee, R. Orbach, C. E. Patton, J. J. Rhyne, J. C. Slonczewski, J. B. Torrance, Jr., E. P. Valstyn, J. E. Wernick, R. M. White and D. K. Wohlleben.

FURTHER INFORMATION:

Additional information may be obtained from the local chairman: K. Lee, IBM Research Laboratory, K44/281, Monterey and Cottle Roads, San Jose, California 95193

INTERNATIONAL CONFERENCE ON MAGNETIC BUBBLES:

A topical conference on this subject is scheduled in close proximity to the Conference on Magnetism and Magnetic Materials. It will be held at the IBM Research Laboratory, San Jose, California on the 9th, 10th, and 11th of December, 1974, with J. Slonczewski, General Chairman. The scheduled program, to be prepared, will consist of invited talks. Details will be given in further announcements.

RIVERS AND SUOZZI, CANDIDATES FOR DIRECTOR/DELEGATE FOR DIVISION IV IN 1975/1976

R. A. Rivers and J. J. Suozzi have been selected as candidates for Director/Delegate to represent all G/S in Division IV. Both candidates have provided the NEWSLETTER with statements pertaining to their candidacy.

R. A. Rivers, Division IV Director/Delegate Candidacy Statement

There is one primary issue: "How can IEEE become an effective force in making possible a lifetime career in Electrical and Electronic Engineering". There are many aspects to the problem. It is an operating system problem involving: our society, our employers, our rule making government, our Body of Knowledge storage and dissemination system including our educators, and last but not least, ourselves as practicioners in the profession. Our Groups and Societies with their activities in support of the development, storage and dissemination of our specialized Bodies of Knowledge are absolutely necessary and desirable. Without these activities by our Groups and Societies such activities would have to be accomplished by

R. S. Rivers, Aircom, Inc.
Union, New Hampshire, 03887

some other well meaning but possibly not as competent an organization. While absolutely necessary, it is not sufficient to engage only in Technical Activities.

As Engineers, we find employment because someone wants innovation and improvement. We are able to design new things because our employers find it profitable. If our social system is modified so that innovation is not tolerated or desired, we will have no employment. It is, thus, necessary for us to influence government whenever and wherever rules are being promulgated or public funds allocated that affect our ability to innovate. We have goals in common with our employers in making innovation and improvement profitable.

As professionals, we should work to make continuing technical competence possible in a real world environment. Our technical publications should be expanded in scope to include all of the information needs of members. These publications should be continually reviewed using a criteria of satisfying the needs of the reader-member, as well as the writers.

I view the role of Division Director as one of representing the membership of the Groups and Societies of the Division. I will strive to represent the membership on the IEEE Boards and Committees.

My background as president of a society, member of the TAB publications board, and my present position as TAB Finance Chairman has given me wide experience in the various problems facing IEEE, ranging over the broad spectrum of administrative, fiscal, and publication matters. My career experience in various technologies represented in the division should be helpful in performing my duties effectively.

If elected as your Division Director, I will strive for the following: (a) Explore all means to improve communication and cooperation within the division for the benefit of all; (b) Be a strong advocate for Division IV views at the IEEE Board of Director level; (c) Support continued strong publication and education programs within IEEE; (d) Support strongly the involvement of IEEE in professional matters; (e) Examine and provide leadership toward improved efficiency within the Institute itself on services to members; and (f) Support the IEEE's timely involvement in current national and/or international issues where our technological expertise is essential.

J. J. Suozzi, Bell Laboratories
Whippany, New Jersey, 07981

J. J. Suozzi, Division IV Director/Delegate Candidate Statement

Division IV encompasses a very broad technological area of interest within IEEE. It is one of the largest divisions by membership and is responsible for about one-fourth of all the transaction pages published by IEEE. The Division Director's prime duty is to reflect the views of the division to the Board of Directors on both technical and professional matters and to work toward obtaining favorable action on these views. A second and no less important duty is that the Division Director, as a member of the IEEE Board of Directors, must also work diligently for the good of the Institute itself. The Division Director, therefore, represents his particular division within the framework of the general welfare of the Institute.

1975 INTERMAG — LONDON

The 1975 INTERMAG Conference, jointly sponsored by the Magnetics Society of the IEEE, the IEE and the Institute of Physics, will be held in London, England, at the Impreial College of Science and Technology on April 14-17, 1975. Plans are presently being formulated, and more information will follow in the next NEWSLETTER.

Topics of wide interest in recent years certain to be discussed at the 1975 INTERMAG Conference include information storage technology both magnetic and non-magnetic, magnetism in bioengineering, hard and soft magnetic materials, magnetic and magnetic-semiconductor devices for power conditioning and signal processing, superconducting devices and systems, magneto-elastic devices, microwave magnetics, magneto-optics, magnetic recording, and magnetic vehicular levitation.

Information can be obtained from:

Professor F. J. Friedlaender
Chairman, American Management Committee
1975 INTERMAG
School of Electrical Engineering
Purdue University
West Lafayette, Indiana 47907
(317) 494-4444.

There will be two satellite conferences associated with '75 INTERMAG. The Second SOFT MAGNETIC MATERIALS CONFERENCE will be held in Cardiff, Wales, on April 9-11, 1975, and the Conference will stress certain individual applications of materials particularly in power engineering. The number of participants will be restricted to about 120. Those interested should contact:

Professor J. E. Thompson
Wolfson Centre
University of Wales Institute of Science & Technology
Cardiff, Wales

In addition, an INTERNATIONAL COLLOQUIUM ON MAGNETIC FILMS is planned for Regensburg, W. Germany, on April 22-25, 1975. Those interested should contact:

Professor Dr. Horst Hoffmann
Universität Regensburg
Fachbereich Physik
84 Regensburg
Universitätsstrasse 31
West Germany

(See separate article in this issue.)

WEST COAST GROUP FLIGHT FOR 1975 INTERMAG CONFERENCE IN LONDON

If you are a Magnetics Society member residing west of the Rocky Mountains, but including Colorado, and are interested in group flight savings for travel to attend INTERMAG-1975, London, and

associated satellite conferences (Soft Magnetic Materials, Cardiff and International Colloquium on Magnetic Films, Regensburg), please immediately notify:

Jon H. Myer
Hughes Research Laboratories
3011 Malibu Canyon Road
Malibu, California 90205

CHARTER RATE TO LONDON FOR INDIVIDUALS ATTENDING 1975 INTERMAG CONFERENCE IN LONDON

Professor Fritz Friedlander, Purdue University, Lafayette, Indiana, 47907,has advised the Newsletter that a recent Civil Aeronautics Board special regulation (Special Regulation 3728 TGC) provides for charter rates to individuals, provided that the booking is made at least 105 days prior to departure from the USA. The cost for a Chicago-London round trip would be on the order of $250. The only problem appears to be in finding out the schedule for available charters which accomodate the INTERMAG program. Interested individuals should contact Dr. Friedlander (317) 494-4444.

SEVENTH INTERNATIONAL COLLOQUIUM ON MAGNETIC THIN FILMS, REGENSBURG, GERMANY, APRIL 22-25, 1975.

The Seventh International Colloquium on Magnetic Thin Films will be held at the University of Regensburg, West Germany from Tuesday, April 22, through Firday, April 25, as a satellite Colloquium of the INTERMAG Conference which will be held in London, U.K. The purpose of the Colloquium is to bring together researchers on magnetic films and on surfaces of magnetic materials, to bring together scientists who work in basic and applied research, and to stimulate new ideas through discussions in a rather informal atmosphere. The Scientific Program of this Colloquium will include the basic experimental and theoretical investigations of magnetic metallic films, magnetic semiconducting films, magnetic insulating films, magnetic amorphous films, and surfaces of magnetic materials.

The main sessions will be reserved for the following subject categories:

Magnetic Domains and Walls	(including structure, static and dynamic behaviour, mobility, coercive force, etc.)
Magnetic Anisotropy	(including the basic concepts of magnetocrystalline, magneto-elastic and uniaxial anisotropy)
Surface Magnetization, Dead Layers	(results on the magnetization at surfaces of magnetic materials compared with those of very thin films, LEED, Auger, ESCA, SIMS, Photoelectrons with special reference to magnetic materials)
Magnetization and Electronic Structure	(investigations and results at films, surfaces, interaction between films and substrates)
Magneto-optical and Magneto-electrical Phenomena	
Resonances	
Phase Transitions	
Interdisciplinary and other Subjects	

Invited speakers will give reviews or new results on these subjects, especially to introduce the subject of the surface of magnetic materials, which should be included in the Thin Film Colloquium. Contributed papers on the above subjects will be allowed only a very short time to preserve the character of the Colloquium as a discussion meeting. The language of the Colloquium will be English. No simultaneous translation of the presentation will be provided. Prospective authors should submit abstracts by December 15, 1974 to:

Prof. Dr. H. Hoffmann
Magnetic Film Colloquium
Universität Regensburg
Fachbereich Physik
84 Regensburg
W. Germany

Details about preparing the abstracts will be given in a Second Call for Papers. To preserve the character of the Colloquium the contributed papers will not be published. Instead, a Colloquium booklet which includes the contents of the contributed papers and the abstracts of the invited papers will be distributed at the Colloquium. The invited papers will be published in IEEE Transactions on Magnetics. The deadline for the manuscripts will be March 1, 1975. Social events including a boat-trip along the Danube river and an informal party are planned.

The German Organizing Committee:

Chairman	H. Hoffmann
Program	E. Geldtkeller (Chairman)
	U. Gonser
	H. Hoffmann
	U. Krey
	K. D. Leaver
	W. Zinn
Local arrangements	U. Krev
Finance	H. Hoffmann

Anyone wishing to be placed on the mailing list for further details should contact Professor Hoffmann as soon as possible.

ELECTROMAGNETIC TRANSPORTATION SESSIONS ATTRACT INTEREST AT TORONTO INTERMAG

Three contributed sessions and two workshops on the subject of Electromagnetic Transportation attracted the interests of a substantial number of attendees at the 1974 INTERMAG Conference in Toronto. Because of this great interest and because of the novel ideas described by the session summary authors, these summaries are presented as a unit, separate from the other INTERMAG summaries which follow in this issue.

SESSION 11 - ELECTROMAGNETIC TRANSPORTATION WORKSHOP (I)
A. R. Eastham

One of the major themes of the 1974 Intermag conference was electromagnetic transportation. Thanks to the efforts of H. Kolm, some 32 papers from 5 countries were presented in 3 sessions. In addition, lively discussions ensued in two workshop sessions. The first electromagnetic transportation workshop, chaired by D. Atherton, was held in the evening before the first technical session. The evening began with the presentation of three post deadline papers. Firstly, J. Parker described the Go-Urban system. The Government of Ontario, as part of a $1.3 billion urban transportation plan, has commissioned a full-scale test of this system, developed by Krauss-Maffei (with controlled electromagnetic suspension and LIM propulsion), on a 4 Km loop of elevated guideway at the Canadian National Exhibition in Toronto. The test system should be operating in late 1975. C. English then described a LIM which was designed by SPAR Aerospace Products Ltd. for the CNE test system. He described facilities which are being constructed at SPAR for the testing of single-sided LIM's on a curved track at speeds up to 70 mph. The third paper, by E. Freeman, was concerned with the problems of normal force in single-sided LIM's. This force, which can far exceed the propulsion force,changes in both magnitude and direction with speed and is a major design consideration for LIM's. The meeting then proceeded to the general workshop session. The Chairman called for a discussion on the levitation, propulsion and guidance of high speed vehicles with electrodynamic (i.e. superconducting magnet) suspension. He noted that while the Japanese initially favoured loop or ladder guideways and U.S. investigators favoured strips, both countries are now investigating alternate configurations. There was a consensus that no one configuration has proved superior and that there is considerable scope for novel designs. E. Burke pointed out that large parasitic eddy current losses occur in thick conductors across the guideway and that loops, ladders, and LSM

windings must be stranded. R. Thornton pointed out that one criterion for the optimum guideway was the minimum magnetic drag for the minimum aluminum, although, as H. Kolm noted, this drag force is only one third of aerodynamic drag. G. Danby pointed out that energy efficiency was likely to be important in any new transportation system. Methods of propulsion were then discussed. There was little enthusiasm for any type of air propulsion, and it was generally agreed that while the LIM was well suited for low clearance electromagnetic suspensions, the LSM was most appropriate for the high clearance electrodynamic suspension. It was noted that the LSM was much easier to analyse than the LIM and that the problems which have arisen in the development of LIM's, such as end effects, normal forces, etc., are not likely to be significant for the LSM. The chairman then drew up guideway configurations proposed by various groups around the world. It was generally agreed that guidance should not be considered separately but as part of an integrated system. It is probable that a variety of systems will persist, optimized to specific locations and traffic patterns. High speed Maglev systems will compete primarily with short haul air transport. F. Moon noted that while TACV's are not likely to be a contender for high speed (250-300 mph) service the dynamic air cushion or ram wing vehicle could be a future competitor. Maglev systems appear to be dividing into electromagnetic suspension with LIM propulsion and electrodynamic suspension with LSM propulsion. The former is well suited to low speed urban transportation, while the latter is most suited to high speed inter-city operation. Near full-scale tests in the near future in several countries should indicate the operational speed ranges for these systems. The first transportation workshop provided a useful exchange of ideas and served to whet the appetite of the delegates for the technical sessions to follow.

SESSION 15 - ELECTROMAGNETIC TRANSPORTATION (I), R. D. Thornton

This was the first of three sessions on "Electromagnetic Transportation" and was devoted primarily to an overview of work going on around the world. Kolm gave an introductory talk that explained some of the basic principles of both attractive and repulsive systems; he also described his own work at MIT on the magneplane. Rudback described the Canadian work currently going on at Queens University, University of Toronto, and McGill University; this work is primarily on repulsive levitation. Rhodes described the Wolfson project at the University of Warwick in England. Borcherts of Ford spoke in lieu of Harding of DOT and described the status of maglev work in the U.S. Atherton presented some results of an analysis done at Queens University that demonstrated the difficulty of achieving wide-gap levitation with an attractive system. Gutberlet gave an overview of the entire German maglev effort, and explained that they have ruled out air cushions and permanent magnets and are now focusing all of their non-wheel effort on electromagnetic (i.e. attractive) and electrodynamic (i.e. repulsive) systems; he showed several slides of operating vehicles and experimental facilities. Urankar described the Siemens program in Germany, and showed pictures of their Erlangen test track (a 280 meter diameter circle banked at 45°) and their recently completed test vehicle. Altogether, in three sessions and two workshops over 30 papers were presented on work related to maglev. With many participants from overseas (particularly Germany, Japan, and England), this was the most important international technical meeting on maglev held to this date. In all of the sessions there was lively discussion by a well informed audience. This session included a considerable discussion of various guideway configurations. G. Danby of Brookhaven made several comments on the null flux system and Atherton commented on the flat guideway design. It seemed to be generally agreed that many guideway configurations could provide stable guidance if the vehicle coils and guideway shape were properly designed; more work is required to find the best shape. The necessary speed for successful HSGT was generally agreed to be between 90 m/s and 150 m/s, but there is clearly relatively little agreement on many aspects of design. Controversies included discussion of whether the attractive system has sufficient speed potential, whether the LSM is best for a repulsive system, whether any new technology can win against established wheeled systems, or whether the budgetary constraints will prevent development of the new concepts.

SESSION 25A - ELECTROMAGNETIC TRANSPORTATION (III), G. R. Slemon

This third session on Electromagnetic Transportation was added to the program because of the large number of timely and relevant papers received. The central theme of the session was the computation of fields in the conductor configurations encountered in magnetically levitated systems. F. C. Moon described the use thermographic techniques to display current distribution in aluminum plates. Methods of field calculation were discussed in papers by P. Silvester, A. V. Sabrias, and G. T. Danby. H. Coffey described experiments on the SRI test vehicle. P. E. Burke presented predictions of eddy current losses in track conductors and structural members arising from superconducting magnets. J. F. Eastham described experiments on "Magnetic Rivers".

SESSION 33 - ELECTROMAGNETIC TRANSPORTATION WORKSHOP II, H. H. Kolm

Like all other sessions on electromagnetic transportation, this final workshop was crowded beyond seating capacity, with people standing in the doorway. All the major projects were represented, as well as individuals working in universities. Twenty to thirty of the participants had come from as far away as Japan, Germany and England, specifically to attend these five sessions, including top level government administrators (such as Dr. Gutberlet of Dornier Systems, main coordinator of the entire German maglev effort). This final workshop session was intended for delineating, as clearly as possible, the most crucial points of general agreement and controversy, with particular emphasis on the most essential problems which remain to be solved. Participation was lively and involved the entire audience so that it is impossible to list participants individually without risk of notable omissions. If pressed to give a concise summary of the discussion, I would report general agreement, for the first time, concerning the fact that the only logical propulsion system for repulsive (electrodynamic) levitation vehicles is the linear synchronous motor, and not the linear induction motor. This agreement despite the fact that both the Germans and the Japanese have used LIM's for their large-scale component test installations. The Germans report (Brown-Boveri Company) that sliding power pickup brushes of conventional design have in fact been tested to 500 km/hr on wheel simulators, that their current capacity has been found satisfactory, but the question of alignment tolerances required, as well as wear rate have not been answered as yet. Cryogenic engineering problems are no longer considered a valid objection to electrodynamic levitation. The 280 meter diameter test ring at Erlangen (Siemens) now has its vehicle installed and tests are underway. The cryogenic system uses forced circulation, two-phase helium flow, but is intended to operate with supercritical helium at high pressure in the ultimate operational system. Renee Rhodes of Warwick University reported initial decisions concerning the Wolfson project; they intend to build a half-scale operating system whose geometry resembles the MIT magneplane. The magneplane project, on the other hand, is due to terminate at the end of 1974 with no further funding in sight. Thornton reported on tests with the 1/25 scale system, which has achieved stable acceleration from standing start; using a permanent magnet vehicle for initial tests. A superconducting vehicle and an active ride control system are nearing completion. Operation of the first vehicle was shown in the film theater, in a film made for Canadian Television (CTV) by Hobel-Leiterman Inc. of Toronto. The Japanese reported that their National Railways have almost decided not to wait for the development of maglev systems, and to install a third, conventional wheeled train line in the Todaido corridor, to be in operation even sooner than 1980. They also reported that wheel noise and vibration was causing a great deal of complaint against the New Tokaido Line (bullet train), and that sentiments against another wheeled train were rising. Toshiba, Mitsubishi and Hitachi are anxious to see maglev developed in time for use. A decision is to be made early this summer.

ADMINISTRATIVE COMMITTEE

AD COM MEETING HIGHLIGHTS
May 16, 1974, Four Seasons Sheraton,
Toronto, Canada

The 1976 INTERMAG will be a joint Conference with MMM in Pittsburgh. There is a dilemma concerning the publishing medium for the conference papers. E. W. Pugh mentioned two possibilities: (1) Transactions on Magnetics and (2) Give the authors their choice between the Transactions on Magnetics or the AIP Conference Proceedings Series. A three man committee was unable to decide the question, leaving the decision to the Conference Chairman, E. W. Pugh, to be made at a later date. Some comments that were offered included: an overwhelming recommendation for one source of all the Conference papers; a suggestion that the option of a publishing medium be given by

session so that all papers of a given session are in one place; a statement that it is not good to break the Transactions on Magnetics series of INTERMAG Conferences.

The 1977 INTERMAG is scheduled for Los Angeles. It may move into the Anaheim Civic Center. The 1978 INTERMAG is being planned for in Florence, Italy. We are still looking for an Italian Organization to co-sponsor the conference. The 1979 INTERMAG may be another joint venture with MMM in New York City, if the 1976 joint conference goes well.

G. Bate reported that the IEEE lists 1,971 S-MAG members, 100 of which are students, as of April 30, 1974. That represents a decrease of 300 since December 31, 1973.

F. E. Luborsky states that it would take about a one-year notice to convert all Transactions on Magnetics issues to author prepared copy. The desirability of a ten-year index for the Transactions was deferred until F. E. Luborsky can get a cost. H. F. Storm suggested that the photos of authors be used with the biographies in the Transactions.

D. A. Thompson reported that his committee on nominations consists of R. C. Byloff, F. J. Friedlaender, J. J. Suozzi, and F. E. Luborsky. F. J. Friedlaender asked for future Life Member suggestions for Fellows. It was noted that the requirement that a Fellow nominee be an IEEE Senior Member is often the only deficiency in a person's qualifications. Honorary Life Memberships in the Magnetics Society were unanomously voted for by R. M. Bozorth and W. F. Brown. Mr. Donald King has contacted F. J. Friedlaender on the possibility of a field award in the area of Magnetics. It was suggested that in Institute-wide award be recommended in the area of Magnetics to be known as the Richard M. Bozorth Award.

Editors Note: The above highlights are published in the NEWS-LETTER so that you, the S-MAG membership, can know what your Ad Com is doing. The membership is invited and encouraged to respond to these items in any way you feel appropriate. Do you approve? Do you have ideas on how S-MAG business can be more effectively carried on? Make your views known!

INTERNATIONAL WORKSHOP ON RARE EARTH-COBALT MAGNETS. OCTOBER 13 TO OCTOBER 16, 1974. DAYTON, OHIO.

The formal lecture program for the workshop at the University of Dayton has been assembled and is published below for the information of the S-MAG membership.

FORMAL LECTURE PROGRAM

INTRODUCTION AND PREVIEW, Karl J. Strnat
University of Dayton
History: present state of development; commercial magnet types, sources prices, research and development efforts; problem areas; future outlook.

SESSION I: RAW MATERIALS, Chairman: J. W. Cunningham
Research Chemicals, Div. of Nucor, Phoenix, Arizona

I-1. Rare Earths - Availability, Extraction, Separation.
Joseph G. Cannon, Molybdenum Corp. of America,
White Plains, New York.
Abundant rare-earth mineral resources are reviewed. Chemical processing options prior to metal preparation are outlined. Market supply/demand factors that affect the price of rare earth-metals are detailed.

I-2. Rare Earth Metals - Production, Availability, Prices.
I. S. Hirschhorn, Ronson Metals Corp., Newark, New Jersey
Commercial production of rare earth metals by electrolytic or metallothermic reduction. Specifications, price and availability of magnet-grade mischmetal, samarium, lanthanum, cerium and praseodymium.

I-3. Cobalt. D. J. Maykuth, Cobalt Information Center
Battelle Memorial Institute, Columbus, Ohio
Ores, deposits, reserves; mining; concentration and refining; forms produced, commercial sources, use pattern, prices.

SESSION II: MAGNET ALLOYS, Chairman: Fred G. Jones,
Hitachi Magnetic Corp., Edmore, Michigan

II-1. Physical Metallurgy of Magnet Alloys.
Alden E. Ray, University of Dayton, Dayton, Ohio.
Alloy types for magnets; phase diagrams; non-equilibrium states, instabilities; phase and grain-size analysis; requirements and methods.

II-2. Magnet Alloy Production. Camillo Herget,
Th. Goldschmidt AG, Essen, W. Germany
Massive and powdered alloys from metals and oxides, characteristics of $SmCo_5$, $MMCo_5$, multiphase alloys, sintering aids, alloys containing Cu,2:17 phases, commercial availability.

II-3. Analysis and Composition Control. A. Brusdeylins,
Th. Goldschmidt AG, Essen, W. Germany
Quality control requirements for magnet alloys; chemical and physical analysis methods for Co, rare earths, metallic impurities, O, N. H; precision, limitations, cost.

SESSION III: MAGNET MANUFACTURE
Chairman: Harold Garrett, US Air Force Materials Laboratory, WPAFB, Ohio.

III-1. Rare-Earth Magnet Preparation. D. L. Martin,
General Electric R & D Center, Schenectady, New York
Magnet types, principal production steps; sintering mechanism; origins of coercivity; alloys used, properties obtained, cost; R/D powder process; temperature compensation.

III-2. Sintered Rare Earth-Cobalt Magnet Manufacturing.
A. E. Paladino, P. F. Weihrauch and D. K. Das
Raytheon Company, Waltham, Massachusetts
Manufacturing procedures for single and two-alloy methods; property-process relationships, cost-performance tradeoffs; commercial magnet grades and new materials for various device applications.

III-3. Precipitation-Hardened Magnets. Yoshio Tawara,
Matsushita Electric Industrial Company, Osaka, Japan
Suitable alloy systems; precipitation, spinodal decomposition and magnetic hardening; processing by casting; magnet production by sintering; property and cost comparision with Cu-free magnets.

SESSION IV: SPECIAL TOPICS IN MAGNET PRODUCTION
Chairman: Andrew C. Nyce, Colt Industries, Cruicible Magnetics Division, Elizabethtown, Kentucky.

IV-1. Unconventional Production Methods.
Harold Garrett, Air Force Materials Lab., Wright-Patterson AFB, Ohio, and
R. J. Janowiecki, Monsanto Research Corp., Dayton, Ohio
Arc-plasma spraying, sputtering; equipment and procedures; special properties of products; prospects for device applications; economic aspects, potential markets.

IV-2. Bonded Magnets. Karl J. Strnat
University of Dayton, Dayton, Ohio
Application potential, user requirements; experiments with metallic and organic binders; powder blending to optimize mag. properties; stability problems, protective measures.

IV-3. The Use of Mischmetal in Magnets. Martin G.H. Wells,
Colt Induatries, Crucible Materials Research Center,
Pittsburgh, Pennsylvania
Natural rare-earth mixture: problems due to composition fluctuations; desirable "Magmisch": compositional tolerances, special blends; practical possibilities of adjustment, cost-control relationship.

SESSION V: PROPERTIES AND PRODUCTION TESTING
Chairman: David J. Iden, University of Dayton
Dayton, Ohio

V -1. Magnetic and Physical Properties. Herbert F. Mildrum and David J. Iden, University of Dayton, Dayton, Ohio
Important magnetic, mechanical and physical magnet properties and design parameters; temperature coefficients, irreversible losses, long term and elevated-temperature stability.

V-2. Magnetizing, Testing, Stabilizing and Calibrating.
Melvin A. Bohlmann, Indiana General Magnet Products, Division of EMM Corporation, Valparaiso, Indiana
Field levels, equipment for magnetizing; charging by magnet

producer or user: Stabilization by field or thermal knockdown; production-lot testing; mag. measuring apparatus and calibration standards.

SESSION VI: DEVICE APPLICATIONS
Chairman: Peter G. Frischmann, General Electric R & D Center, Schenectady, New York.

VI-1. General Design Principles and Device Concepts.
Rollin J. Parker, Hitachi Magnetics Corp., Edmore, Michigan.
Optimum utilization of R. E. magnets in circuits; whole-device redesign; review of present and future device applications; relative economics of different permanent magnet materials; novel uses of magnets now feasible.

VI-2. Cobalt-Rare Earth Magnets for D. C. Machines.
S. Noodleman, Inland Motor Division, Kollmorgen Corp., Radford, Virginia.
New machine configurations; rotating magnets, stationary winding, new commutating mechanism; examples: industrial drive motor, servomotor; properties of desired improved magnet material.

VI-3. Rare Earth-Cobalt Magnets in Wrist Watches and Clocks.
Kurt Bachmann, Brown, Boveri & Cie, Baden, Switzerland.
Magnets in watches and clocks: types of movements, function of magnets, economic aspects; stepping motors in quartz watches; advantages of rare-earth magnets and successful applications in wrist watches.

VI-4. Rare Earth Magnets in Microwave Tubes.
N. J. Dionne and E. C. Wettstein, Raytheon Comp., Waltham, Massachusetts.
Weight size, performance advantage in several tube types; circuit details for CFA's and TWT's, comparison with Alnico tubes; new radial circuit magnets for solenoid replacement in TWT's and image tubes.

VI-5. Sm-Co Focusing of Klystron Amplifier.
L. R. Falce and E. L. Lien, Varian Associates, Palo Alto, California
Computer-designed magnetic circuit; radially magnetized rings produce 2300 G over 2-inch gap; optim. use of energy product reduces focusing-system weight from 38 to 4.5 lbs; circuit design; fabrication techniques, tube performance.

VI-6. Magnetic Bearings, A Survey and Comparison.
Crawford R. Meeks, Hughes Aircraft Company
Los Angeles, California
Magnetic bearings can extend life, improve reliability of mechamisms for air and spacecraft; survey of mag. bearing technology; evaluation of different designs; new bearings using rare-earth magnets; device examples, magnet properties required.

The official deadline for registration (September 1) is past. Those who have not registered, but desire to attend should first verify that space is available by telephone at (513) 229-3535 [K. J. Strnat].

MAGNETICS SOCIETY CHAPTER ACTIVITIES

BOSTON SECTION

The last meeting of the 1973-1974 Season, May 8, 1974 featured a very interesting discussion of the Aurora Borealis and its relation with the earth's magnetosphere by Dr. Robert Eather of Boston College. His talk was accompanied by his remarkable 30 minute 16 mm sound color film, which described auroral research and presents, for the first time, color motion pictures of actual auroral activity. Dr. Eather pointed out that: even though auroral displays appear to be random and non-reoccuring, photographs taken simultaneously from high altitude aircraft at the north and south poles demonstrate that the two polar displays are mirror images.

During the year, the Boston chapter has had interesting presentations on the following varied topics:

September 11, 1973	Dr. J. C. Sethares	Microwave Magnetic Surface Waves in Saturated Ferrimagnets.
October 16, 1973	Dr. P. W. Newrath (Tufts N.E. Medical Center)	Electromagnetic Fields and Living Organisms.
December 12, 1973	Dr. H. A. VanVleck (Harvard Univ.)	Milestones in the History of Magnetism.
January 10, 1974	Dr. C. Max Fowler (Los Alamos Sci. Lab)	Explosives Magnetic Flux Compression.
February 12, 1974	Dr. T. C. Wang (G.M. Res. Center)	Research & Development of Linear Induction Motors.
March 7, 1974	Dr. David Cohen (MIT, F.B.N.M.L.)	Human Magnetic Field. Its Measurement & Characteristics.
April 10, 1974	Dr. Subir Banerjee (U. of Minnesota)	Why the Earth's Magnetic Field Reverses.

This Fall, several meetings are planned, featuring two talks on Magnetic Levitation, Ferrofluid Separation and Magnetohydrodynamics.

The Chapter officers are:

Chairman:	William Harrold, Raytheon Co. (617)358-2721 X2046
Vice Chairman:	Dr. Robert Rottmeyer, Digital Equipment Corp. (617) 897-5111 X3259
Secretary:	Dr. Paul Weihrauch, Raytheon Co. (617)899-8400 X3659
Treasurer:	Robt. F. Spain, Cambridge Memories (617)969-0050

MAGNETIC MATERIALS FOR ELECTRONICS, ORSAY, FRANCE, MARCH 12, 1974

The IEEE Magnetics Society, along with the Societe Francaise des Electriciens et Electroniciens and the Societe Francaise, acted as a co-sponsor of the meeting on Magnetic Materials for Electronics in Orsay, France on March 12, 1974. The following program outline and talk abstracts summarize the meeting content. The full proceedings will be published in the Journal de Physique Appliquee.

The aim of this French Meeting was to get persons together from Universities and from Industry and to stimulate exciting discussions between them. Professor L. Nèel, Nobel Prize Laureate from the University of Grenoble delivered the introductory talk (about half an hour).

1) Physical Basis. Chairman Pr. Bertant (University of Grenoble)

Crystallographic Structure and Magnetism:
J. Rossat - Mignot - University of Grenoble.
Some magnetic properties (arrangement of magnetic moments, transition temperature, anisotropy energy, magnetization) are shown to depend, in a simple way, on the crystallographic structure of the material. The effective Hamiltonian depends mainly on two independent factors: the nature of the system without magnetic interactions and the physical nature of the mechanisms responsible for the magnetic interactions. The differences between a transition ion and a rare earth ion are pointed out. The different kinds of interactions are taken into account. The importance of the crystallographic structure to the magnetic order is shown. The problem of magnetic anisotropy is illustrated by some examples.

Magnetic Domains:
P. Brissonneau - University of Grenoble.
A review was presented of the various kinds of energies occuring to determine the arrangement of the localized magnetic moments; the exchange energy, the magnetostatic energy, the magnetocrystalline anisotropy, the magnetoelastic effects, and the coupling energy with lattice defects. Then, it results in any ferromagnetic sample dividing itself spontaneously in domains of uniform magnetization with the object of decreasing the total energy of the moment system, two adjacent domains being separated by a transition region called a wall. We examine the main techniques used to observe the domains and the effects of the general configuration on the magnetization processes.

Spin Synamics and Spin-photon Interactions:
H. Le Gall - Centre National de la Recherche Scientifique - Bellvue
A survey of the para- and ferromagnetic spin evolution is given from a unified description of the different spin-photon, spin-spin and spin-phonon interactions. The basic mechanisms are

discussed in detail by using the real and virtual character of the electric and magnetic dipole interactions. In the microwave range, the spin evolution depends on the pumping geometry (perpendicular or parallel), on the excitation level (linear, non-linear and parametric excitation) and on the transient or steady-state pumping type. Two transient or pulse evolutions are discussed: one is the basis of the spin-echo technique and the second describes the adiabatic or non-adiabatic (spin-flip) evolution of a spin system in a d.c. magnetic field having a change of its direction. In a ferromagnet, the spin-flip induces magnons which increase the reversal magnetization time. After the description of the spin-waves and magnons in the ferro- and antiferromagnets, the magnon-magnon, magnon-phonon and magnon-magnetic impurities interaction are analyzed. In the optical range, the spin-phonon interactions induce many magnetooptical (M.O.) effects, either absorption type (2-magnon and magnon-phonon absorption, magnon-side-bands), or elastic scattering type (Faraday and Cotton-Mouton effects) and inelastic scattering type (1, 2, and 4-magnon Raman effects). The physical and analytical relations between the different M.O. effects are obtained by introducing the electric and magnetic dipoles induced by the light, either in the Maxwell equations (classical macroscopic description), or in the electric and magnetic dipole interactions Hamiltonians (second-quantization macroscopic description). In the last part, the microscopic origin of the spin-photon interactions is discussed from the real and virtual transitions which appear in the expression of the tensorial dynamical polarizability of a magnetic ion with the spin-orbit and exchange couplings.

2) Magnetic Materials in Electronics. Chairman Pr. Pauthenet University of Grenoble.

Hard Materials for Permanent Magnets:
H. Lemaire (SERMAG).

Often ignored because of their low profile, permanent magnets are increasingly becoming valuable components for electronical and electrotechnical devices used on a large scale for loud-speakers, door latches, low power motors,...., as well as in measuring systems, separators, and microwave devices. The total number of unit magnets produced per year in a large plant amounts to several hundreds of millions, from the small magnets weighing 4 mg of high quality material such as Cobalt-Rare Earth used in electric watches, to the big 40 kg magnet, directly cast in Ticonal 600 for the stator of an electric generator. The same 10^7 factor in the weight can be found in the coercivities of ferromagnetic materials, going from 10^{-2} Oe for very soft materials to 10^5 Oe for very hard materials. This review deals with the various hard materials now in production, illustrated by a few new laboratory results. If the old theory of pinned Bloch walls, initially developed for magnet steels, is revived again for cobalt-rare earth alloys substituted with copper and iorn, the origin of the properties of most modern hard materials is interpreted in terms of single domain fine-particle theory: in one case, magnetization reversal is governed either by a shape an sotropy (Ticonals, powder magnets) or a crystal anisotropy (platinum-cobalt alloy, hard ferrites) - in the other case, it is governed by nucleation of reversed domains or unpinning of Bloch walls (sintered cobalt-rare earth magnets). The study of first magnetization curves, as well as intrinsic curves or recoil curves, is very useful to distinguish between various mechanisms of coercivity and is illustrated here by new results obtained on high coercivity materials, as Ticonal 2000 ($(BH)_{max.} = 6.5.10^6$ G. Oe), Sermalloy P, Plasto-Ferrite magnets Ferriflex 10 very well oriented ($(BH)_{max.} = 2.0.10^6$ G. Oe) and Cobalt-Rare Earth Coramag. Although an increase in coercivity is usually followed by a decrease in remanence, this does not appear in intermetallic compounds based on transition and rare earth metals, thus, allowing very high specific energies. Synthetis, mechanical and magnetic shaping thermal properties of these compounds, is shown and discussed.

Evolution of Soft Ferrites for Telecommunications and Television:
R. Sibille (LCC).

In spite of the fact that the soft ferrites are old materials (their development was made in the 1940's), they are still in evolution and a great development in this field is predicted for the next ten years at least. After a review of the characteristics needed by telecommunications and television, the aurhot reviews the main stages of the industrial development of the soft ferrites during the past 15 years: improvement of composition, magnetic circuits, technologies, a.s.o. Results are given and the trends of actual research are pointed out.

Microwave Ferrites:
J. Nicolas (Thomson C.S.F.)

The general mode of operation of microwave ferrites is given after a short review of magnetic resonance. The different kinds of losses, which exist in these materials, are considered. The physico-chemical problems related to the dielectric losses are pointed out. In connection with the magnetic losses, three linewidths are introduced: the resonance linewidth ΔH, the effective linewidth ΔH_{eff} measured far from resonance and the spin wave linewidth related to the critical threshold field for the non-linear power effects. These linewidths depend, in different ways, on the damping of the spin motions. The materials actually used at microwave frequencies are surveyed. The objects of research, which seem now the most interesting, are pointed out: polycrystalline garnets with very small resonance linewidths, garnets which have very stable temperatures, and new lithium spinels.

Ferrites for Memory Cores:
M. Grumbert, Jeanlis and de Sylvestre (COFELEC-memoires).

After a short review of operating conditions for memory cores and the definition of the manufacturers parameters, ideal characteristics of memory core are stated. The different configurations used are illustrated. Core preparation methods are surveyed. Two particular problems raised by research on optimum electromagnetic performance are: phenomenon of magneto-elastic resonance due to magnetostriction and aging of core characteristics under specific conditions of quick sintering. The range lines of actual development of materials for memory cores are given, as well as a comparison with semi-conductors.

Materials for Bubble Domain Memories:
J. Mareschal, D. Challeton, J. Daval, B. Ferrand, J. D. Gay (LETI)

Some problems in the search for materials for bubble domain memories are revealed from studies made at the L.E.T.I. since 1968. Operation principle and economical requirements of displays, static and dynamic magnetic properties of needed materials are breifly given. All materials and growth methods used up to now are reviewed. Single crystals of rare earth orthoferrites were among the first examined materials, but the stable bubble size was too large. Similar difficulties were met with other non-cubic materials. Heteroepitaxial garnet films with stress or growth induced uniaxial anisotropy have all the desired magnetic requirements. Problems of developing economic techniques for the growth of these epitaxial films are discussed from recent results on chemical vapor deposition, hydrothermal synthesis and liquid phase epitaxy. Elaborations of these materials are expensive. In spite of the very good quality of the actual grown single cyrstals films, this explains the actual effort to substitute them by ferrimagnetic amorphous thin films.

Advances in Magnetic Recording Materials:
A. A. Von der Giessen (Philips Research Laboratories, Eindhoven, The Netherlands).

Magnetic recording is primarily carried out on this layers that consist of a dispersion of magnetic particles in an organic binder system. These particles are single domains of either γ-Fe_2O_3 or CrO_2, the magnetic anisotropy of which is due to their acicular shape. The recording performance of γ-Fe_2O_3 coatings have been enhanced considerably in the past five years by improving the particle morphology. Attempts to make the recording quality of iron oxides equal to that of CrO_2 by increasing their magnetocrystalline anisotropy by co-doping failed because of the resultant insufficient physical stability. Taking into account the good morphology of the present CrO_2, a further significant increase of recording performance by the architecturing of oxidic materials is not to be expected. Considerable progress, $\sim$6 dB with respect to CrO_2, is possible, however, by using a well-shaped metallic iron or iron-alloy particles, owing their much higher saturation metnetization.

3) Workshop. Chairman Mr. Chiron

Recent Trends in Bubble Memories:
C. J. M. Rooijmans (Philips Research Laboratories).

The relation between materials composition, overlay technology and device functioning will be discussed. Attention will be given to the perfection of the substrate and film: the occurrence of hard bubbles, and the operational margins of some designs. A laboratory model, using clockwise and counter-clockwise rotation of the in-plane field will be shown.

1974 INTERMAG CONFERENCE, MAY 14-17, TORONTO, CANADA — SESSION SUMMARIES

Session chairmen for many of the 1974 INTERMAG Conference Sessions have written their impressions of the sessions and

discussion which followed. The response of chairmen was particularly good, and it is hoped that future session chairmen at 3M and INTERMAG Conferences will continue the trend. The full conference proceedings will appear as the September, 1974 issue of the IEEE Transactions on Magnetics.

SESSION 1 - GARNET FILM PREPARATION & CHARACTERIZATION, E. A. Giess

In the first paper of the session on Garnet Film Preparation and Characterization, J. W. Nielsen (Bell Labs) described factors involved in the preparation of 1 1/2" diameter films for bubble domain devices. This scale up in film area does not appear to introduce any serious processing problems and in fact, improves the material yield. A post deadline paper from Rockwell International gave further information on multiple wafer dipping, but with substrates also 1 1/2" in diameter. Several bubble materials papers from Japanese laboratories showed a high level of technological development overseas. It was interesting to observe in this engineering conference a number of papers relating to scientific understanding of materials design factors. Despite the existence of a relatively high level of LPE film processing capability, not all of the fundamental physical parameters are fully understood.

SESSION 2 - HIGH DENSITY DIGITAL RECORDING, J. C. Mallinson

This session, consisting of six invited papers, covered nearly all aspects of high density digital recording with the notable exception of disc files. The 250 attendees were advised that Dennis Mee (IBM) would remedy this omission in Session 6, paper 6.2. A. A. Goldberg (CBS) presented F. Davidoff's (CBS) paper on "Digital Video for Broadcasting"; since about 10^8 bits per record data rates are envisaged, digital video recording presents a major technical challenge. High density digital recorders based upon helical and transverse video recorders were discussed in two papers by D. G. Jackson and J. B. Matley (IVC), and J. Miller (Ampex). Both the IVC MMR-1 and the Ampex TBM systems operate at 10^6 bits per square inch areal densities; a factor of four improvement was claimed feasible for the TBM, which was designed a decade ago. R. Potter (IBM) presented an extremely able review of digital recording theory emphasizing techniques rather than results; nevertheless, he showed that output levels ten times those obtainable with single turn heads were achievable with "shielded" magnetoresistive heads and that this should make possible areal densities approaching 10^8 bits per square inch possible. The profound implications of mechanical tolerances in recording systems were explored by M. Wildmann (Ampex); due to tracking errors he predicted that the maximum track densities possible with tapes and discs are close to 500 and 2000 tracks per inch, respectively. Finally, J. McDowell (IBM) discussed channel coding for digital recording and stressed the need to match the coding to the band-pass characteristics of the recorder.

SESSION 3 - SYMPOSIUM ON MAGNETOMETRY AND GEOMAGNETISM (I), D. I. Gordon

Magnetometers of various types for measuring weak magnetic fields and their application to the measurement of geomagnetic and space magnetic fields were discussed in this session. M. H. Acuna [NASA Goddard Space Flight Center] described low noise fluxgate magnetometers for outer-planet (Jupiter and Saturn) exploration. These fluxgates include new circuitry for driving the fluxgate cores into deep saturation while keeping power consumption low and an improved tuned detection circiut identified in general terms as a variable reactance bridge operational amplifier. When coupled with the low noise high stability ring core sensors developed by Gordon et al. [Naval Ordnance Laboratory], this circuitry displayed an RMS output noise level of ~0.01 nT for a 0-10 Hz bandwidth. Power consumption is 100 mW/axis. C. J. Bader and C. S. de Renzi [Burroughs Corp.] described a thin-film magnetometer of the inductance-variation type. When operated in a dual transducer configuration with magnetic feedback and capacitive enhancement using six 16 mm square films in each transducer, a resolution of 0.1 nT is obtained with power consumption of 2.5 to 4.5 mW. Drift is a few nT/°C. J. E. Zimmerman and N. V. Frederick [NBS] reported on the successful use of SQUID magnetometers for geomagnetic measurements. This type of SQUID is a 12-hole "fractional-turn" type with inductance less than 10^{-11} H. The resolution is 10^{-4} nT. The cryostats enclosing the sensors are 13 cm OD and 60 cm long with a liquid helium capacity of 1.7 liter and an operating time between fillings of up to 40 hours. R. E. Slocum and B. I. Marton [Texas Instruments] described a new nuclear free precession magnetometer which differs from the earlier technique (i.e., nuclear free precession of protons in liquids) by using gaseous He^3 as the resonance element and an optical pumping technique to polarize the nuclei. This He^3 magnetometer was demonstrated to have a sensitivity of 0.1 nT and is expected to have absolute accuracy equal to or better than proton magnetometers and with lower power requirements. R. E. Slocum and D. D. McGregor [Texas Instruments] discussed the measurement of geomagnetic field components using a single axis magnetometer based on parametric resonance in optically pumped 2^3S_1 level of He^4. Sensitivity is established to be 0.01 nT in a 5 Hz bandwidth. J. E. Opfer et al. [Develco, Inc.] described the construction and use of a superconducting second-derivative gradiometer. This technique is used to discriminate against fields from remote sources while being sensitive to local magnetic phenomena. Its use for measuring magnetocardiograms of subjects in an unshielded environment was also discussed. Considerable improvement over a first-derivative gradiometer was obtained.

SESSION 4 - PERMALLOY FILM MATERIALS AND DEVICES, Prof. A. V. Pohm

Although the subject of numerous investigations, the sources of anisotropy in thin permalloy films have not been fully understood. Three excellent papers were presented relating to this problem by Uchiyama et al., Takayasu et al., and Hoffman et al. In addition, the static and dynamic properties of domain walls, block lines and cross tie structures were examined in papers by Pietsch et al., Berg et al., Konishi et al., and Schwee et al. The papers provided fine experimental results. Discussion of the papers highlighted the fact that a full theoretical description of domain wall motion is extremely complex. Papers by Luborsky et al., Umesaki et al., and Shigetoku et al., described results on plated wire and fine stripe memory systems in present commercial use. K. Schroder presented a concept for a memory system using bulk materials.

SESSION 7 - MAGNETO-OPTICS AND MnBi, A. Berkowitz

A major contribution to the understanding of MnBi was presented by T. Chen and W. E. Stutius, Xerox. From measurements on single crystals of the low temperature phase (LTP) and the high temperature phase (HTP) in the quenched state (QHTP), they demonstrated that if the (LTP) had a composition MnBi, the (HTP) had a composition $Mn_{1.08}Bi$. The transformation at 355°C on heating goes $MnBi \rightarrow Mn_{1.08}Bi + Bi$, and the transformation on cooling at 340°C goes $Mn_{1.08}Bi \rightarrow MnBi + Mn$. These reactions were also found in thin-films of the compound. Thus, the utility of these materials for Curie point writing is limited by structural heterogeneity and low temperature transformation of the (QHTP). This result emphasizes the importance of finding dopants for MnBi which will reduce T_c below the phase transformation on heating.

SESSION 8 - SYMPOSIUM ON MAGNETOMETRY AND GEOMAGNETISM (II), J. E. Zimmerman

I believe the most noteworthy feature of the two sessions (3 and 8) on Magnetometry and Geomagnetism was the preponderance of papers on superconducting magnetometers, their noise limits, and their use in diverse applications.

SESSION 9 - GARNETS AND SPINELS, P. J. Flanders

Nicolas et al. of Thomason-CSF (France) and Machida et al. of Matsushita (Japan) reported on low frequency microwave garnets with substitutions which gave good temperature stability and narrow resonance linewidth. Magnetic losses in ferrites due to strains were studied by Knowles and by Snelling of Mallards (England). The former found good agreement between experiment and calculations where 30% of the magnetic losses in pot-cores were due to machining and attributed to flux, which passed through a surface layer under compressive stress; the latter examined the loss parameters in specially formed Mn-Zn ferrite samples between -40 and 100°C when placed under tension and compression. In a comprehensive study of Br-Substituted Cu Cr_2Se_4 spinels, Pink et al. of Siemens (Germany) showed the importance of using $CuBr_2$ rather than CuBr to achieve chemical stability over a wide compositional range.

SESSION 14 - RECORDING MEDIA, A. J. Kurtzig

The session was attended by about 250 people who asked numerous questions of each of the speakers and made several significant comments. All eight papers were well received. Shinji Umeki of TDK described their AVILYN particles - Fe_3O_4 coated with a cobalt compound - which have the high coercivity of CrO_2 or

Co-δFe_2O_3 but without the temperature dependence of these particles or the wear problem of CrO_2. The nature of the Co compound on the surface or the mechanism for the high coercivity is not well understood. The surface layer is estimated to be 100 Å thick. D. H. Mayer of BASF explained the relative wear rates of ferrite versus mumetal heads on CrO_2 vs. δFe_2O_3 tapes on the basis of the relative hardnesses of these materials. The results are consistent with observations that the wear of mumetal heads is similar when the two tapes are used but that for ferrite heads, CrO_2 tape produces greater wear because the CrO_2 is harder than the ferrite which in turn is harder than the δFe_2O_3. K. H. Olsen of 3M described the electrolytic corrosion of Fe particles in tapes made with acidic binders. This corrosion can result in complete Fe depletion in some areas. The corrosion can be eliminated by proper binder formulation. R. L. Comstock of IBM described some very encouraging recording results on Fe_3O_4 thin film disks. Defect densities have not been carefully measured or controlled on these disks to date. Geoffrey Bate of IBM described a dc measurement of the normal component was shown to be as large as an effective 10 microinch "dead" layer in poorly oriented tapes and as small as an effective 3 mircoinch layer in well oriented CrO_2 tapes. These "dead" layer thicknesses would be independent of media thickness. The normal component of the recorded magnetization is expected to be concentrated near the head surface because of the large normal fields there during the writing process. It is expected that this effective dead layer would be more serious in contact recording than in flying head systems. Professor Monson of Harvey Mudd College pointed out that the "dead" layer was far from dead magnetically. It would be expected to result in bit shifts.

SESSION 16 - REACTORS, TRANSFORMERS, POWER MAGNETICS, I. W. Geysen

In a very interesting session the different authors were giving papers all over the scope of the energy-domain of magnetic field calculations. No special remarks can be made to the discussions.

SESSION 17 - MATERIALS CHARACTERIZATION TECHNIQUES FOR THIN FILMS AND SURFACES - THEIR POTENTIAL USES FOR MAGNETIC DEVICES, C. H. Bajorek

This session was novel to this year's INTERMAG in that it attempted to stimulate discussion of recently developed material characterization techniques and device reliability concerns which addressed more than just the magnetic characteristics of devices. P. A. Turner of Bell Laboratories presented an overview of potential yield and reliability detractors (oxidation corrosion, interdiffusion, electromigration) in magnetic devices of current interest. He also discussed to what extent will device problems of this type require the use of novel characterization techniques like auger, x-ray photoemission, secondary ion emission and backscattering spectroscopy. These techniques were reviewed by R. A. Pollak of IBM, C. A. Evans of the University of Illinois, and M. A. Nicolet of Cal. Tech. Additional insight into both topics was provided by J. Ramsey of IBM, who described the synergism of complementary analytical techniques in solving semiconductor device problems. Overall, the session was well received, but the audience was most interested in the device reliability topics relevant to magnetic bubble materials and devices.

SESSION 20 - HARD MAGNETIC MATERIALS, F. E. Luborsky

The Hard Magnetic Materials session was entirely devoted to various aspects of cobalt rare earth materials and applications. It is becoming increasingly clear that this new family of permanent magnet materials will have a major impact on applications and device design. A number of the papers in this session dealt with the question of the metallurgical structures and phases present at various stages of treatment of the alloys and the resultant effects of these on the magnetic properties in other Co_5R materials and in the $Co_{17}R_2$ materials is still unresolved. Only two papers in this session dealt with applications related characteristics. One reported on a continuing study of the stability of Co_5Sm magnets on exposure to elevated temperatures in air. The stability of "prestabilized" magnets showed considerable improvement over previously reported results on unstabilized magnets. Another paper discussed the preparation of radially oriented Co_5Sm, important for applications in motors, by a hot forming technique.

SESSION 21 - PLENARY SESSION III, F. B. Humphrey

The session was well attended demonstrating the fact that scientists and engineers in magnetics have broad interests. After the session every one adjourned to the next room for the reception.

SESSION 22 - BUBBLE MEMORIES, P. J. Bonyhard

Much of what was presented in this session underlined the general impression that bubble technology has come a long way towards the practical. P. C. Michaelis of Bell Laboratories reported on several functioning memory modules in the 0.5 Mbit capacity range and T. T. Chen of Rockwell described a functioning bubble flight recorder model in the 50 kbit capacity range. Other papers, dealing primarily with bubble readout, rotating field generation and module packaging, also gave evidence of the progress of the technology towards maturity. The rest of the papers were addressed to novel aspects of systems design, indicating an ever widening range of potential applications. Discussion centered primarily on specific technical points raised by the presentations.

SESSION 23 - RECORDING THEORY, G. F. Hughes

Analytic methods for high longitudinal density digital recording highlighted Session 23 on RECORDING THEORY. C. S. Chi (DEC) and D. E. Speliotis (Microbit) are obtaining 5-15% accuracy in computer predictions of recording channel playback, using self consistent computer calculations in the time and frequency domain. In contrast, J. Mallinson of Ampex described the long wavelength (low bit density) situation where narrow tip heads and their localized mathematical methods, cause playback problems (poor and non uniform long wavelength response). J. P. Lazarri of CII, France, pointed out that integrated narrow pole tip heads possess the further analytic complication that the layered nature of the Permalloy pole tips must be included and he gave calculations indicating 5000 bit/cm capacilities. Gordon Hughes, Xerox, explored some of the fringe field consequences of high density in the other axis: high tracks per cm. Three-dimensional field calculations indicated that a ring core can erase a side guardband about 1 1/2 gap lengths off the side of the head.

SESSION 25 - AMORPHOUS BUBBLE FILMS, AMORPHOUS COMPOUNDS AND SOFT MAGNETIC MATERIALS, Alex P. Malozemoff

The session had two parts; the first dealing with amorphous materials, the second with soft materials. Two papers (25.1, 25.2) presented by S. Matsushita and Y. Sakurai of the University of Osaka described the properties of sputtered GdCo films for magnetic bubble applications. Variation in properties with deposition rate was reported, and in discussion, R. J. Gambino of IBM suggested that this was primarily due to the change in bias voltage on the anode. The most spectacular result of the session was undoubtedly their observation of an enormous, extraordinary Hall coefficient in amorphous GdCo, making these films candidates for H-all effect detectors; the reason for the size of the effect is not known. G. S. Cargill of Yale University (25.3) reported on two new examples of perpendicular induced anisotropy, in amorphous electrodeposited CoP and CoNiP films, but in contrast to GdCo, these films have insufficient anisotropy to make them practical for bubble applications. N. I. Marzwell of Cal. Tech. (25.4) reported on amorphous PdMnP alloys. H. T. Savage of NOL (25.5) reported that by annealing $TbFe_2$, large energy products could be obtained for possible permanent magnet applications. Some discussion centered on the peculiar low temperature hysteresis properties of the unannealed amorphous material which shows a time dependent relaxation of the coercivity; Cochran of McGill pointed out that amorphous $SmCo_5$ doesn't show the effect and speculated that it might be common to the amorphous iron-containing materials in particular. In the second part of the session, W. M. Swift and S. K. Bhate of Westinghouse (25.6, 25.7) reported on an experimental and theoretical study of eddy current losses in 3% Si-Fe. Discussion centered on the interpretation of an extra hysteresis loss observed above the eddy current loss. Paper 25.8 by Qureshi and Ahmed on after effect in SiFe was not presented. D. R. Thornburg of Westinghouse (25.9) reported on the optimum annealing conditions for improving the magnetic characteristics of commercial FeCo alloys. Finally, E. L. Huston of International Nickel (25.10) showed how cube-texturing could improve the magnetostrictive properties of NiCo alloys for transducer applications.

SESSION 27 - VIDEOPLAYER DEVICES FOR THE CONSUMER MARKET Sherman W. Duck

The Invited Session on Videoplayers provided a cross-section of the latest technical efforts towards the accomplishment of a long sought goal: A commercial videoplayer device for the

consumer market. Four approaches were described, two magnetic and two optical. Kihara's paper (which included a demonstration of a working model) described a radically new video recording system using a flexible magnetic card, and a rotating magnetic head to achieve 10 minutes of playing time. The Seehawer paper described a magnetic disc recorder with an in-contact head in a tracking arm. The disc rotates at 180 rpm. Optical videodisc systems, with transparent (Hrbek) and reflective (Broadbent) disc media were described. Each use a low-power laser and solid state detector for reading the video signal from the disc. Track-to-track spacing is approximately 2 micrometers, illustrating the high information capacity per unit area achievable with optical media. All four videoplayer systems described make use of contact printing or mass duplication techniques to achieve a low cost for pre-recorded programs. Donnelly's paper, which opened the session, described the consumer videoplayer market, discussing what is known, and what isn't, about the consumer's relative valuation of videoplayer features, such as record vs. play-only, and the possible conflict between alternative video information systems, such as pay-TB and cable-TV.

SESSION 29 - WORKSHOP ON RARE EARTH PERMANENT MAGNET PROPERTIES & APPLICATIONS, R. J. Parker

The workshop on rare earth permanent properties and applications consisted of an overview of the trends in property development, device concepts, and economic dimensions, followed by four case histories of how RCo_5 magnets have influenced the performance and function of various magneto-electric devices. There was good interaction between the audience and the speakers with most of the discussion centering around the possibilities of future property improvement, supply and cost of rare earth elements and the issues of rearranging magnetic circuits to use the properties to full advantage. The workshop provided some interesting studies in systems analysis and generally suggested that RCo_5 magnets can, in many instances, provide product feature and function that justify their higher cost.

SESSION 30 - BUBBLE DEVICE FABRICATION-PROCESSES, PROBLEMS AND PROGNOSTICATIONS, W. D. Doyle

Seven experts in different aspects of integrated device fabrication provided an information-packed day for well over 200 attendees. Although the session was held on the last day of the conference, the sustained, intense level of questioning from the audience was an elequent tribute to the high caliber of the presentations which stretched from 9:00 a.m. to 4:00 p.m. In the opening talk, J. Triacca of Qualitron reviewed the present limitations of conventional mask fabrication. He showed that 1μ dimension could be resolved over an area of 4mm x 4mm on a master mask but that making copies routinely was difficult. F. H. Dill of IBM convinced an initially sceptical audience that resist exposure could be made a science rather than an art. He showed how the experimentally observed etch rates in positive type resists could be explained theoretically if the optical characteristics of the resist were measured. A. J. Perneski of Bell Telephone Laboratories described the process now being used to fabricate 16K bubble chips. He reviewed the possible choices for spacer layers and conductors and concluded that sputtered quartz and evaporated Al-Cu, respectively, were the best choices. He stated that the observed yield for 30 wafers with 16K chips was 15%. J. P. Reetskin continued the discussion of processing with particular emphasis on the relative merits of evaporation, sputtering and electroplating. He highlighted the problem of step coverage with high resolution scanning electron micrographs of the improved coverage obtainable with etched Al-Cu rather than Au conductors. Some of the difficulties to be expected in fabricating circuits with submicron dimensions were exposed. T.H.P. Chang of IBM reviewed electron beam instrumentation for microfabrication and showed some very large patterns exposed at IBM. He pointed out the difficulties which chevron patterns can give due to proximity effects during exposure. D. Mueller of Texas Instruments continued the discussion of electron beam fabrication in more detail. He believed that 0.05μ resolution could be obtained over 3mm x 3mm. The possibility of combining conventional lithography to define sub-micron features was described and illustrated with CCD devices. The final paper by Henry I. Smith left no doubt that the use of conformable masks and attention to detail allowed the definition of sub-micron lines with optical techniques. He also reviewed the use of x-ray lithography to copy sub-micron geometry masks. The session concluded with a short panel discussion.

SESSION 31 - RECORDING LIMITS, J. H. Judy

The Recording Limits session included presentations on high track density ferrite heads and on calculation of maximum obtainable track densities. Results of experimental and theoretical investigations of the effect of submicron head-tape separations on recording performance as well as its sensitivity to the mechanical characteristics of interface itself were discussed. In addition, an analysis of tape dynamics of a tape drive based on mechanical-impedance measurements was described. An analysis of the noise associated with use of ferrite head in audio recording was presented. The technique employed in producing crystal-oriented polycrystalline ferrite heads with substantially improved wear characteristics was discussed in detail. The technical advantages of magnetoresistive reading heads over conventional inductive ones were ennumerated. A new magnetic recording technology providing high area density storage (20Kfci and 2Ktpi) with rapid access by laser beam addressing was presented. A narrow section of a conventionally-recorded track is thermomagnetically transferred by a focused laser beam onto a second magnetic medium for high-density storage and the process is simply reversed for reading.

SESSION 32 - BARKHAUSEN EFFECT, MAGNETIC FLUIDS, AND OTHERS, H. W. Fuller

The session covered a range of miscellaneous topics, and also represented a mixture of levels of interest and contribution. At the peak of novelty and general interest was Paper 32-6, "Liquid Magnetic Bubbles", by L. T. Romankiw, M. G. Slusarczuk and D. A. Thompson of I.B.M. The bubbles, consisting of a colloidal suspension of magnetic particles in an immiscible host fliud, were shown to have properties strikingly similar to original domain-type magnetic bubbles. The much greater size and slower mass-transfer speed of the liquid bubbles would, at first, seem to make them little more than a curiosity, but their potential employment as a light valve panel-display technique should be taken seriously. G. Harpavat of Xerox Corporation gave the results of interesting, and industrially useful, calculations of magnetic forces acting on a chain of spherical ferromagnetic beads in a non-uniform yield. The results give the strengths of the bonds between all beads in an N-bead chain, and so allow the prediction of the order in which bead bonds would break when chain tension is applied. Two papers were delivered on a new technique for bulk-materials studies like fatigue-crack growth and ferromagnetic phase transformations by a group from the Department of Chemical Engineering and Materials Science, Syracuse University. The technique consists of sensing signals induced in a pick-up coil by physical changes occuring in a coil-magnetized specimen. The model used for explaining the observations was based on the Barkhausen effect, although questions raised after the papers made a good point for looking at the measurement technique as a reluctance-change sensor. The apparent sensitivity of the new technique compared with, say, acoustic emission observation, however, would seem to indicate it as an important new instrumentation tool for measurements.

SESSION 35 - MAGNETIZATION MECHANISMS, F. J. Friedlaender

The six papers presented in this session dealt with domain nucleation, coercive force phenomena, domain wall motion, and spike domains. B. K. Middleton, Manchester Polytechnic, Manchester, England, presented some new calculations on the nucleation of circular domains in thin magnetic films. A. H. Eschenfelder presented a paper, co-authored by A. Onton and M. Lorenz, all from IBM, San Jose, California, which described some interesting hysteresis phenomena in MnAlGe films in which the coercive force can be altered reversibly by thermal treatment. A complete model and experimental verification was presented in the talk. A. Aharoni, Weizmann Institute of Science, Rehovot, Israel, discussed the problem of wall structure calculations in magnetic films. He presented a new model which is considerably less involved mathematically than previous models without any significant sacrifice in accuracy. The wall structures calculated by this means agree well in their asymmetric shape with recent experimental observations. The following two papers dealt with spike domains. The first, by M. E. Jones of Imperial College, London, compared the results of calculations with experimental data for single crystal nickel platelets. In the second paper on this topic, G. F. Dionne, MIT Lincoln Laboratories, Lexington, Massachusetts, presented a detailed analysis of the effect of stress on the spike domain structure and hence, provided some insight into the remanence ratios obtained for the class of materials $Y_3 Mn_x Fe_{5-x} O_{12}$. B. Heinrich presented a paper co-authored by A. S. Arrott and D. S. Bloomberg, Simon Fraser University, Burnaby, B.C., on the magnetization processes in iron whiskers, modeled as cylindrical tubes. A detailed micromagnetic calculation was presented which yielded specific results on the dynamic magnetization processes.

SESSION 35 - B. BIOMAGNETICS, F. J. Friedlaender

Though it came at the end of the conference, the Biomagnetics session was well attended and included two very interesting papers. Y. Sonoda of Kumamoto University, Japan, presented a method of studying speech patterns by monitoring tongue movements by means of a magnet attached to the tongue. The movements of the magnet and hence, the tongue, are observed by means of suitably placed magnetometers, near the face of the subject to be observed. In the second paper, S. Yerushalmi of the Weizmann Institute of Science, Rehovot, Israel presented a paper co-authored by H. Newmark, Agricultural Research Organization, Volcani Centre, Beit Dagan, Israel, which described the monitoring of food in its progress through the stomachs of ruminants. A small amount of magnetic tracer material is used ("attached" to the food) and detected by means of a magnetometer placed at the entrance of the appropriate stomach.

SESSION 36 - INVERTERS, CONVERTERS AND HYBRIDS, E. Yamada

Six papers were presented in Session 36. Dr. Bendzsak explained the influence of magnetization characteristics upon steady state tripler performance by evaluating the effect of different iron magnetization characterists (36-1). Professor Bessho reported on the behaviour of special power converters (36-2). Professor Lee analyzed the voltage-spike observed in parallel inverter composed of transistors and indicated several ways to suppress it (36-4). A method for balanced firing of thyristors by using magnetic phase shifter was presented by Professor Harada (36-5). Professor Benda described an impulse generator using thyristors in combination with a non-linear ferrite transmission line (36-7). Mr. Hollitscher explained the present applications of Hall effect integrated circuits to magnetic circuits (36-8).

SPECIAL SYMPOSIUM ON MAGANETIC BUBBLE TECHNOLOGY HELD PRIOR TO TORONTO INTERMAG

(The following was extracted from a letter from R. C. Byloff to W. A. Baker.)

This year at INTERMAG an all day tutorial session on magnetic bubble technology was held on the day prior to normal conference activities. The credit for this very successful venture should go to Hsu Chang. Hsu, on the spur of the moment, determined that such a special session would be of benefit to the conference. Hsu organized it and requested Bill Baker to include a last minute insert into the program booklet. Refreshments were provided.

While certain problems arose largely connected with accomodating the early registrants, and the size of the session rooms, the session was very well attended and very well received. In future INTERMAGS if such a tutorial session is anticipated, more complete planning of the session and the support necessary to carry it off would be appropriate.

CONFERENCE ACTIVITIES

APPLIED SUPERCONDUCTIVITY CONFERENCE - 1974
September 30-October 1, 1974, Argonne National Laboratory
C. Laverick, Argonne Nat. Lab., Argonne, Illinois, 60439.

1974 ELECTRONIC & AEROSPACE SYSTEMS CONFERENCE (EASCON)
October 7-9, 1974, Washington, D. C.
EASCON 74, Suite 700, 1629 K Street, N.W.
Washington, D. C. 20006

1974 CONFERENCE ON DISPLAY DEVICES AND SYSTEMS
October 9-10, 1974, New York, New York
T. Henion, Palisades Institute,
201 Varick Street, N.Y., N.Y. 10014

LINEAR ELECTRIC MACHINES
October 22-24, 1974, London
IEE Conference Department, Savoy Place,
London WC2R OBL. England.

IEEE INTERNATIONAL SYMPOSIUM ON INFORMATION THEORY - 1974
October 27-31, 1974, Notre Dame, Indiana
J. L. Massey, Electrical Engineering Department
University of Notre Dame
Notre Dame, Indiana 46556

20TH HOLM SEMINAR ON ELECTRICAL CONTACTS
October 29-31, 1974, Chicago
R. E. Armington, Illinois Institute of Technology
Chicago, Illinois 60616

IEEE ULTRASONICS SYMPOSIUM
November 11-13, 1974, Milwaukee, Wisconsin
Professor M. Levy, Department of Physics
University of Wisconsin, Milwaukee, Wisconsin 53201

FOURTH IEEE SEMICONDUCTOR LASER CONFERENCE
November 18-20, 1974
A. R. Calawa, MIT Lincoln Laboratory
P. O. Box 73, Lexington, Massachusetts 02173

1974 IEEE NATIONAL TELECOMMUNICATIONS CONFERENCE
December 2-4, 1974, San Diego, California
P. N. Migdal, Teledyne Micronetics,
7155 Mission Gorge Rd., San Diego, California 92120

CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS
December 3-6, 1974, San Francisco
K. Lee, IBM, Monterey and Cottle Roads,
San Jose, California 95193

INTERNATIONAL CONFERENCE ON MAGNETIC BUBBLES
December 9-11, 1974, San Jose, California
J. Slonczewski, IBM, Yorktown Heights, N.Y. 10598

1974 IEEE INTERNATIONAL ELECTRON DEVICES CONFERENCE
December 9-11, 1974, Washington, D. C.
Dr. W. C. Holton, Texas Instruments, Inc.,
MIS 145, P.O. Box 5936, Dallas, Texas 75222

1975 IEEE VEHICULAR TECHNOLOGY CONFERENCE
January 21-22, 1975, Toronto, Canada
G. A. Ross, 122 Rayette Road, Concord, Ontario

1975 POWER ENGINEERING SOCIETY WINTER MEETING
January 20-31, 1975, New York, N.Y.

1975 INTERNATIONAL CONFERENCE ON COMPOSITE MATERIALS
April 7-11, 1975, Geneva, Switzerland
April 14-18, 1975, Boston Massachusetts
A. R. Scott, TMS-AIME, 345 East 47th Street,
New York, N.Y. 10017

1975 INTERMAG
April 14-17, 1975, London
F. J. Friedlaender, Purdue University,
W. LaFayette, Indiana 47907

1975 INTERNATIONAL RADAR CONFERENCE
April 21-23, 1975, Washington, D. C.
Dr. M. Skolnik, NRL, Code 5300, Washington, D. C. 20375

1975 ELECTROMAGNETIC COMPATIBILITY SYMPOSIUM
May 20-23, 1975, Montreux, Switzerland
EMC Symposium, Box 97, 1820 Montreux, Switzerland.

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The editor will make every effort to include received copy in the Newsletter on a timely basis. To do this, the publication schedule will be relatively flexible.

The target date for the completion of camera ready copy is generally the middle of the month preceeding the issue month. Copy received before the first of that preceeding month can usually be included. The inclusion of copy received after that time can be included if the information is important and timely, and if such inclusion can be accomplished without undue delays in getting the Newsletter mailed out.

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March	February 10	February 1
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