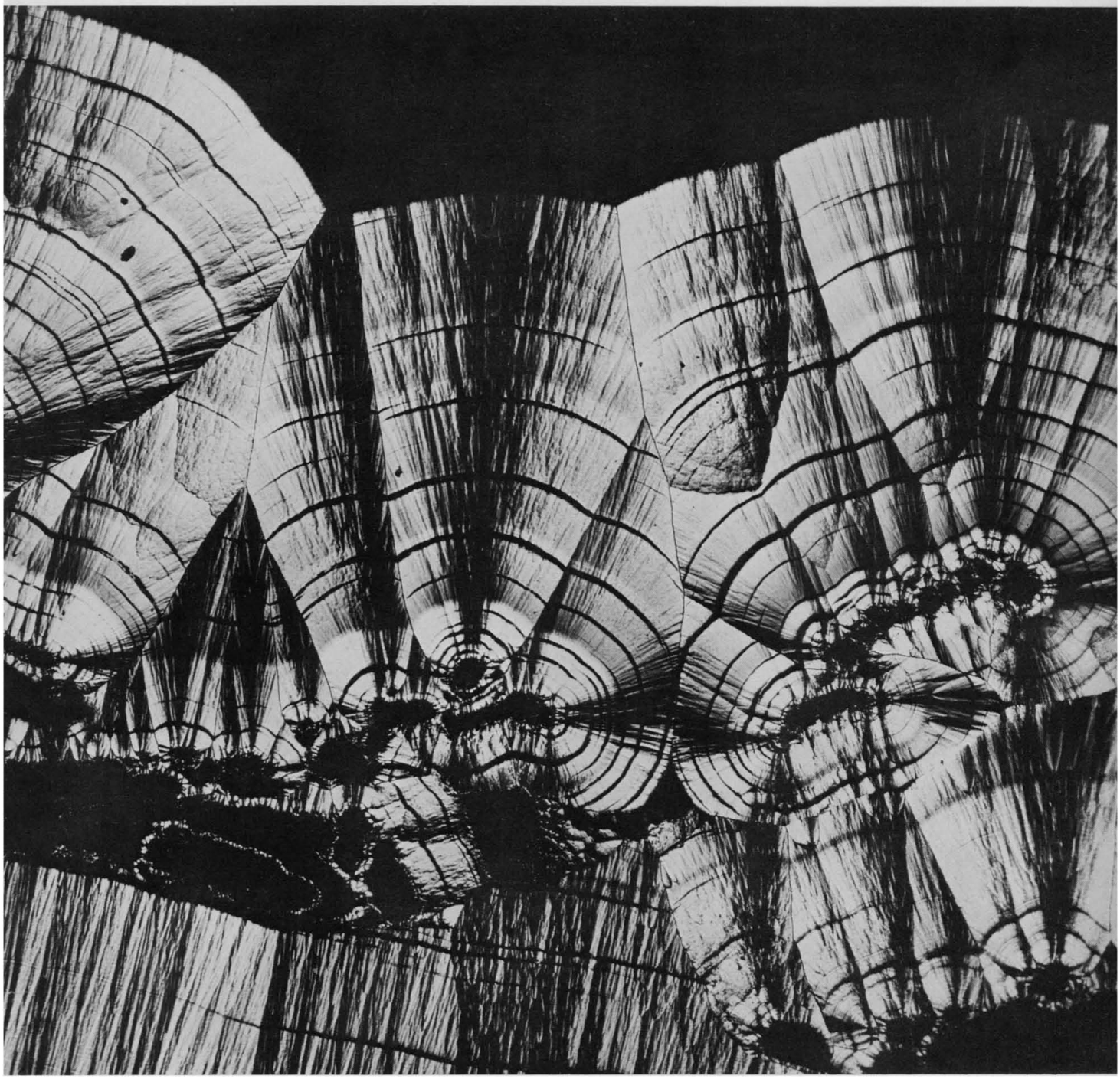
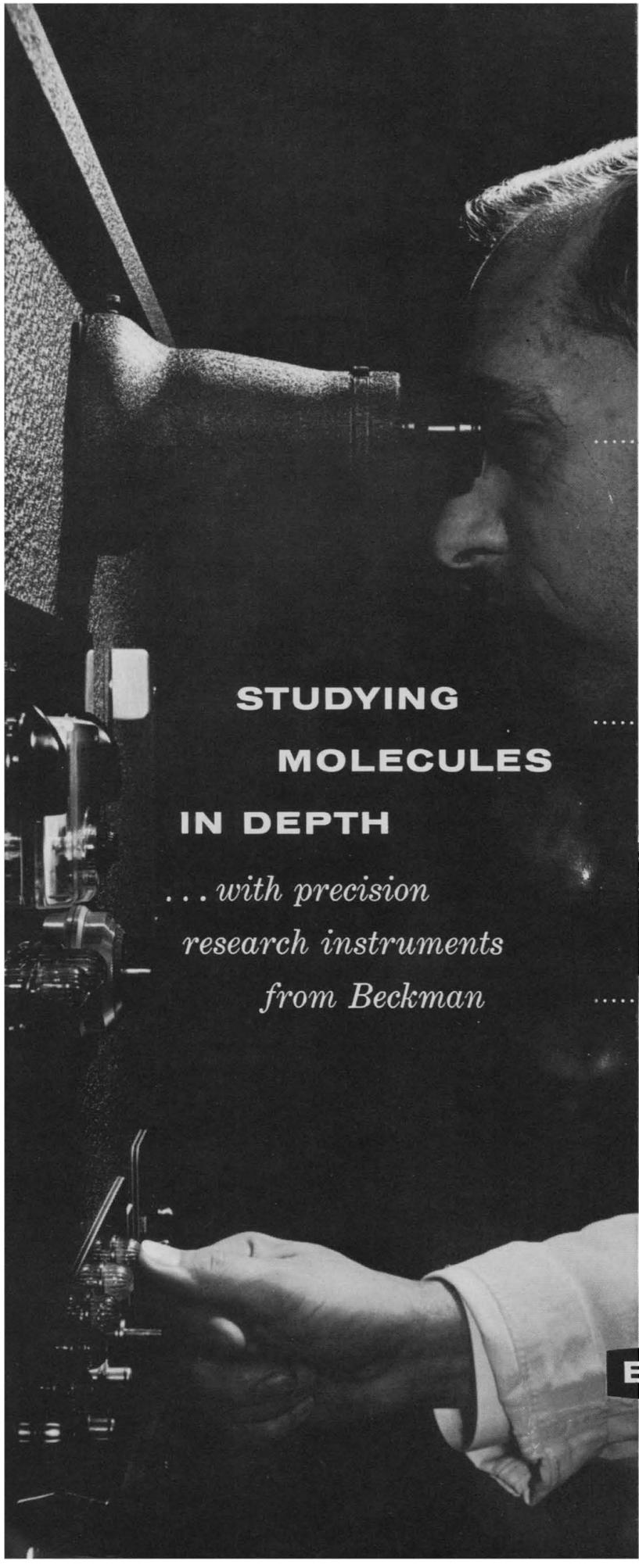
SCIENCE

18 May 1962

Vol. 136, No. 3516

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





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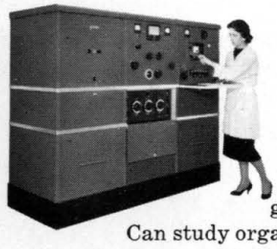

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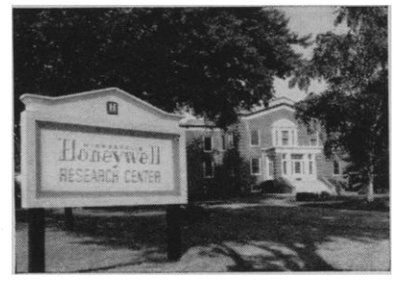
Cover Turbostratic deposit of pyrolytic graphite. Nucleation at impurity sites produces the characteristic "acorns." Polished section, polarized light, × 123 [*T. J. Clark* and *L. A. Hartcorn,* Hanford Laboratories Operation, General Electric Company]

Basic Research at Honeywell
Research Center
Hopkins, Minnesota



Coherent Electromagnetic Sources: LASER and IRASER (Light and Infrared Amplification by Stimulated Emission of Radiation).

The development of the maser in 1954 opened the microwave region of the spectrum to many new uses. Now these same principles have been extended to the visible and infrared portions of the spectrum suggesting a wide variety of important applications.

Successful practical operation of a laser (light amplification by stimulated emission of radiation) would make possible the use of light in ways never before thought possible. For instance, one important application would open the optical range of the spectrum for communications use. Laboratory lasers have been operated but many problems remain to be solved before practical operation is possible.

Conventional light sources are fundamentally noise generators and the emerging light is a jumble of separate waves that reinforce or cancel each other in random fashion. In order to be useful for communication purposes (as radio waves are used) light waves would have to be generated so that they have:

1. Directionality—produce a beam of light with a small divergence.
2. Coherence—be coherent in time and space so that the waves at various points in space act in unison.
3. Monochromaticity—have a narrow line width or a very narrow frequency range.

The maser achieves the three requirements stated above. The principle is based on the fact that electrons have discrete orbits corresponding to fixed energy levels.

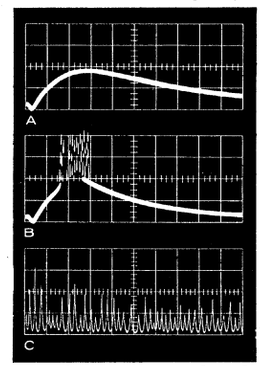
The first practical demonstration of this principle in the optical range of the spectrum was accomplished in 1960 using a ruby crystal. A flash of light is used to invert the normal electron population distribution within the ruby. The electrons in the chromium atoms of the ruby are raised by this flash of light to an excited state with two steps required to carry them back to ground. In the first step they give up some of their energy to the crystal lattice and fall to a metastable level from which they can fall to ground level emitting fluorescent light at 6943 A°. When a population inversion exists between the metastable level and the ground state the first few photons released will stimulate the still excited electrons to give up photons which stimulate still further emission in a cascading effect resulting in an intense burst of red light at 6943 A°. This light has the three properties suggested earlier: directionality—a spreading angle of a fraction of one degree; coherence—demonstrated in interference experiments; and monochromaticity—line width 0.1A°.

Other lasers have been operated including helium-neon gas giving off photons at 1.153 microns in the infrared, samarium doped calcium fluoride emitting at 7082A° and uranium doped calcium fluoride emitting at 2.1 to 2.5 microns.

Although sources are available for certain frequencies, problems remain. It is desirable to be able to develop sources that can be tuned or varied in frequency. More coverage of the infrared and visible spectrums is highly desirable. A modulating mechanism must be found to impress useful information onto the beam of light. Material must be found that will work at lower powers and at higher temperatures.

It is interesting to note the extent to which communication channels would be expanded beyond the present crowded electromagnetic spectrum if the visible spectrum were used. One angstrom unit in the visible spectrum is about 100,000 megacycles wide. Thus a coherent beam of light of frequency spread of 1A° could carry the same information as 25,000 television channels.

Honeywell scientists are presently operating lasers to study the fundamental phenomena that occur. For example the emission from the ruby laser occurs as a series of sharp spikes (see illustration at right.) The top trace (A) shows the natural fluorescent emission of the ruby when the exciting light is not sufficiently intense to cause the population inversion. The middle trace (B) shows the onset of stimulated emission at a slightly higher pumping level. The bottom trace (C) shows an expanded portion of the stimulated emission and indicates the spiked nature of the output.



Honeywell scientists have developed a mathematical model that seems to explain why pulses occur, the way they are spaced and the way they will vary. They are presently working with solid state materials that seem to have the potential of operating at normal temperatures and with low power requirements. Another device under development at Honeywell's Research Center will utilize cesium vapor and will operate in the infrared portion of the spectrum. Work is underway on methods of modulating the light beam using techniques similar to those used in radio.

The possibilities of opening the infrared and visible spectrums to communications, the practicality of optical radar, new possibilities in extremely high resolution photography, new developments in photo chemistry all add further emphasis to continuing work on lasers at Honeywell and other laboratories. If you would like to know more about Honeywell's work in this field and are engaged in scientific work involving lasers, you are invited to correspond with Mr. John Ready, Honeywell Research Center, Hopkins 8, Minnesota.

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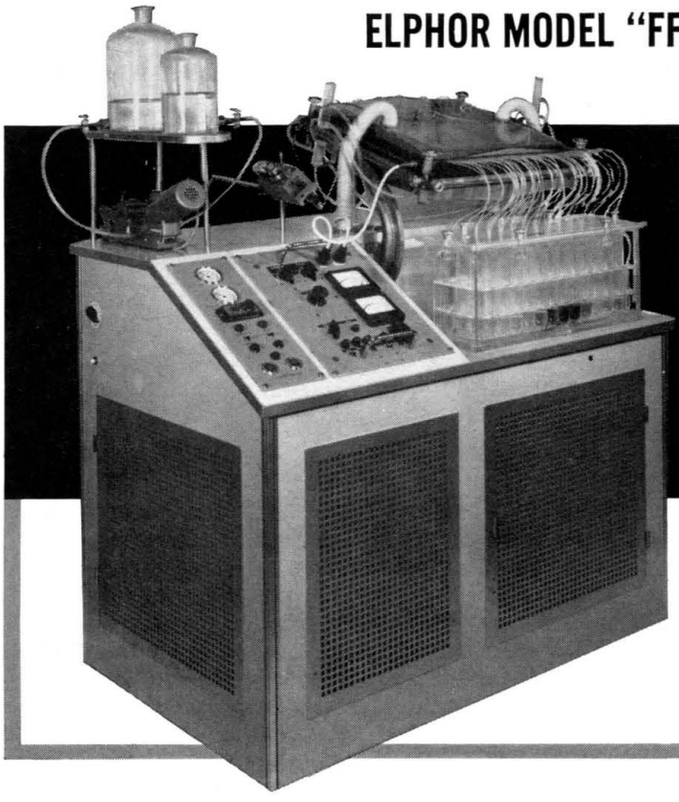

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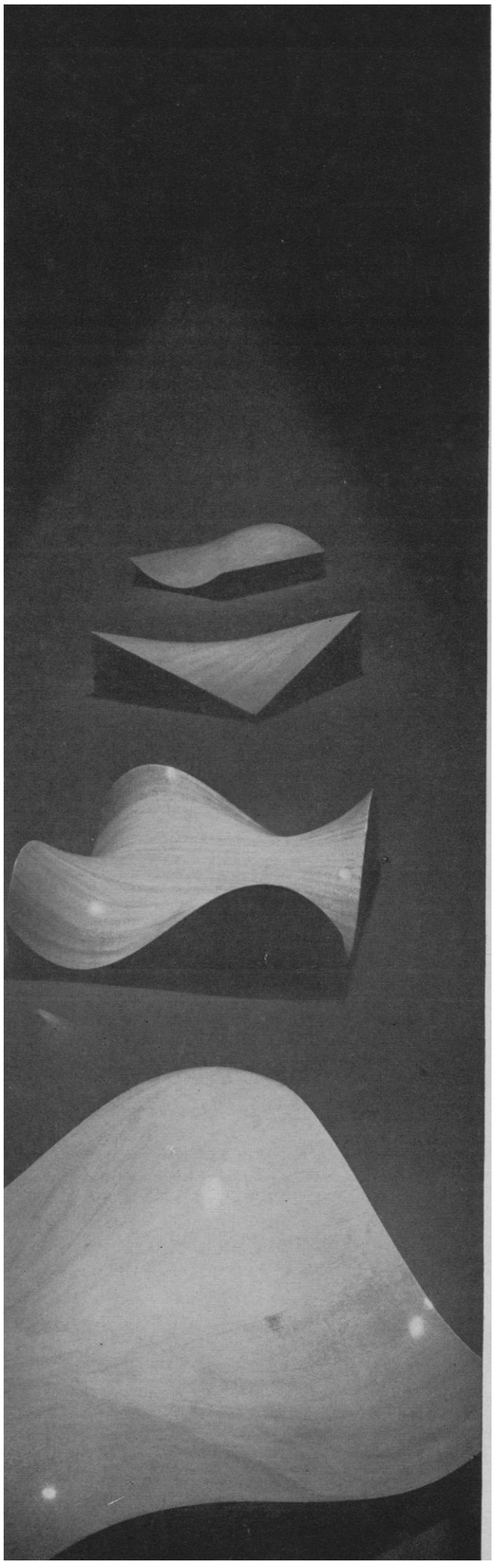

One of a series

Interpolation: the mathematical art of reading between the lines

It begins with the problem "Given certain isolated points: What is happening in between?" Men from Napier and Newton have then proceeded to discover formulas for the most probable in-between points.

Recently mathematicians at the GM Research Laboratories have been looking at new ways to interpolate in three-dimensional space. As a result they've come up with a fresh approach to the mathematical representation of surfaces. It is called *smooth surface interpolation.*

Their new interpolation formula is the sum of twelve terms. Each term corresponds to a way you can deform an elastic plate by bending or twisting its corners. (Four of the ways are shown in our illustration.)

To develop a surface, those isolated points in space are first fitted with a crisscross network of curves using a 3-D extension of shipbuilders' spline interpolation. Each rectangular element of the network can then be interpolated with the new formula so it will join smoothly and without a ripple to adjacent elements. Result: a completely smooth surface. A continuously differentiable surface.

A distinct contribution to mathematical theory, this work has suggested a host of related techniques *and* potential applications to our new advanced mathematics group. We think it typical of General Motors' constant effort to seek and find—A BETTER WAY.

General Motors Research Laboratories

Warren, Michigan

18 May 1962, Volume 136, Number 3516 **SCIENCE**

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A Children's Zoo of Math

In preparing material for children, a mathematician can go the keeper of a children's zoo one better. He is not limited to tame or domestic varieties of what nature offers, but can invent his own creatures. David Page of the University of Illinois Arithmetic Project has developed several such creatures, and an idea of this work may be gained from a glimpse at the latest addition to the menagerie, a kind of "algebra" called "maneuvers on lattices." The topic is sufficiently rich to offer scope for genuinely creative thinking, yet so simple that even a child can do it. It may be started early in elementary school, but it has possibilities for all later grades, even through high school.

The most natural way to begin maneuvers on lattices is to consider the most natural of lattices:

30 31 32 . . .
20 21 22 23 24 25 26 27 28 29
10 11 12 13 14 15 16 17 18 19
0 1 2 3 4 5 6 7 8 9

Now comes the secret code. Let "5↑" stand for the number directly above 5, namely 15, "6↑" for 16, "7↑" for 17, and so on. Arrows may also point in other directions: "15→" for 16, "15←" for 14, and so on. Next comes the deciphering of messages. More than one arrow may be used at a time: for example, "15↑↑" or "15→→→↑→↓." The problem is to figure out what numbers the more complicated expressions represent.

At first children will work out the answers step by step, making laborious use of the lattice, but soon they will make some discoveries. One child will discover that he can save time by counting all the arrows pointing in a given direction; a second will note that in expressions like "↑↓↑" certain pairs can be canceled out; and a third will find that the expression "↑→↓←" takes you around a loop. Here the teacher is working for shortcuts, generalities, and even matters of mathematical elegance.

Another kind of problem concerns the edges. Expressions like "29→" or "10←" may initially be regarded as nonsense, as meaningless, because they take you off the lattice. But a rule not to go off the lattice is very restrictive, and so there will soon be a search for appropriate meanings for these expressions. Some typical definitions, starting with the most natural one for an adult, are "29→ = 30" or *Reversed typewriter* (up a line at the right margin, then over to the left margin); "29→ = 28" or *Bounce back the way you came*; and "29→ = 0" or *Go directly to zero and start over.*

Not all definitions will prove equally acceptable to everyone. There will be strong objections and strong preferences, and the reasons must be brought out. Thus, not all of the above definitions preserve a rule implicit in the earlier use of the code: namely, that "29→↑ = 29↑→," or as a mathematician would say, the arrows commute. Here the teacher is working for the idea of generalizing a mathematical theory, that is, enlarging it to include more objects or more operations than are in the original system, with an eye to whether the original rules still hold or must be modified or dropped.

And so improvement in mathematics teaching need not be limited to seeking better ways to teach, say, the multiplication tables or to introducing selected aspects of more advanced subjects, say, set theory, at an earlier stage, but may include devising new mathematical topics. Experience in the classroom so far is encouraging, but it does show that teachers must develop a special kind of tolerance. Teachers must expect that children will be coming up with their own answers, with answers not in the book, just as at the playground children are forever finding new ways to go down the slide, and up it, too.—J.T.

MNEW FROM MNEMOTRON!*

We are silent about the "M" in Mnemotron but not about our new 700 Series Data Recorder. With good reason. For one, it brings the size and cost of data recording systems down to sensible proportions if your data is analog voltage from DC to 5000 cycles per second. And its features would not embarrass even the costliest instrumentation recorder. Here are a few:

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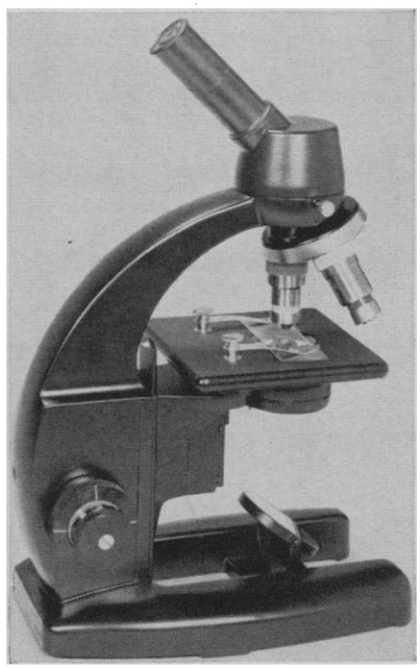
Cooke Briefs are generally devoted to discussion of research and special optical equipment of our manufacture. This issue will describe some microscopes which have proven most suitable in teaching and routine applications. Prices have been noted.

M15AX Teaching Microscope

The microscope stand and its focusing motions are the same as those used for the M15 Clinical and Research models. We supply a robust, stable stand, designed to meet modern requirements of convenience, which will stand up for many years under hard student use. High strength aluminum alloy pressure die castings and shell moldings (epoxy finished) and ball-bearing motions moving in hardened steel slideways are provided. This is not a "disposable" student microscope.



M15AX (Magnifications 100X — 400X) $238.

As protection against misuse by inexperienced students a friction clutch on the coarse adjustment prevents damage to the focusing motions; objectives are spring-loaded to avoid accident to lenses or slides.

The microscope is so designed that a wide selection of body tubes, stages and substages can be easily and quickly interchanged. Thus, a simple instrument may be built up, by acquisitions over a period of time, into a versatile equipment with many research capabilities.

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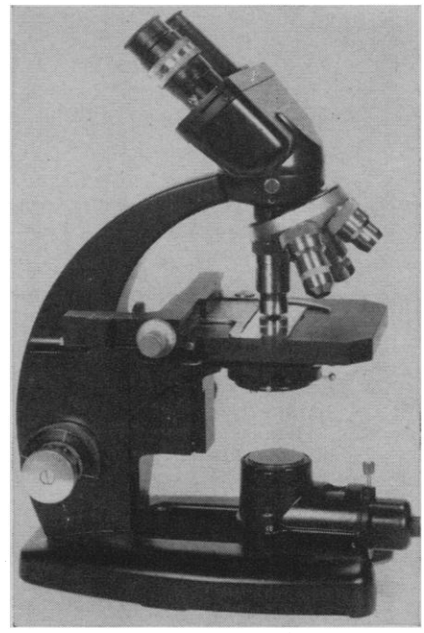
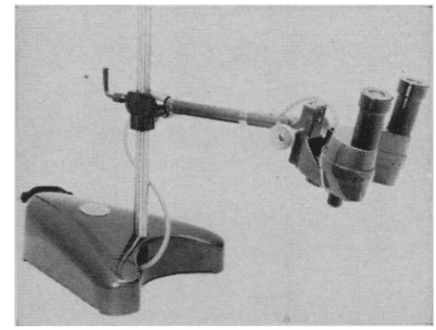


M15BY (Magnifications 30X — 1000X) $494.

By mounting additional objectives, a binocular body and a graduated mechanical stage the student M15 becomes a suitable medical microscope, unexcelled in optical performance. It is ready for further elaboration as a dark ground, phase contrast or photomicrographic instrument, as required.

The MICROPLAN 40X, high-dry objective can be supplied for use with this microscope. This lens is a notable advance in objective design, giving amazingly flat fields at medium powers — without any sacrifice of resolution or contrast.

The Sterimag (Stereoscopic Microscope)



Sterimag (10X or 20X models) $175.

This instrument is widely used in industrial inspection work, but has also an important application as a student tool in elementary botany and biology laboratories and in geology. Image quality is excellent, working distances are unusually large and field of view diameters equal or exceed those obtained with more elaborate and more expensive stereoscopic microscopes.

Either a 10X or 20X model can be supplied; magnifications are fixed and cannot be changed. However, for routine observations and dissection, these magnifications are usually sufficient.

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A built-in light source, with focusable condensing system and adjustable mounting, gives high quality illumination conveniently and without the complications which come from use of an exterior lamp. Transformer for the lamp is mounted inside the base. Domestically manufactured bulbs can be used for replacement.

Low-priced, the Sterimag has many positive advantages for student and routine use.

Meetings

Forthcoming Events

May

20–24. American Assoc. of Cereal Chemists, Saint Louis Park, Minn. (B. S. Miller, Dept. of Flour and Feed Milling, Kansas State Univ., Manhattan)

21–22. Society of American Military Engineers, annual, Washington, D.C. (SAME, 808 Mills Bldg., Washington 6)

21–23. National Aerospace Instrumentation Symp., Washington, D.C. (C. Creveling, Goddard Space Flight Center, Greenbelt, Md.)

21–24. Air Pollution Instrumentation Symp., Chicago. Ill. (D. F. Adams, Div. of Industrial Research, Washington State Univ., Pullman)

21–25. Max Planck Inst. for the Advancement of Science, general assembly, Düsseldorf, Germany. (MPIAS, Kaiserswerther Str. 164, Düsseldorf)

21–25. Plastic and Reconstructive Surgery of the Eye and Adnexa, intern. symp., New York, N.Y. (R. Troutman, Manhattan Eye, Ear & Throat Hospital, 210 E. 64 St., New York 21)

21–25. Thermodynamics of Nuclear Materials, symp., Vienna, Austria. (Intern. Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

21–26. Ceramic Congr., intern., Copenhagen, Denmark. (Arbejdsgivere, Indenfor de Keramiske Industrier, Nørre Volgade 34, Copenhagen K)

21–26. Rubber Technology Congr., annual, London, England. (Secretary, Institution of the Rubber Industry, 4, Kensington Palace Gardens, London, W.8)

22–24. National Microwave Theory and Techniques, symp., Inst. of Radio Engineers, Boulder, Colo. (L. G. Cumming, IRE, 1 E. 79 St., New York 21)

22–24. Self-Organizing Systems, conf., Chicago, Ill. (G. T. Jacobi, Armour Research Foundation, 10 W. 35 St., Chicago 16)

22–25. Rationalizing Consumption of Electric Power, intern. symp., Warsaw, Poland. (Ministry of Mines and Power, Krucza 36, Warsaw)

22–25. Rubber Technology Conf., Scarborough, England. (Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8)

22–26. Disposal and Utilization of Solid Domestic and Industrial Wastes, intern. congr., Essen, Germany. (Haus der Technik, Schliessfach 668, Essen)

22–26. International Medico-Athletic Federation, congr., Santiago, Chile. (G. La Cava, Via A. Serra, 104, Rome, Italy)

23–24. Forming and Testing of Sheet Metal, intern. colloquium, Düsseldorf, Germany. (J. Hooper, Intern. Deep Drawing Research Group, John Adam St., Adelphi, London, W.C.2, England)

23–25. American Soc. for Quality Control, annual, Cincinnati, Ohio. (A. W. Wortham, Texas Instruments, Inc., P.O. Box 5474, Dallas 22)

24–26. Institute of Radio Engineers, conf. on space communications, Seattle, Wash. (IRE, 1 E. 79 St., New York 21)

24–26. International Assoc. for Bronchology, Bruges, Belgium. (R. Pannier, c/o Service de Pneumo-Phtisologie, Hôpital Saint-Jean, Bruges)

25–27. Society for Applied Anthropology, annual, Kansas City, Mo. (C. Price, Menninger Foundation, Topeka, Kansas)

26–27. Ukrainian Medical Assoc. of North America, biennial, Detroit, Mich. (R. W. Sochynsky, UMANA, 2 E. 79 St., New York 21)

26–30. International Federation for Hygiene and Preventive Medicine, intern. congr., Vienna, Austria. (E. Musil, IFHPM, Mariahilfer Strasse 177, Vienna)

27–30. Chemical Inst. of Canada, annual conf. and exhibition, Edmonton. (CIC, 48 Rideau St., Ottawa 2, Ont.)

27–30. East-West Diabetic Workshop, Chicago, Ill. (B. R. Hurst, 1646 Pittsfield Building, 55 E. Washington, Chicago 2)

27–2. International Federation of Prestressing, 4th congr., Rome, Italy. (IFP, 6, rue Paul Valéry, Paris, 16e)

28–30. American Assoc. for Contamination Control, 1st annual, San Francisco, Calif. (D. M. Petersen, Central Vacuum Corp., 3008 E. Olympic Blvd., Los Angeles 23, Calif.)

28–30. Biology of the Transuranic Elements, symp., Richland, Wash. (R. C. Thompson, Hanford Biology Laboratory, General Electric Co., Richland)

28–30. Heavy Water Reactors, Canadian Nuclear Assoc., annual conf., Ottawa, Ont., (CNA, 19 Richmond St. West, Toronto 1)

28–30. International Discussion on Heat Treating, Lausanne, Switzerland. (Institut für Härterei-Technik, Postfach 13, Bremen-St. Magnus, Germany)

28–1. Modern Techniques of Computation and Industrial Automation, colloquium, Paris, France. (Assoc. Française de Régulation et d'Automatisme, 19, rue Blanche, Paris 9e)

28–2. International Ophthalmic Optical Congr., Berlin, Germany. (G. H. Giles, Intern. Optical League, 65 Brook St., London, W.1, England)

28–2. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, N.Y. (United Nations, New York)

29–2. American College of Cardiology, Inc., Denver, Colo. (I. Brotman, 1746 K St., NW, Washington, D.C.)

29–3. Latin Oto-Rhino-Laryngology Soc., Madrid, Spain. (M. Calderin, Diego de Leon 62, Madrid)

29–22. World Meteorological Organization, congr., Geneva, Switzerland. (WMO, 41, Avenue Giuseppe Motta, Geneva)

29–31. Tissue Culture Assoc., annual, Washington, D.C. (R. E. Stevenson, Natl. Cancer Inst., Bethesda 14, Md.)

31–3. European Symp. on Fresh Water from the Sea, Athens, Greece. (P.O. Box 1199, Omonoia, Athens)

31–3. German Bunsen Soc. for Physical Chemistry, general assembly, Münster. (F. Vorländer, Varrentrappstr. 40–42, Frankfurt am Main, Germany)

31–7. Television Conf., intern., London, England. (Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2)

June

1–2. European Acad. of Allergy, Prague, Czechoslovakia. (C. Herscheimer, Theyss-Str. 23, Berlin, Germany)

3–8. American Soc. for Testing and Materials, Committee on Mass Spectrometry, annual, New Orleans, La. (G. Crable, Geneva College, Beaver Falls, Pa.)

4–6. Association of Iron and Steel Engineers, Colorado Springs, Colo. (T. J. Ess, AISE, 1010 Empire Bldg., Pittsburgh 22, Pa.)

4–6. Chemistry and Technology of Chloring and Chloroderivatives, mtg., Szczecin. Polish Chemical Soc. (A. Z. Zielinski, Politechnika Szczecinska, U1. Pułaskiego 10, Szczecin 3)

4–6. Edison Electric Inst., annual, Atlantic City, N.J. (A. B. Morgan, EEI, 750 Third Ave., New York 17)

4–6. International Water Study Sessions, Liége, Belgium. (CEBEDEAU, 2, rue Armand Stévart, Liége)

4–7. Nuclear Congr. and Intern. Atomic Exposition, biennial, New York, N.Y. (Engineers Joint Council, 29 W. 39 St., New York 18)

4–8. Medical Library Assoc., annual, Chicago, Ill. (D. Washburn, American Dental Assoc., 222 E. Superior St., Chicago 11)

4–8. Modern Thermal and Hydraulic Power Plants, intern. study days, Liége, Belgium. (Secretary, Assoc. des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, rue Saint-Gilles, 31, Liége)

4–8. Society of Chemical Industry, overseas section, annual, Stockholm, Sweden. (G. P. Armstrong, c/o Distillers Co. Ltd., 21 St. James Sq., London, England)

4–8. Society of Physical Chemistry, annual, Paris, France. (O. Emschwiller, Ecole Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris 5e)

4–10. Corrosion of Reactor Materials, conf., Intern. Atomic Energy Agency, Salzburg, Austria. (IAEA, 11 Kaerntnerring, Vienna 1, Austria)

5–6. International Neurological Meeting, Paris, France. (J. Sigwald, Société Française de Neurologie, 68, Boulevard de Courcelles, Paris 17e)

5–7. Fuels Symp., American Soc. of Mechanical Engineers, New Brunswick, N.J. (C. R. G. Dougherty, College of Engineering, Rutgers Univ., New Brunswick)

5–8. Microwave Communication, Budapest, Hungary. (G. Bognár, Hungarian Acad. of Sciences, Akadémia utca 2, Budapest V)

5–8. Group for the Advancement of Spectrographic Methods, annual congr., Paris, France. (Groupement pour l'Advancement des Méthodes Spectrographiques, 1, rue Gaston-Boissier, Paris 15e)

6–8. American Scientific Glassblowers Soc., annual symp. and exposition, Washington, D.C. (G. A. Sites, ASGS, 309 Georgetown Ave., Wilmington 3, Del.)

6–8. Canadian Federation of Biological Societies, annual, Quebec. (A. H. Neufeld, Dept. of Pathological Chemistry, Univ. of Western Ontario, London, Ont., Canada)

6–9. International Assoc. for Cereal Chemistry, Vienna, Austria. (F. Schweitzer, Maurer, Heudöfelgasse 41, Vienna 23)

6–9. Union of Textile Chemists and

Colorists, annual, Baden-Baden, Germany. (Verein der Textilchemiker und Coloristen, Blauenstr. 17, Badenweiler, Germany)

7–9. Manufacturing Chemists' Assoc., Inc., White Sulphur Springs, W.Va. (R. D. Lambert, MCA, 1825 Connecticut Ave., NW, Washington 9)

7–9. U.N. Food and Agriculture Organization–Intern. Union of Forest Research Organizations, Joint Committee on Bibliography, Freiburg, Switzerland. (Intern. Agency Liaison Branch Office of Director General, FAO, Viale delle Terme di Caracalla, Rome, Italy)

7–13. Quantitative Biology, symp., Cold Spring Harbor, N.Y. (Long Island Biological Assoc., Cold Spring Harbor)

8–9. Nutrition Soc. of Canada, annual, Quebec City. (E. V. Evans, Dept. of Nutrition, Ontario Agricultural College, Guelph, Ont., Canada)

9. Community Air Pollution, conf., Austin, Tex. (J. O. Ledbetter, 305 Engineering Laboratories Bldg., Univ. of Texas, Austin 12)

10–14. Institute of Food Technologists, Miami Beach, Fla. (C. L. Willey, 176 W. Adams St., Chicago 3, Ill.)

10–15. International Alliance for Diffusion by Wire, annual general assembly, Lausanne, Belgium. (T. C. De Vynck, Van Stopenberghestr. 3, Ghent, Belgium)

10–16. International Congr. of Sanitary Engineering, Washington, D.C. (E. E. Wagner, Engineering & Sanitation Branch, Office of Public Health, Intern. Cooperation Administration, Washington 25)

11. International Soc. of Neurovegetative Research, symp., Marseilles, France. (Prof. Mosinger, Institut de Médecine Légale, Faculté de Médecine, Marseilles)

11–13. Chemical Physics in the Onsager Reciprocal Relations, intern. conf., Providence, R.I. (J. Ross, Dept. of Chemistry, Brown Univ., Providence)

11–13. Microscopy, symp., Chicago, Ill. (McCrone Research Inst., 451 E. 31 St., Chicago 16)

11–14. Health Physics Soc., Inc., annual, Chicago, Ill. (C. C. Palmiter, c/o Federal Radiation Council, Rm. 597, Executive Office Bldg., Washington 25)

11–14. Instrument Soc. of America, instrument-automation conf. and exhibit, Seattle, Wash. (W. H. Kushnick, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

11–15. American Medical Assoc., annual, Chicago, Ill. (F. J. Blasingame, AMA, 535 N. Dearborn St., Chicago 10)

11–15. International Congr. on Rehabilitation, Dresden, Germany. (K. Werner, Intern. Congr., Harz 42–44, Halle an der Saale, Germany)

11–15. International Council for Bird Preservation, intern. conf., New York, N.Y., (British Museum of Natural History, Cromwell Rd., London, S.W.7, England)

11–15. Molecular Structure and Spectroscopy, symp., Columbus, Ohio. (R. A. Oetjen, Dept. of Physics and Astronomy, Ohio State Univ., 174 W. 18 Ave., Columbus 10)

11–18. Industrial Statistics and Quality Control for Chemical and Processing Industries, seminar, Rochester, N.Y. (Extended Services Div., Rochester Inst. of Technology, Rochester 8)

11–22. All-European Inst. of Scientific Studies for the Prevention of Alcoholism, Warsaw, Poland. (A. Tongue, Intern. Bureau against Alcoholism, Case Gare 49, Lausanne, Switzerland)

11–22. Geophysics, summer seminar, Cloudcroft, N.M. (J. R. Foote, P.O. Box 1053, Holloman AFB, N.M.)

11–24. Electronics, Nuclear Energy, Wireless, Television, and Cinema, intern. exhibition, Rome, Italy. (Secretariat, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, Via della Scrofa 14, Rome)

11–24. Stratigraphy and Structure of the Appalachians, summer conf., Washington, D.C. (M. F. Norton, Dept. of Earth Sciences, American Univ., Massachusetts and Nebraska Aves., NW, Washington, D.C.)

12. Society of Plastics Engineers, technical conf., Boston, Mass. (H. C. Cookingham, c/o D. H. Litter Co., Inc., P.O. Box 247, Ballardvale, Mass.)

12–15. American Soc. of Mammalogists, annual, Middlebury, Vt. (B. P. Glass, Dept. of Zoology, Oklahoma State Univ., Stillwater)

12–15. Globes, 1st intern. congr., Vienna, Austria. (Coronelli-Weltbund der Globusfreunde, Gusshaustrasse 20, Vienna IV)

12–15. Immune Pathology, mtg., German Soc. of Pathology, Dortmund, Germany. (A. Terbrüggen, Deutsche Gesellschaft für Pathologie, c/o Pathologisches Inst., Bielefeld, Germany)

12–15. Organic Chemistry of Natural Products, intern. symp., Brussels, Belgium. (Secrétariat du Symposium Internationale de Chimie Organique, c/o Fédération des Industries Chimiques de Belgique, 32, rue Joseph II, Bruxelles 4)

12–15. Textile Inst., intern. meeting, Eastbourne, England. (D. Moore, 10 Blackfriars St., Manchester 3, England)

12–16. American Soc. of Parasitologists, Washington, D.C. (F. J. Kruidenier, Dept. of Zoology, Univ. of Illinois, Urbana)

13. International Commission for the Prevention of Alcoholism, annual, Warsaw, Poland. (ICPA, 6840 Eastern Ave., NW, Washington 12)

13–16. American Assoc. of Bioanalysts, Philadelphia, Pa. (L. D. Hertert, 490 Post St., Rm. 1049, San Francisco 2, Calif.)

13–16. Gas Chromatography, intern. symp., Hamburg, Germany. (W. Fritsche, Gesellschaft Deutscher Chemiker, Frankfurt am Main, Postfach 9075, Germany)

13–29. International Radio Consultative Committee, Bad Kreuznach, Germany. (Villa Bartholoni, 128, rue de Lausanne, Geneva, Switzerland)

14–15. DECHEMA Annual Meeting, Frankfurt am Main, Germany. (DECHEMA, Postfach 7746, Frankfurt am Main 7)

14–16. American Assoc. of Feed Microscopists, annual, Chicago, Ill. (T. G. Campbell, AAFM, 1825 N. Laramie Ave., Chicago 39)

14–16. German Soc. for Rocket Technology and Space Travel, annual, Brunswick, Germany. (GSRTST, Neuensteiner Str. 19, Stuttgart-Zuffenhausen, Germany)

14–17. American Soc. of Ichthyologists and Herpetologists, Washington, D.C. (J. A. Peters, Biology Dept., San Fernando Valley State College, Northridge, Calif.)

15–17. Congress of Scientists on Survival, natl. conf., annual, New York, N.Y. (H. H. Lerner, SOS, 51 E. 90 St., New York 28)

15–19. European Orthodontic Soc., congr., Groningen, Netherlands. (K. G. Bijlstra, Kamplaan 5, Groningen)

16–17. Society for Economic Botany, annual, Washington, D.C. (Q Jones, New Crops Research Branch, Plant Industry Station, Beltsville, Md.)

17–20. American Dairy Science Assoc., College Park, Md. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

17–20. American Soc. of Agricultural Engineers, Washington, D.C. (J. L. Butt, ASAE, 420 Main St., St. Joseph, Mich.)

17–20. Botanical Soc. of America, field meeting, Newark, Del. (G. F. Somers, Dept. of Biological Sciences, Univ. of Delaware, Newark)

17–21. American Nuclear Soc., annual, Boston, Mass. (O. J. DuTemple, ANS, 86 E. Randolph St., Chicago 1, Ill.)

17–21. Enzymic Action of the Central Nervous System, intern. symp., Göteborg, Sweden. (A. Lowenthal, Institut Bunge, 59, rue Philippe Williot, Berchem-Antwerp, Belgium)

17–21. International Ornithological Congr., Ithaca, N.Y. (G. Sibley, Cornell Univ., Fernow Hall, Ithaca)

17–22. American Inst. of Electrical Engineers, summer meeting, Denver, Colo. (R. S. Gardner, AIEE, 33 W. 39 St., New York 18)

17–22. American Soc. of Medical Technologists, Washington, D.C. (S. Saarnijoki, R.R. #2, Hill Rd., c/o W. C. Maine, Harwinton, Conn.)

17–23. American Library Assoc., Miami Beach, Fla. (D. H. Clift, ALA, 50 E. Huron St., Chicago 11, Ill.)

18–19. Broadcast and Television Receivers, conf., Institute of Radio Engineers, Chicago, Ill. (IRE, 1 E. 79 St., New York 21)

18–20. American Neurological Assoc., annual, Atlantic City, N.J. (M. D. Yahr, Neurological Inst., 710 W. 168 St., New York 32)

18–21. Agricultural Inst. of Canada, annual conf., Ottawa, Ont. (AIC, Univ. of Ottawa, Ottawa, Ont.)

18–21. U.S. Congress on Theoretical and Applied Mechanics, Berkeley, Calif. (W. Goldsmith, Dept. of Applied Mechanics, Univ. of California, Berkeley 4)

18–22. American Soc. for Engineering Education, Colorado Springs, Colo. (W. L. Collins, Univ. of Illinois, Urbana)

18–22. Combustion Engines, intern. congr., Copenhagen, Denmark. (R. L. Stanley, U.S. Natl. Committee for ICCE, 2000 K St., NW, Washington 6)

18–22. Mathematical Programming, symp., Chicago, Ill. (R. L. Graves, Graduate School of Business, Univ. of Chicago, Chicago 37)

18–22. Research and Development of Technical Devices for the Blind, intern. congr., New York, N.Y. (N. C. Holopigian, American Foundation for the Blind, 15 W. 16 St., New York 11)

18–22. Spectroscopy, intern. conf., Col-

lege Park, Md. (B. F. Scribner, Natl. Bureau of Standards, Washington 25, D.C.)

18–23. American Soc. for Horticultural Science, Caribbean region, annual, Antigua, Guatemala. (E. H. Cásseres, Londres 40, México 6, D.F.)

18–23. Continuous Culture of Microorganisms, intern. symp., Prague, Czechoslovakia. (I. Málek, Czechoslovak Acad. of Science, Inst. of Biology, Na cvičišti 2, Prague 6)

18–23. International Scientific Congr. on Electronics, Rome, Italy. (Rassegna Eletronica, Nucleare e della, Cinematografia, Via della Scrofa 14, Rome)

18–23. Space, intern. technical-scientific mtg., Rome, Italy. (Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, Via della Scrofa 14, Rome)

18–23. U.N. Educational Scientific and Cultural Organization, Youth Inst., Study Seminar on Natural Sciences in Youth Science Clubs, Munich, Germany (UNESCO, Germeringerstrasse 30, Munich/Gauting, Germany)

18–24 Aug. Institute of Theoretical Physics, annual, Boulder, Colo. (W. E. Brittin, Dept. of Physics, Univ. of Colorado, Boulder)

19–20. Applications of Quality Control in Chemical and Processing Industries, seminar, Rochester, N.Y. (Extended Services Div., Rochester Inst. of Technology, Rochester 8)

19–21. American Physical Soc., Evanston, Ill. (K. K. Darrow, Pupin Physics Lab., Columbia Univ., New York 27)

19–21. Biomedical Engineering Symp. and Exhibit, annual, San Diego, Calif. (Program Committee, Inter-Science, Inc., 8484 La Jolla Shores Dr., La Jolla, Calif.)

19–22. Institute of the Aerospace Sciences, natl. summer meeting, Los Angeles, Calif. (H. S. Hansen, Halex, Inc., P.O. Box 546, El Segundo, Calif.)

19–22. Data Processing, intern. conf., New York, N.Y. (Conf. Registrar, Natl. Machine Accountants Assoc., 507 Fifth Ave., New York 17)

20–24. European Center of Federations of the Chemical Industry, congr., Vienna, Austria. (ECFCI, Bauernmarkt 13, Vienna)

20–24. Long-Term Climatic Variations, conf., Aspen, Colo. (F. Ward, CRZH, AFCRL, Hanscom Field, Mass.)

20–29. European Federation of Chemical Engineering, annual congr., Olympia, London, England. (Congr. Secretary, Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1)

21–22. American Rheumatism Assoc., annual, Chicago, Ill. (F. E. Demartini, 622 W. 168 St., New York 32)

21–23. Astronomical Soc. of the Pacific, summer meeting, Victoria, B.C. (H. A. Abt, Kitt Peak National Observatory, Kitt Peak, Ariz.)

21–23. Endocrine Soc., annual, Chicago, Ill. (N. L. Mattox, 1200 N. Walker, Oklahoma City, Okla.)

21–23. Interaction Between Fluids and Particles, London, England. (Soc. of Chemical Industry, 14 Belgrave Sq., London)

21–25. American College of Chest Physicians, annual, Chicago, Ill. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago 11)

21–28. Design of Experiments for

Chemical and Processing Industries, seminar, Rochester, N.Y. (Extended Services Div., Rochester Inst. of Technology, Rochester 8)

22–24. International College of Angiology, mtg., Chicago, Ill. (H. E. Shaftel, 3301 Newkirk Ave., Brooklyn 3, N.Y.)

22–3. International Conf. on Chemical Arts—Chemistry Exhibition, Paris, France. (Société de Chimie Industrielle, 28, rue Saint Dominique, Paris, 7°)

24–27. Cytodifferentiation and Macromolecular Synthesis, symp., Soc. for the Study of Development and Growth, Monterey Peninsula, Calif. (A. C. Braun, Rockefeller Inst., New York 21)

24–28. Association of Official Seed Analysts, Miami, Fla. (E. W. Sundermeyer, 325 U.S. Court House, 8th and Grand Ave., Kansas City 6, Mo.)

24–29. American Soc. for Testing and Materials, annual meeting and exhibit, New York, N.Y. (ASTM, 1916 Race St., Philadelphia 3, Pa.)

25–27. American Soc. of Heating, Refrigerating and Air-Conditioning Engineers, Inc., annual, Miami Beach, Fla. (ASHRAE, United Engineering Center, 345 E. 47 St., New York 17)

25–27. National Convention on Military Electronics, annual, Washington, D.C. (J. J. Slattery, Electronics Div., Martin Co., Baltimore, Md.)

25–28. Society for Investigative Dermatology, Chicago, Ill. (H. Beerman, SID, 255 S. 17 St., Philadelphia 3, Pa.)

25–29. Coordination Chemistry, intern. conf., Stockholm, Sweden. (L. G. Sillen, Dept. of Inorganic Chemistry, Royal Inst. of Technology, Stockholm 70)

25–29. Gordon Research Conf. on Nuclear Chemistry, New London, N.H. (W. G. Parks, Univ. of Rhode Island, Kingston)

25–29. Nobel Physicists, Lindau im Bodensee, Germany. (Ständiger Arbeitsausschuss für die Tagungen der Nobelpreisträger in Lindau, Postfach 11, Lindau im Bodensee)

25–29. Theoretical Interpretation of Upper Atmosphere Emissions, intern. symp., Paris, France. (J. W. Chamberlain, Yerkes Observatory, Williams Bay, Wis.)

25–30. Alpine Tundra Ecology, seminar. Estes Park, Colo. (M. Potts, Rocky Mountain Natl. Park, P.O. Box 1080, Estes Park)

25–30. Electromagnetic Theory and Antennas, symp., Copenhagen, Denmark. (Symp. Secretary, Øster Voldgade 10G, Copenhagen K.)

25–20 July. National Science Foundation, Summer Conf. for College Teachers of the History of Mathematics, Ann Arbor, Mich. (P. S. Jones, Dept. of Mathematics, Univ. of Michigan, Ann Arbor)

26–28. American Assoc. of Physics Teachers, Northfield, Minn. (R. P. Winch, Dept. of Physics, Williams College, Williamstown, Mass.)

26–28. American Meteorological Soc., general meeting, Fairbanks, Alaska. (J. E. Miller, Dept. of Meteorology and Oceanography, New York Univ., University Heights, New York 53)

26–29. American Home Economics Assoc., Miami Beach, Fla. (D. S. Miller, 3705 Van Buren Ave., Corvallis, Ore.)

26–29. Poultry Science Assoc., Urbana, Ill. (C. B. Ryan, Texas A & M College, College Station)

26–30. Rarefied Gas Dynamics, intern. symp., Paris, France. (L. Talbot, Dept. of Aeronautical Sciences, Univ. of California, Berkeley)

26–4. German Chemical Engineering Congr. and Exposition, Frankfurt am Main. (J. J. Doheny, American Chemical Soc., 86 E. Randolph St., Chicago 1, Ill.)

27–28. Computers and Data Processing, symp. annual, Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst., Univ. of Denver, Denver 10, Colo.)

27–30. Society of Nuclear Medicine, annual, Dallas, Tex. (S. N. Turiel, SNM, 430 N. Michigan Ave., Chicago 11, Ill.)

28–29. Radio Frequency Interference, natl. symp., San Francisco, Calif. (R. G. Davis, Dept. 58–25, Lockheed Missile & Space Co., P.O. Box 504, Sunnyvale, Calif.)

28–30. Joint Automatic Control Conf., annual, New York, N.Y. (A. S. Robinson, Kollsman Instrument Corp., 80–08 45th Ave., Elmhurst 73, N.Y.)

28–30. Secondary Fungus Infections, intern. conf., Durham, N.C. (E. W. Chick, Veterans Administration Hospital, Durham)

30–7. International Conf. on Health and Health Education, Philadelphia, Pa. (Conf. Secretariat, ICHHE, 800 Second Ave., New York 17)