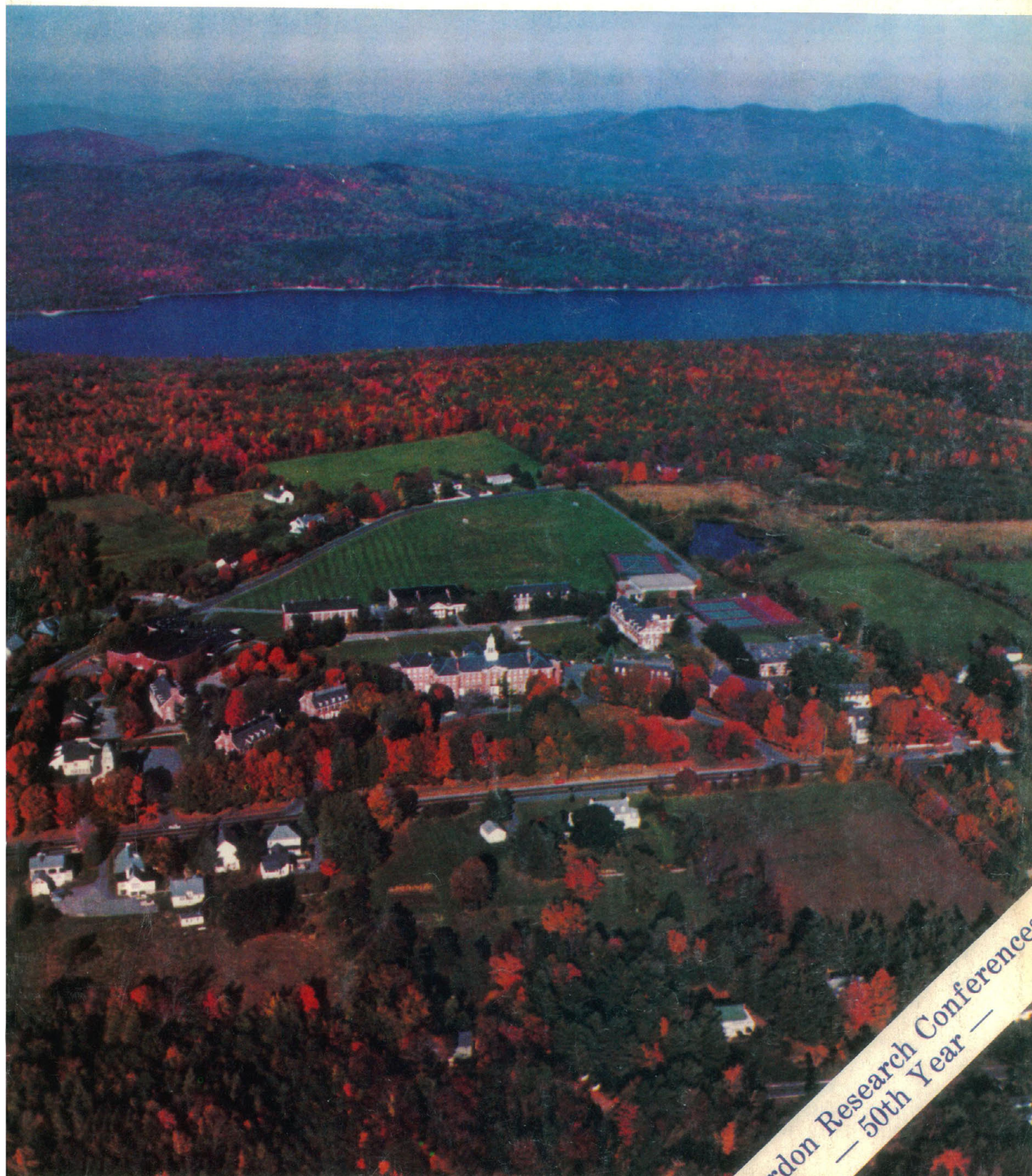


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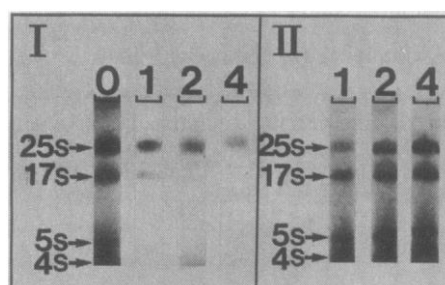
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• Towbin et al., *Proc. Nat. Acad. Sci. (US)* 76: 4350, 1979

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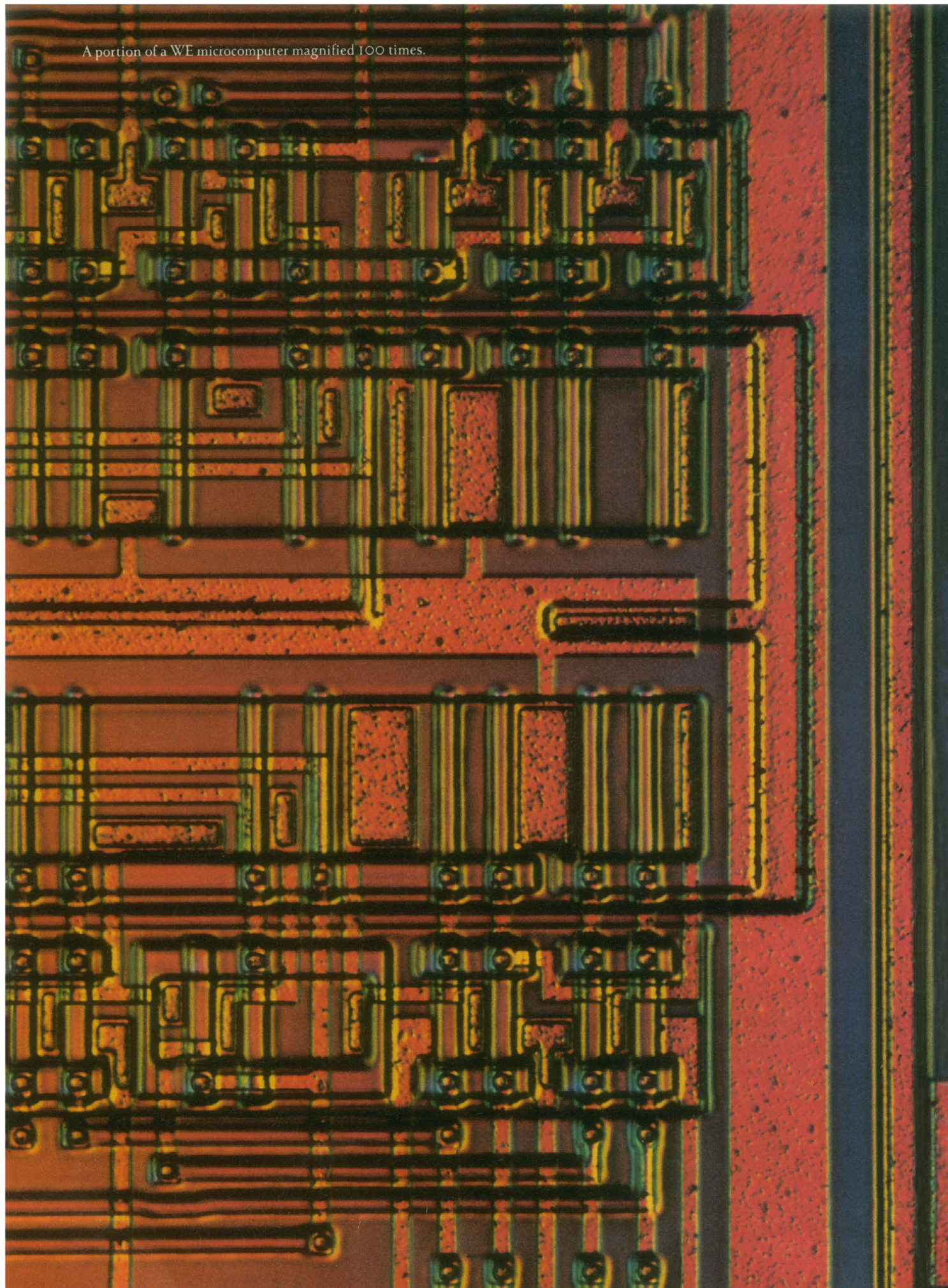
## COVER

Aerial view of Colby-Sawyer College, New London, New Hampshire, summer headquarters of the Gordon Research Conferences located in the heart of the Lake Sunapee-Dartmouth region. In the background can be seen the Pleasant Lake and the Ragged Mountains—a panorama for the enjoyment of the conferees. See page 1191. [Photography Unlimited, New London, New Hampshire 03257]

The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.



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a better way to type.



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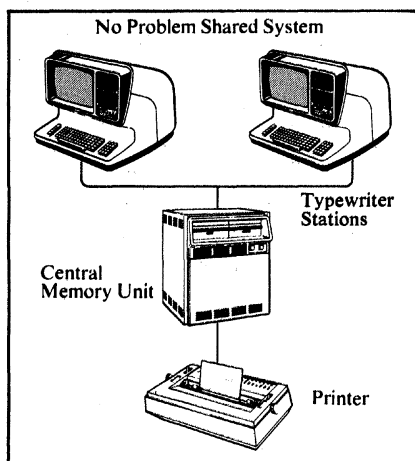


With the No Problem typewriter, one typist can now do work as fast as 3 or 4 people using ordinary electric typewriters.

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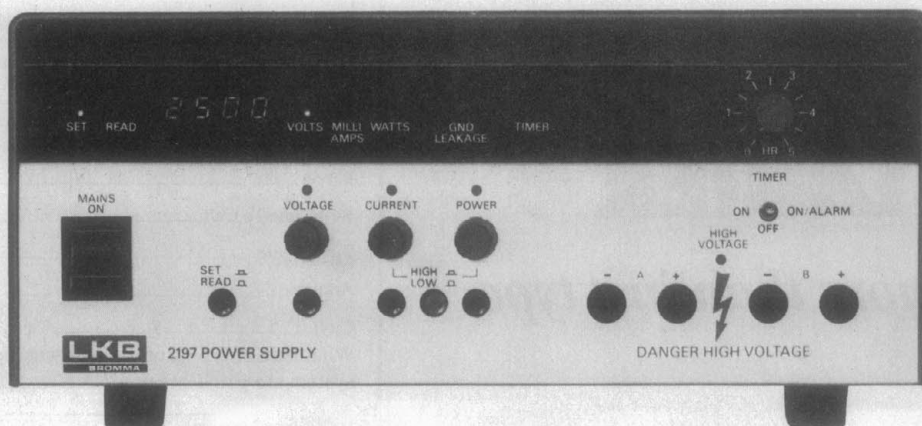
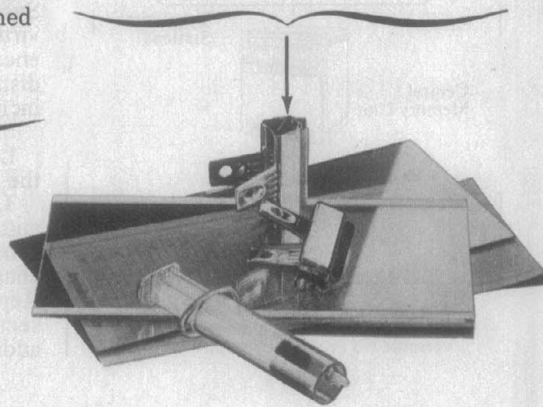


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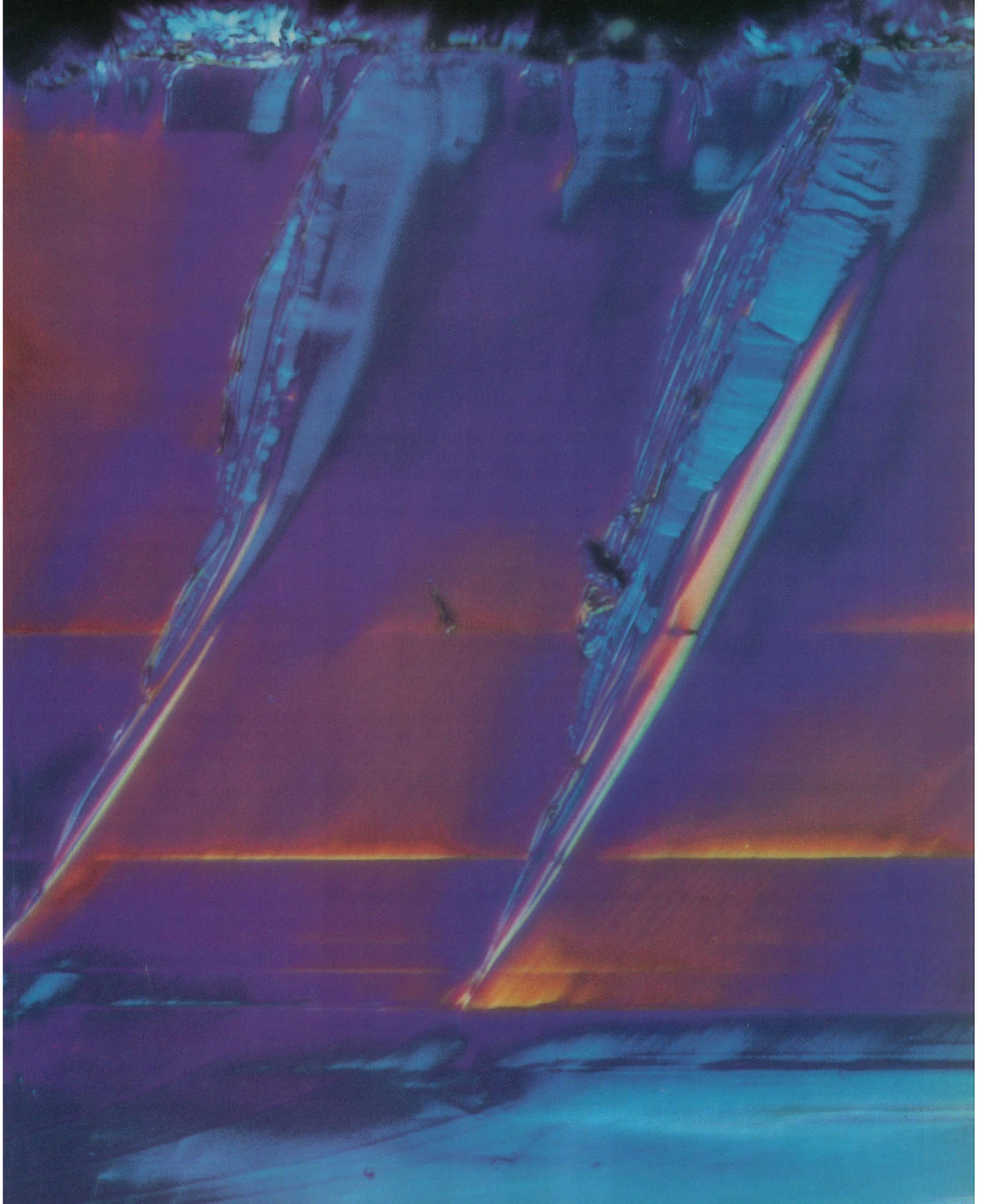
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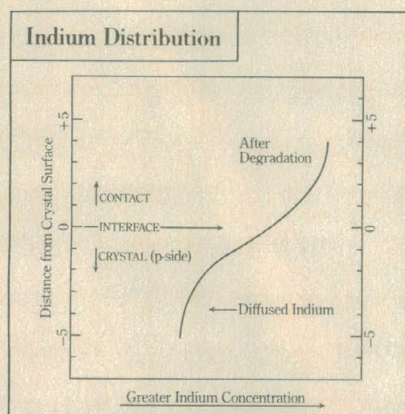
# The Strategic Misalignment





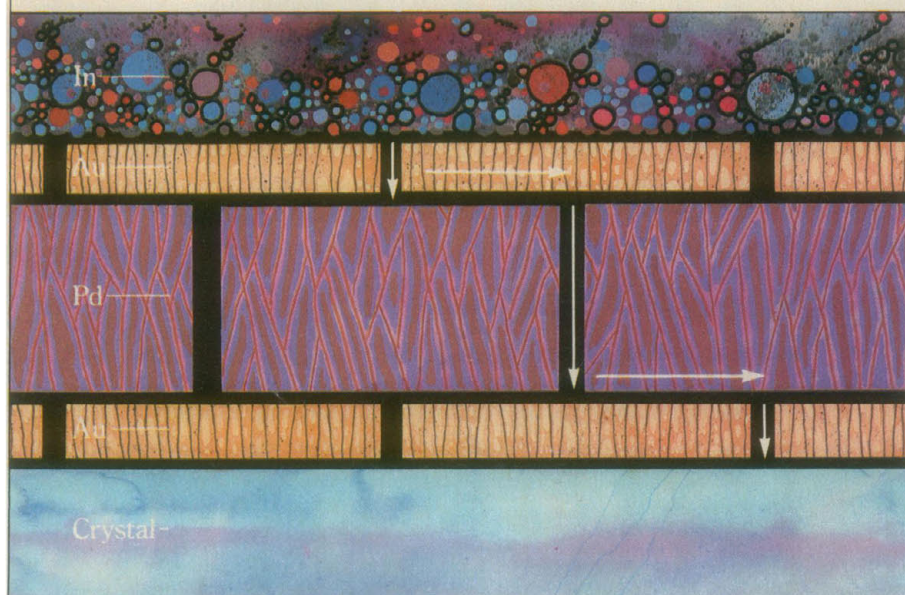
# The Strategic Misalignment

*Tunable semiconductor lasers can now measure specific gases in automotive exhaust with 25-millisecond response time. A successful strategy for improving laser reliability developed at the General Motors Research Laboratories makes this and other new spectroscopy capabilities practical realities.*



Electron microprobe analysis of a crystal-contact interface, indicating indium penetration into the PbSnTe crystal.

Diagram of hypothetical indium diffusion paths for a three-layer contact structure of Au-Pd-Au.



THE ACHIEVEMENT of long lifetime and frequency stability makes the lead-tin-telluride diode laser a practical infrared spectrometer. Earlier innovations brought to this laser the characteristics of increased power, higher temperature operation, greater efficiency and wider tuning range.

Operating in the 5- to 10-micron range, the PbSnTe laser spectrometer can resolve the time-dependent emission of carbon monoxide, sulfuric acid vapor, methane and other species of interest in automotive exhaust. This permits measurement of transients in carbon monoxide to carbon dioxide gas conversion in a

catalytic converter. This capability represents a significant advance over conventional spectroscopy instrumentation. The laser is also being tested by NASA for use in detecting the molecular species involved in chemical reactions in the stratosphere.

New knowledge of the process by which laser reliability is compromised has been revealed in fundamental studies conducted by Dr. Wayne Lo and his colleagues at General Motors. Dr. Lo's investigations have demonstrated that laser lifetime and stability are limited by the development of excessive electrical contact resistance. He has been able to stop increases in resistance by devising a multilayer ohmic contact consisting of different metal films. This configuration has extended laser operating lifetime to more than 1,000 hours and increased shelf-life to an estimated 25 years.

Slow degradation due to a gradual increase in contact resistance was observed in idle lasers stored at room temperature, but not in lasers maintained at a maximum temperature of 77 K, despite several hundred hours of continuous operation. These results suggested the temperature-dependent process of diffusion.

Degradation occurred primarily on the p-type side of the laser, where the contact consisted of a thin layer of gold followed by a



layer of indium. Electron microprobe analyses revealed that indium, a semiconductor donor, was diffusing through the gold layer into the crystal, apparently causing a reduction in hole carrier concentration near the p-surface. This effect was counteracted to a great degree by sandwiching a thin layer of platinum between the layers of indium and gold. Laser reliability reached a full year.

When degradation was still observed, although to a reduced extent, Dr. Lo advanced the hypothesis that diffusion and transport were taking place along grain boundaries in the polycrystalline contact layers. He proposed replacing the Pt-Au barrier with a three-layer structure. Since palladium film structures have fewer grain boundaries than those of platinum, providing fewer leakage paths for the indium, Pd was tested in place of Pt.

**D**IODE LASERS composed of  $\text{Pb}_{0.86}\text{Sn}_{0.14}\text{Te}$  and fabricated with a variety of contacts were maintained at  $60^\circ\text{C}$  in order to accelerate aging, with periodic interruptions for testing. The results showed that a multilayer structure of In-Au-Pd-Au, in which the grain boundaries tend to be misaligned, provides maximal reduction of indium penetration, confirming Dr. Lo's hypothesis.

The misaligned boundaries force diffusion to take place laterally, which slows transport into the crystal. The additional layer slows the process even further.

Solving the contact problem represents the culmination of efforts that began at General Motors with the development of an "ingot-nucleation" vapor transport method for growing crystals. The resulting crystals are of high purity, with a dislocation density of less than  $1000\text{ cm}^{-2}$ . Lasers made from these crystals incorporate a low temperature cadmium-diffused p-n junction. This process, invented by Dr. Lo, increases the laser's output to five milliwatts.

A tuning range of  $500\text{ cm}^{-1}$  and pulsed operating temperatures of up to  $140\text{ K}$  are achieved by a two-step annealing process. This technique induces a graded carrier concentration that increases infrared light confinement in the laser structure, thus reducing losses and increasing output.

"These innovations," says Dr. Lo, "combine to produce a laser that allows us to make measurements previously impossible."

## THE MAN BEHIND THE WORK

Dr. Wayne Lo is a Senior Research Scientist in the Physics Department at the General Motors Research Laboratories.



Dr. Lo was born in Hupei, China. He did his undergraduate work at Cheng-Kung University in Taiwan. He received an M.S. from the University of Rhode Island and a Ph. D. in electrical engineering from Columbia University in 1972. His doctoral thesis concerned the characterization of deep-level states and carrier lifetimes in gallium arsenide light-emitting diodes.

Before undertaking graduate studies, Dr. Lo was instrumental in setting up the first American transistor production plant in Taiwan. In 1973, he joined General Motors, where he is currently in charge of semiconductor laser and spectroscopy research.



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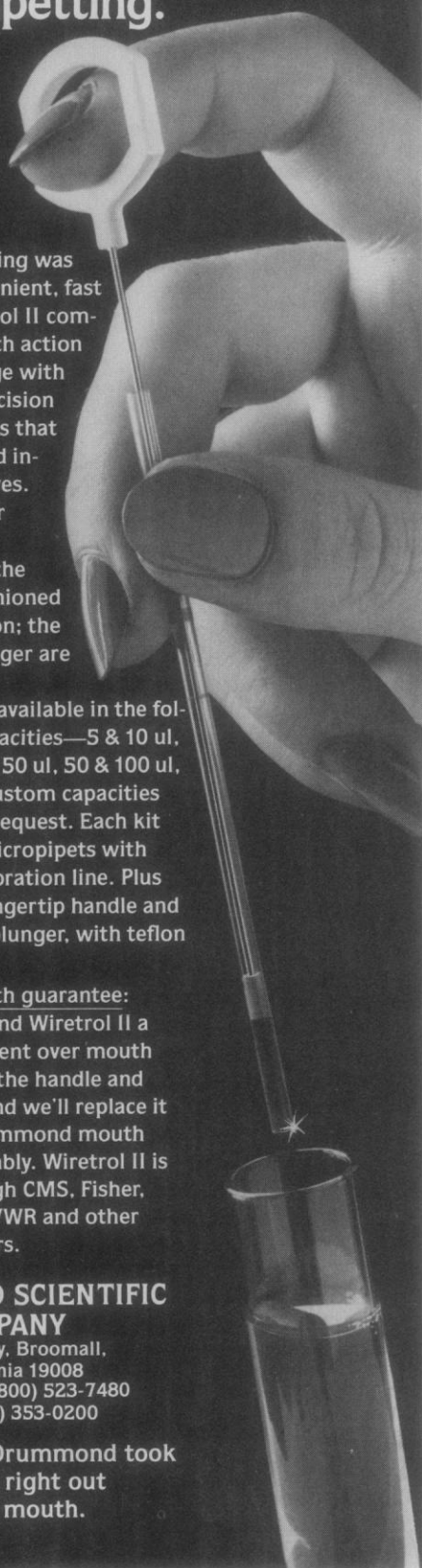
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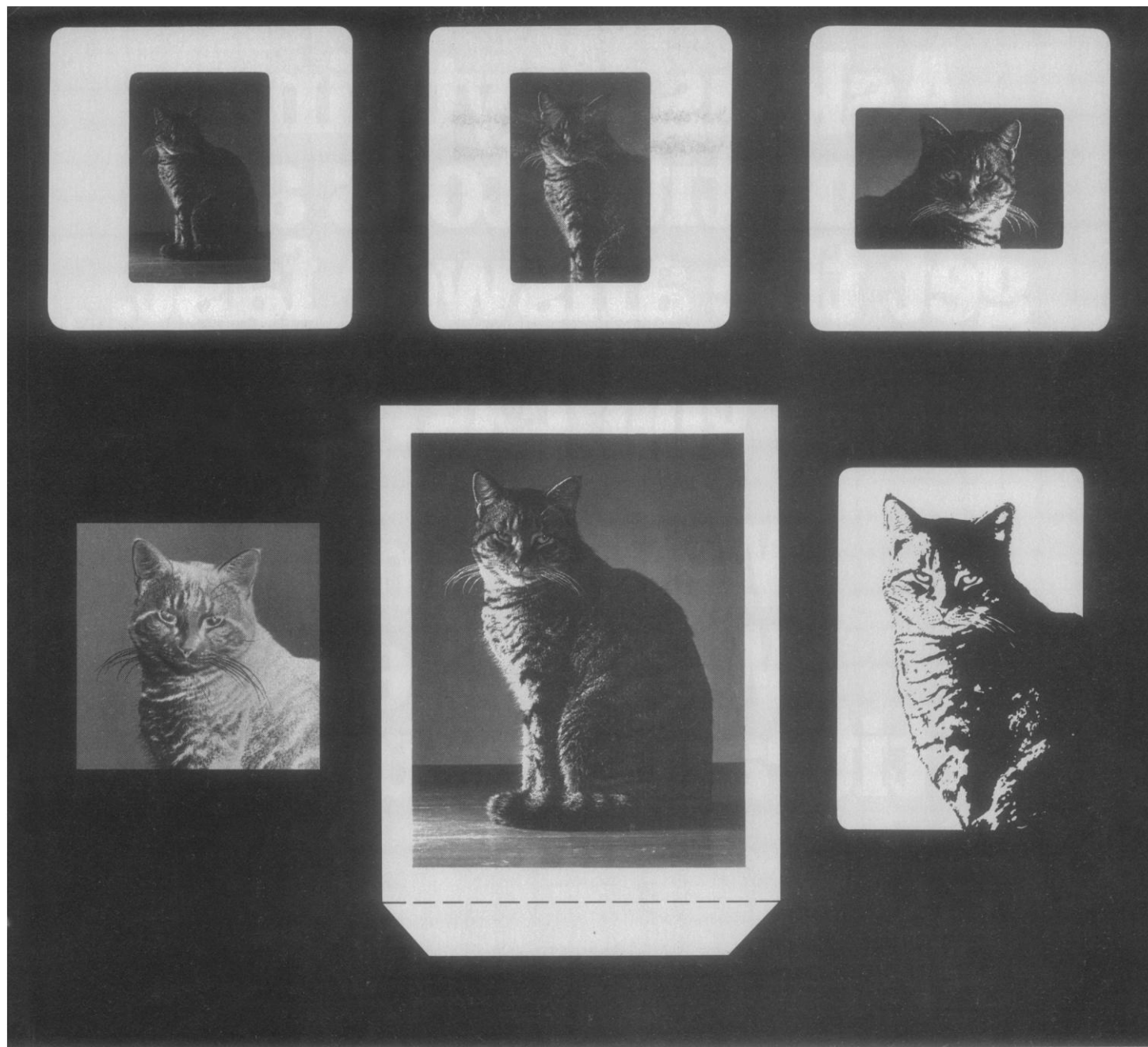


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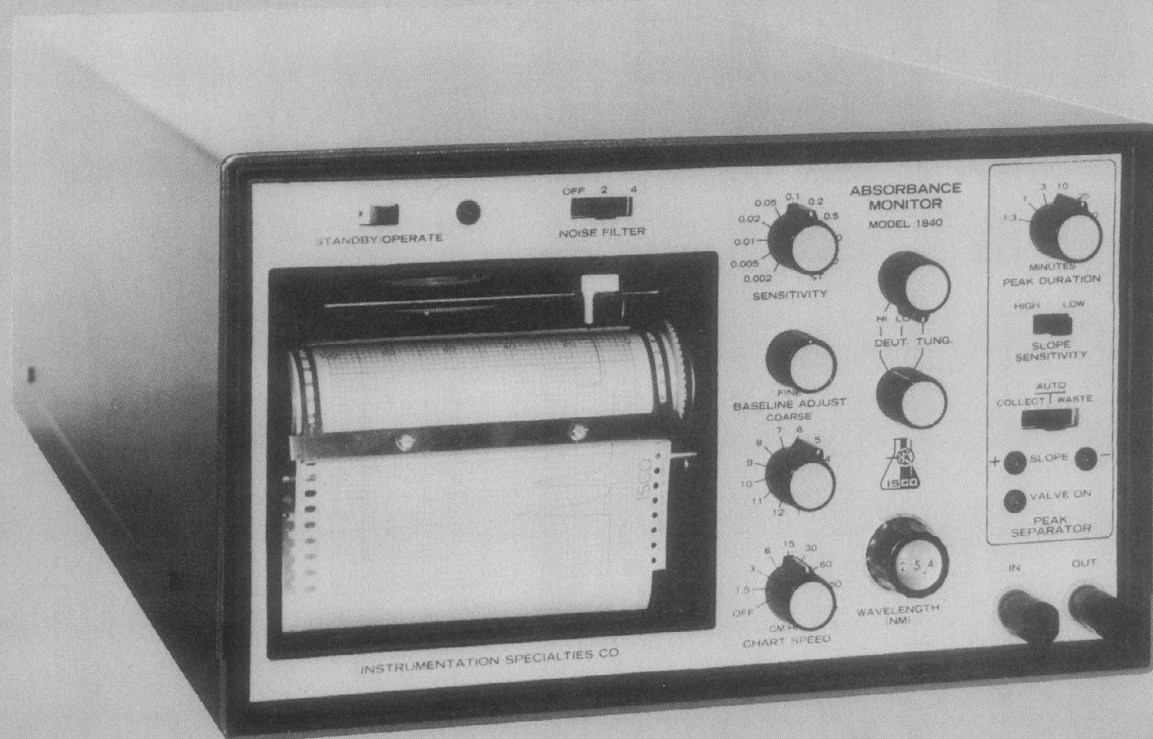
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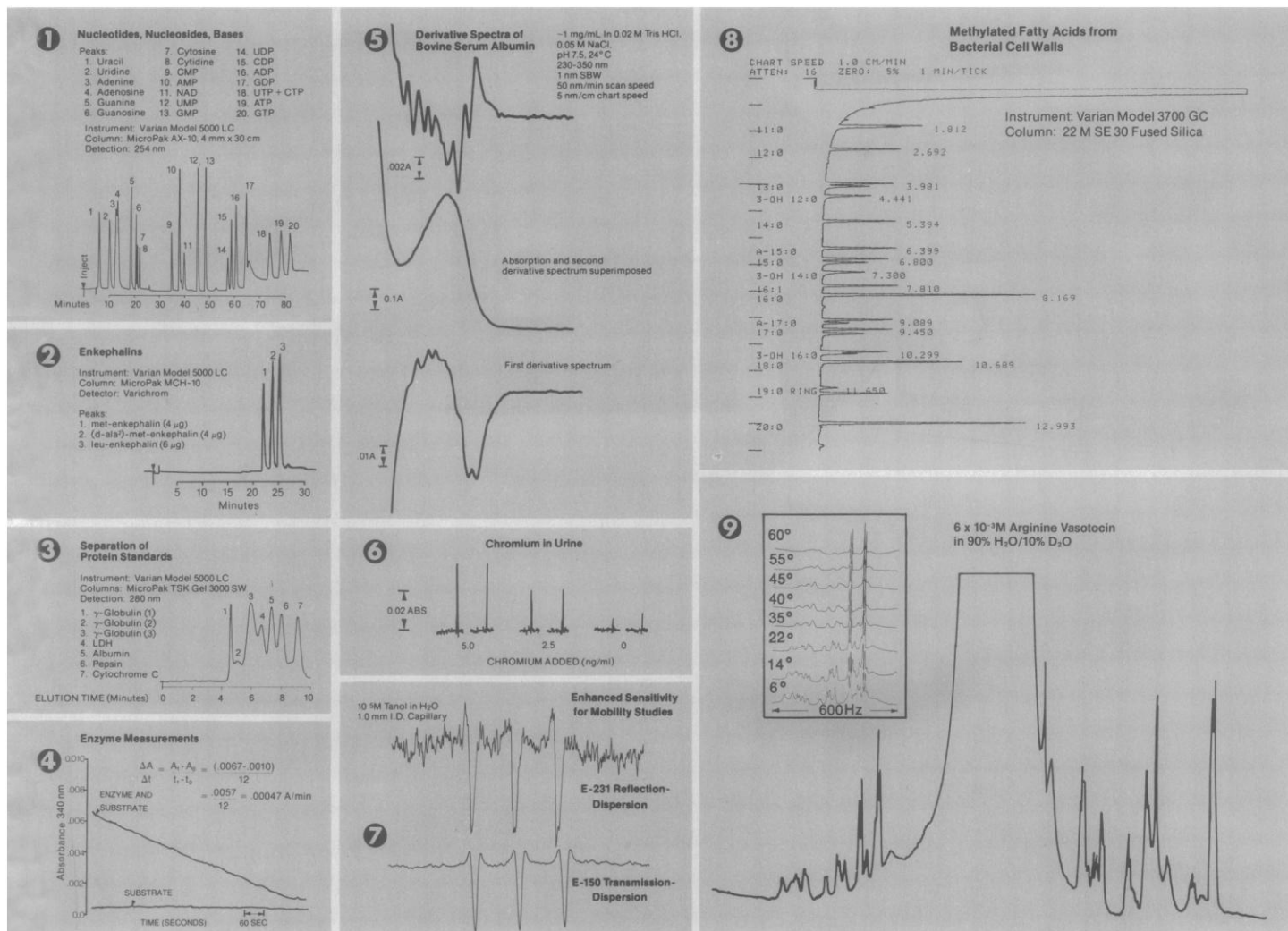
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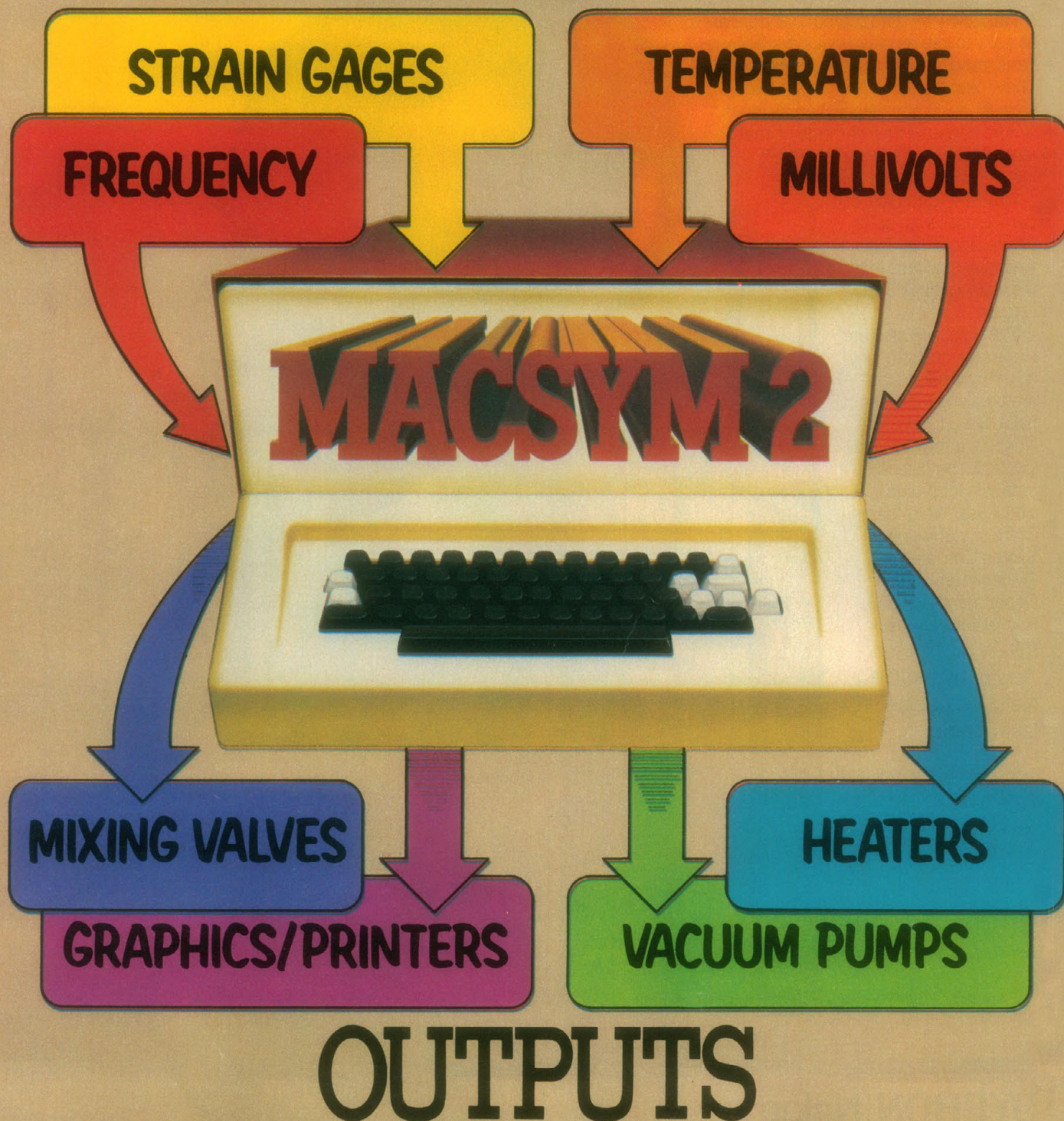
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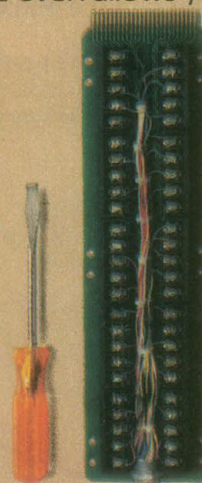
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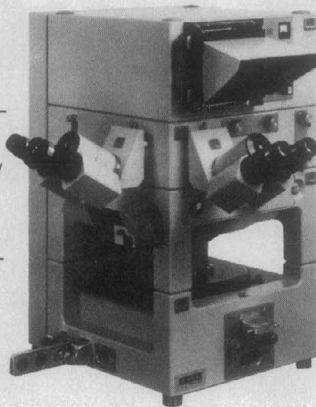


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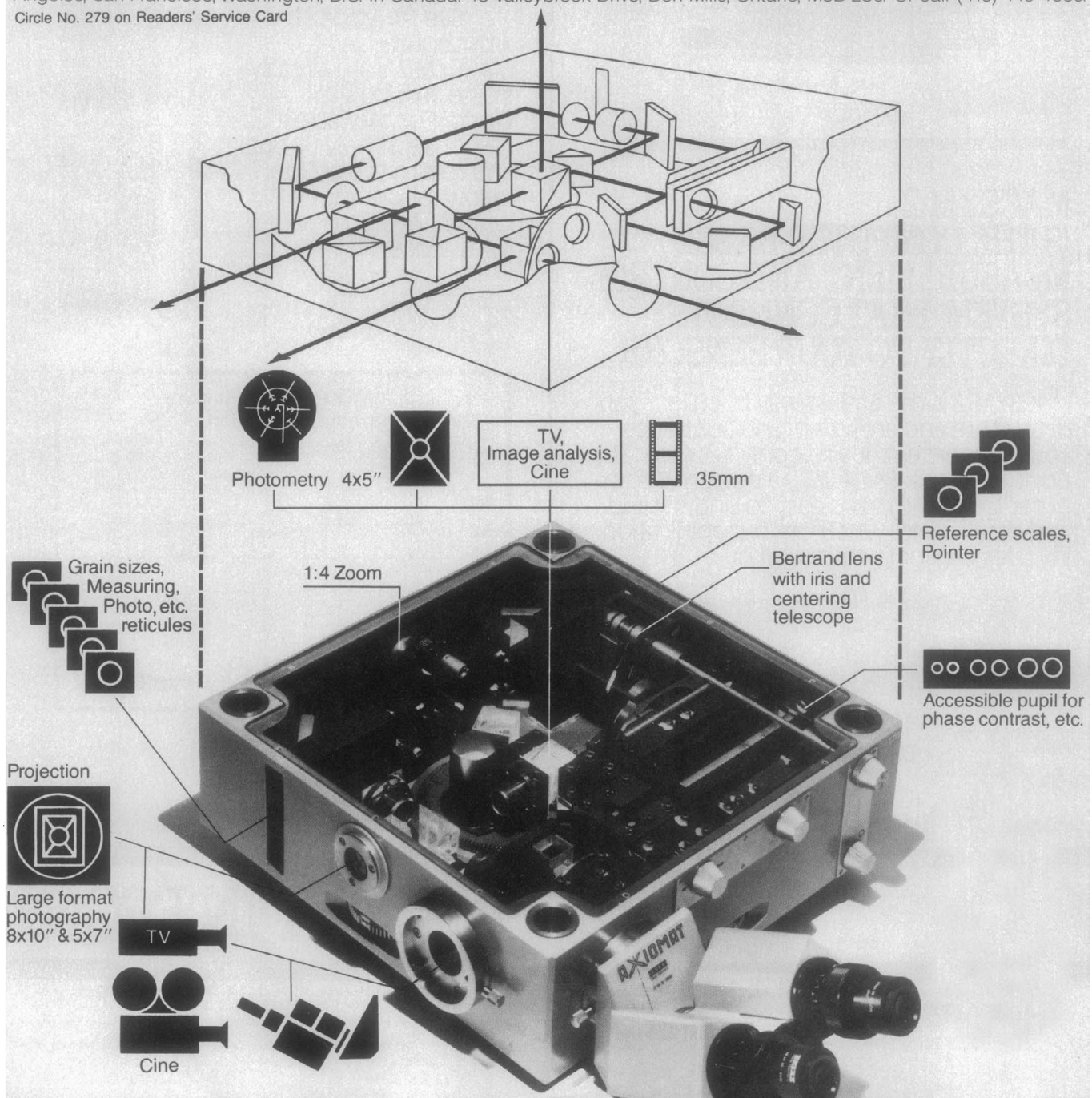


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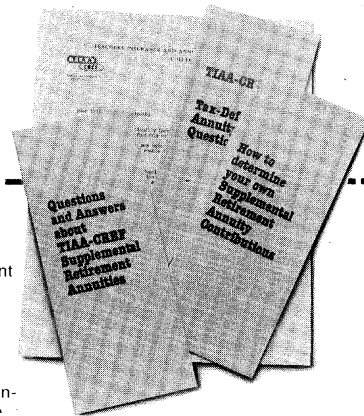
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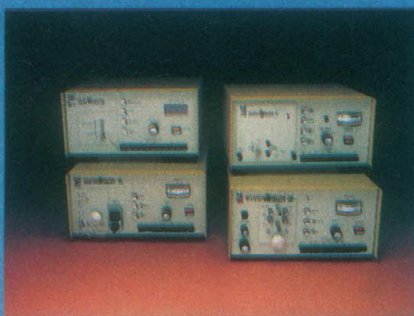
**ConstaMetric IIG** — dual module high pressure pump featuring over pressure protection, digital display of pumping conditions and auxiliary pump shut-down for gradient applications.

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**Model 308 Computing Integrator** — space saving, vertical design offers continuous visual display of run progress, automatic data integration with print-out on built in printer. Device can correct for shifting baseline as well as normalize up to 80 peaks. Available with remote output connectors to other data recording devices.

**Chromatograph Control Module -CCM** — liquid chromatograph control module capable of automating HPLC operation and 2 channels of data acquisition. Features an easy-to-read 9" CRT screen, ROM resident BASIC, magnetic tape cassette and 2 pen printer/plotter which reports integrated results along with the chromatography.



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LDC also offers integrated HPLC systems comprised of the full array of pumps, detectors and controllers shown above.



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## The Mission of the National Science Foundation

For 30 years the National Science Foundation (NSF) has demonstrated a remarkable ability to address the nation's concern for the support of the sciences. Although to those in the field funds have never appeared adequate, there is no question that today, by any measure, the scientific effort in the United States stands at the forefront of the world. The NSF has played a significant role in making this happen, and I see no indication that the foundation's interest in or commitment to this role has diminished.

Recently there has been increasing concern about the problems developing in engineering and the vitality of the U.S. technological enterprise. In these areas, too, the NSF has long played a role. The foundation has supported basic engineering research and engineering education as part of its program from its inception. Further, since its organic act was amended in 1968, the NSF has experimented with a variety of modes of support for applied research. Plans for a reorganization recently announced by the foundation are intended, it appears to me, not to diminish the emphasis on fundamental science but to recognize the importance of maintaining a strong basic engineering program as well. At the same time, there is once again the opportunity to recognize the blurred, often artificial, distinction between basic and applied research and to strengthen the foundation's overall support for programs in basic engineering and in the natural and social sciences. The reorganization will also strengthen unified programs of disciplinary support.

Engineering is in some ways unique. It deals with a broad spectrum of activities ranging from fundamental research to product design and development. The principal difference between engineering and science, as they are usually understood, is that engineering is basically oriented toward the environment created by man. A close linkage exists between fundamental engineering research and traditional scientific research, for example, in biology, chemistry, mathematics, and physics. And new relationships have developed, as in bioengineering.

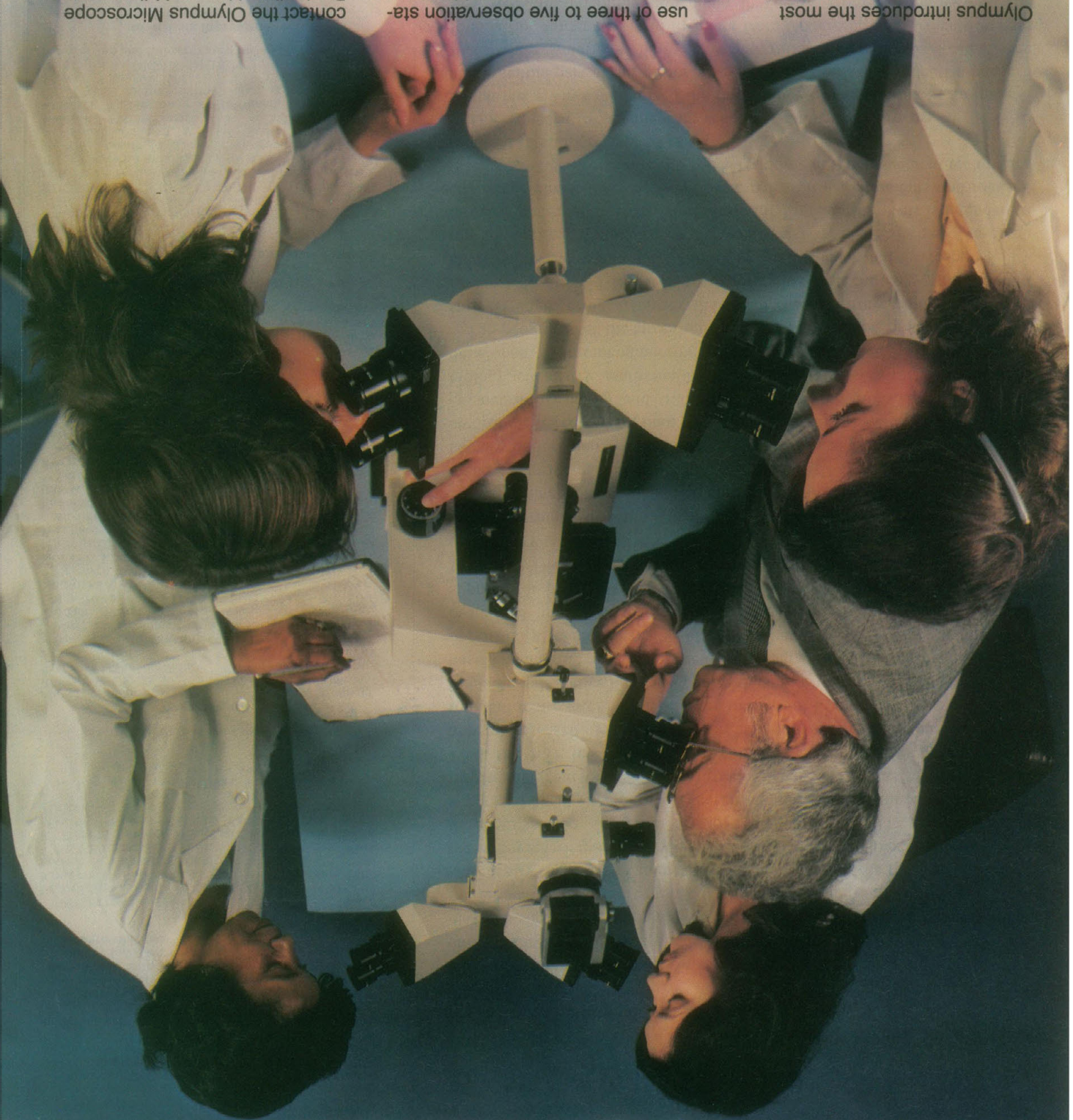
The programs of the proposed NSF Directorate for Engineering would support engineering activities that span the spectrum from fundamental research to applied research to experiments in technology transfer with industry. At the same time, under this plan it is clear that the responsibility for conducting applied research would rest in all NSF basic research directorates, including the Directorate for Engineering. This is intended to encourage closer links between basic research developments and focused research, while preserving the special funding and management techniques required to support applied research.

This concern for engineering reflects a maturation process at the NSF which has always recognized the importance of engineering as an integral and essential part of our nation's scientific fabric. It also reflects a concern that, while America's innovative and productive spirit is lagging, the foundation, under its broad mandate from Congress, can further stimulate first steps in the innovation chain that leads from the laboratory and the laboratory into the marketplace.

The NSF's proposed realignment of responsibilities is neither a cosmetic nor a quick response to recent concerns expressed by all those interested in the future role of engineering. It is intended to provide a workable structure for timely and mutual support of activities in all NSF directorates.

—NORMAN HACKERMAN, *President, Rice University, Houston, Texas*

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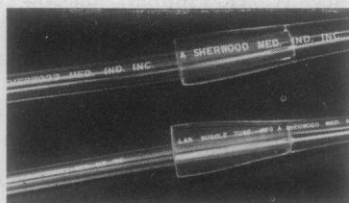
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tors in heavy metal intoxication"; R. Hall, "Safe at the plate."

31 July. Evaluation of ultrastructural toxicological changes: (J. Campbell, discussion leader): P. Lea, "Present technology and developments for the future"; F. de la Iglesia, "Specific models used in evaluating drugs and chemicals."

## Transport Phenomena in Lipid

### Bilayers and Biological Membranes

#### Tilton School

Sally Krasne, chairperson; Alan Finkelstein, vice chairperson.

17 August. Fusion in artificial lipid membranes (A. Parsegian, chairperson): Nejat Duzgunes, "The effect of composition on membrane fusion"; Peter Cullis, "Non-bilayer lipid structure and lipid fusion processes." Fusion in cell membranes (A. Finkelstein, chairperson): R. Pagano, D. Hockstra, "Studies of membrane fusion using energy transfer between fluorescent phospholipid analogues"; R. Ornberg, "Electron microscopic studies of the kinetics of membrane fusion in *Limulus* amoebocytes."

18 August. Protein mobility and migration in membranes (S. McLaughlin, chairperson): E. Elson, "Cytoskeletal control of membrane protein mobility"; M. Poo, "Lateral migration of cell membrane components induced by electric field." Protein insertion into membranes (P. Mueller, chairperson): H. Schindler, "Incorporation of the acetylcholine-activated channel into planar bilayer membranes"; W. Wickner, "Protein insertion into cell membranes."

19 August. Recording from single ionic channels in cell membranes (E. Neher, chairperson): R. Horn, "Analysis of single sodium channel currents in muscle"; G. Yellen, "Properties of single-channel currents in sympathetic ganglion cells." Biophysics of visual transduction processes (W. Hagins, chairperson): J. Kornbrot, "Light-activated release of calcium from intact retinal rods"; W. Hubbell, "Charge movements in disk membranes"; S. Yoshikami, "Interface between biochemistry and biophysics in visual transduction."

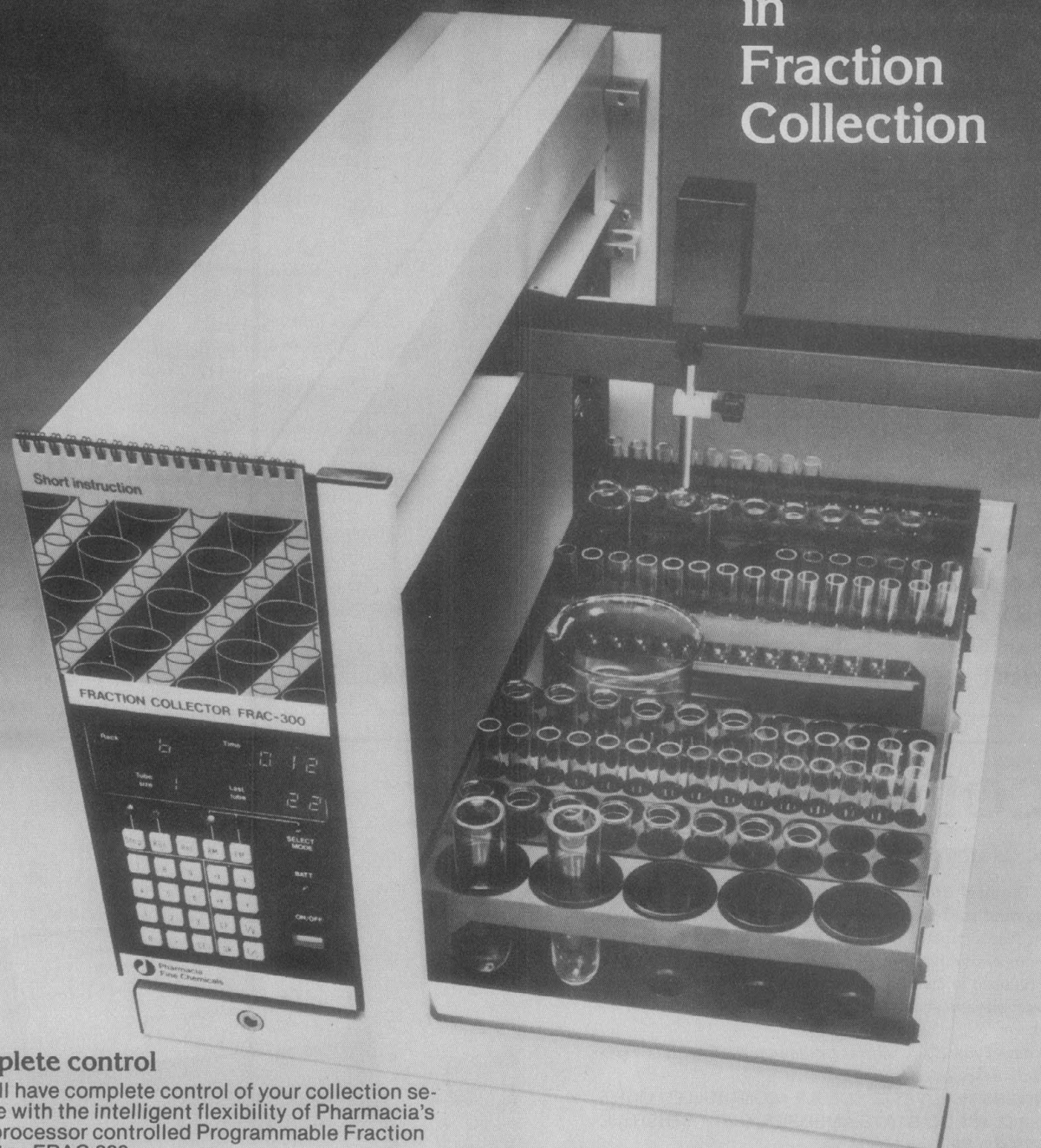
20 August. Ion and water movements across epithelial membranes (E. Wright, chairperson): K. Spring, "Water movements across epithelial membranes"; T. Zeuthen, "Ion movements across epithelial membrane." Poster session—7:30 p.m.

21 August. Anion transport kinetics across red blood cell membranes (R. Gunn, chairperson): P. Knauf, "Niflumic acid interactions with the anion



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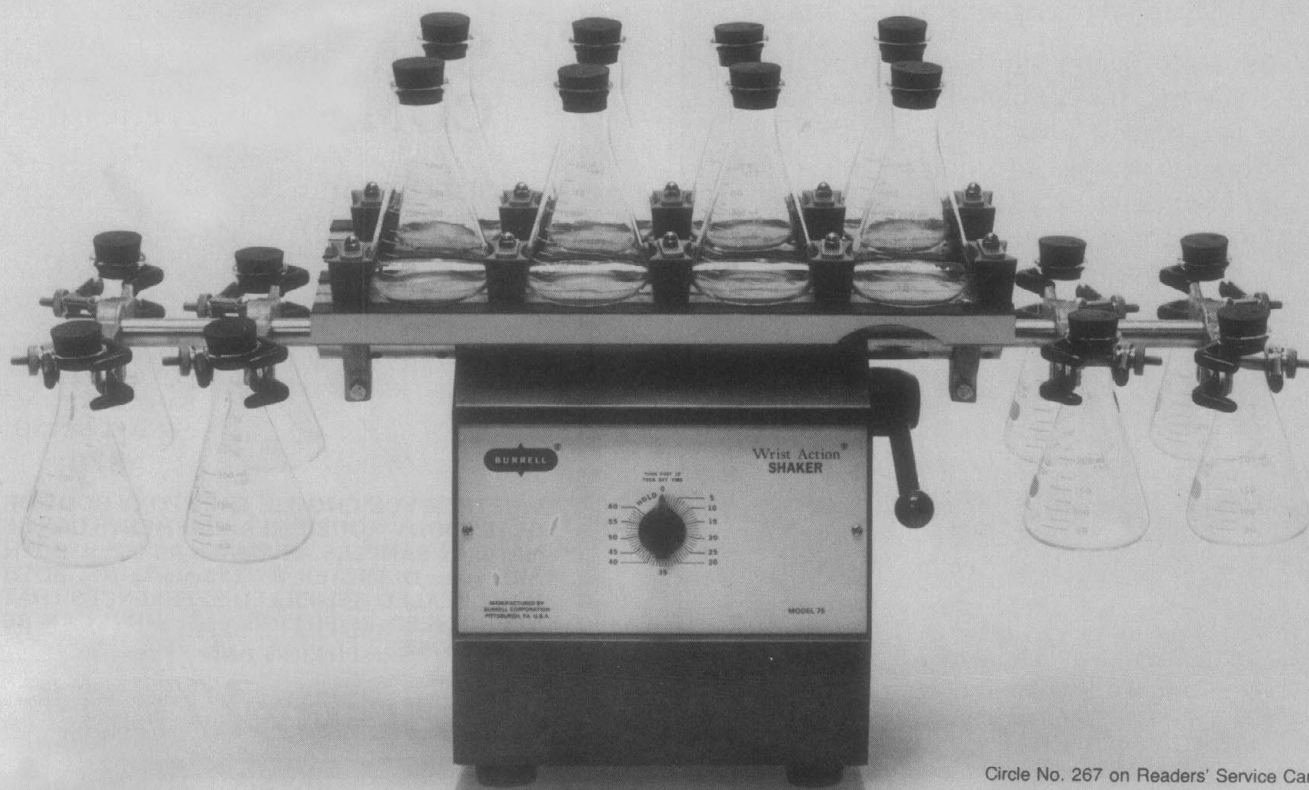
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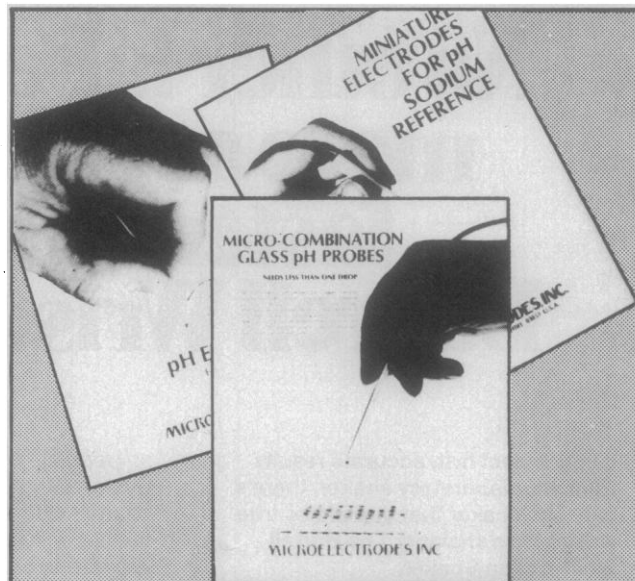
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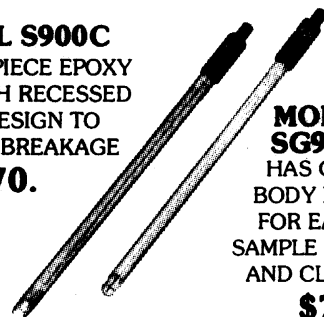
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transporter"; M. Jennings, "Single turn-overs of the chloride transporter"; M. Milanick, "Proton sulfate co-transport."

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##### *Plymouth State College*

Willis B. Person, chairperson; William T. King and John Overend, vice chairpersons.

8 June. Modern experimental aspects (W. T. King, chairperson): Bryce Crawford, Jr., "Infrared intensities: Past and present"; S. Kondo, "Recent experimental studies of infrared intensities." The normal coordinate problem (I. Mills, chairperson): H. F. Schaeffer, "Quantum mechanical calculation of potential functions"; D. C. McKean, "An experimentalist's evaluation of force fields from quantum mechanical calculations."

9 June. Quantum mechanical calculations of accurate dipole moment functions (H. F. Schaeffer, III, chairperson): N. S. Hush, "Rigorous calculations: The effect of configuration interaction"; P. Pulay, "Rigorous intensity calculations for medium-sized molecules." Slightly more approximate quantum mechanical calculations of intensities (J. Boggs, chairperson): A. Komornicki, "Gradient methods for ab initio prediction of vibrational intensities for small molecules"; D. Dixon, "Ab initio calculations of infrared intensities by finite difference methods."

10 June. Prediction of vibrational intensities by transfer of intensity parameters (G. Zerbi, chairperson): L. A. Gribov, "Electrooptical parameters"; M. Gussoni, "Transferability of intensity parameters"; W. B. Person, "Atomic polar tensors." Chemical interpretation of intensity results (W. J. Orville-Thomas, chairperson): J. C. Decius, "The charge, charge-flux model for interpretation of intensities"; K. Wiberg, "Chemical significance of intensities."

11 June. Intensities of combination of bands and overtones (J. Overend, chairperson): D. Whiffen, "Theory of intensities of higher overtones"; R. L. Swoford, "Experimental measurements of intensities of high overtones." Intensity measurements with diode lasers (R. McDowell, chairperson): A. Mantz, "Line intensity measurements with tunable diode lasers"; M. Mumma, "Measurements on planetary atmospheres."

12 June. Infrared intensities and infrared lasers (K. Fox, chairperson): J. Steinfeld, "Application of vibrational intensities to studies of IR laser induced photochemistry"; D. Dows, "High intensity spectroscopy and laser chemistry."

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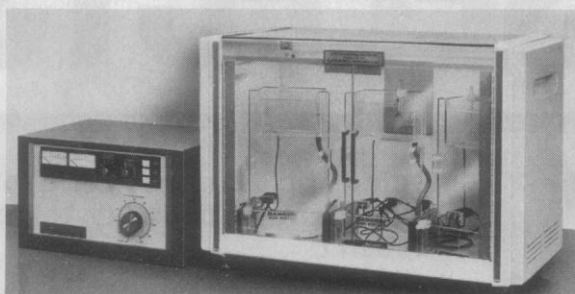
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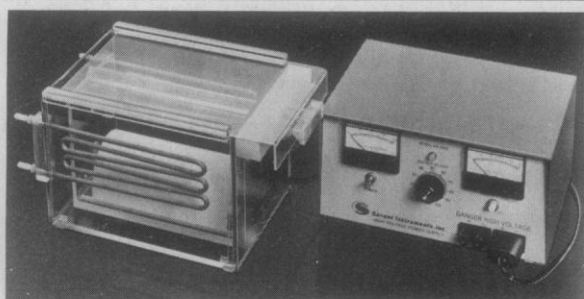
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Name: (Please Print) \_\_\_\_\_ Location \_\_\_\_\_

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Indicate your particular activities which justify favorable consideration of you as a participant in and contributor to this Conference. (Not required of speakers.) Applications are referred to the Conference Committee for review in accordance with the established regulations, and this information is essential.

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Conferee (double occupancy)	\$220.00	Conferee (double occupancy)	\$280.00
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**PAYMENT:** The full fixed fee will be required IN ADVANCE OF ALL PARTICIPANTS AND GUESTS. Attendance and/or accommodations will NOT be reserved unless this fee is paid 3 weeks prior to the Conference. Foreign participants will also be required to pay Gordon Research Conferences in advance in U.S. dollars payable through a U.S. Bank. The fixed fee cannot be prorated or reduced for anyone (speakers, discussion leaders, conferees) and is charged to all regardless of the length of stay at a Conference.

Please return to:

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Office — Summer Schedule

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The recording of lectures by tapes, etc. and the photography of slide material are prohibited. Printed reference to Gordon Research Conference papers and discussion is not permitted. Authors are requested to omit references to the Conference in any publication. Guests are not permitted to attend the conference lectures and discussion sessions. Each member of the Conference agrees to these regulations when registration is accepted.

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