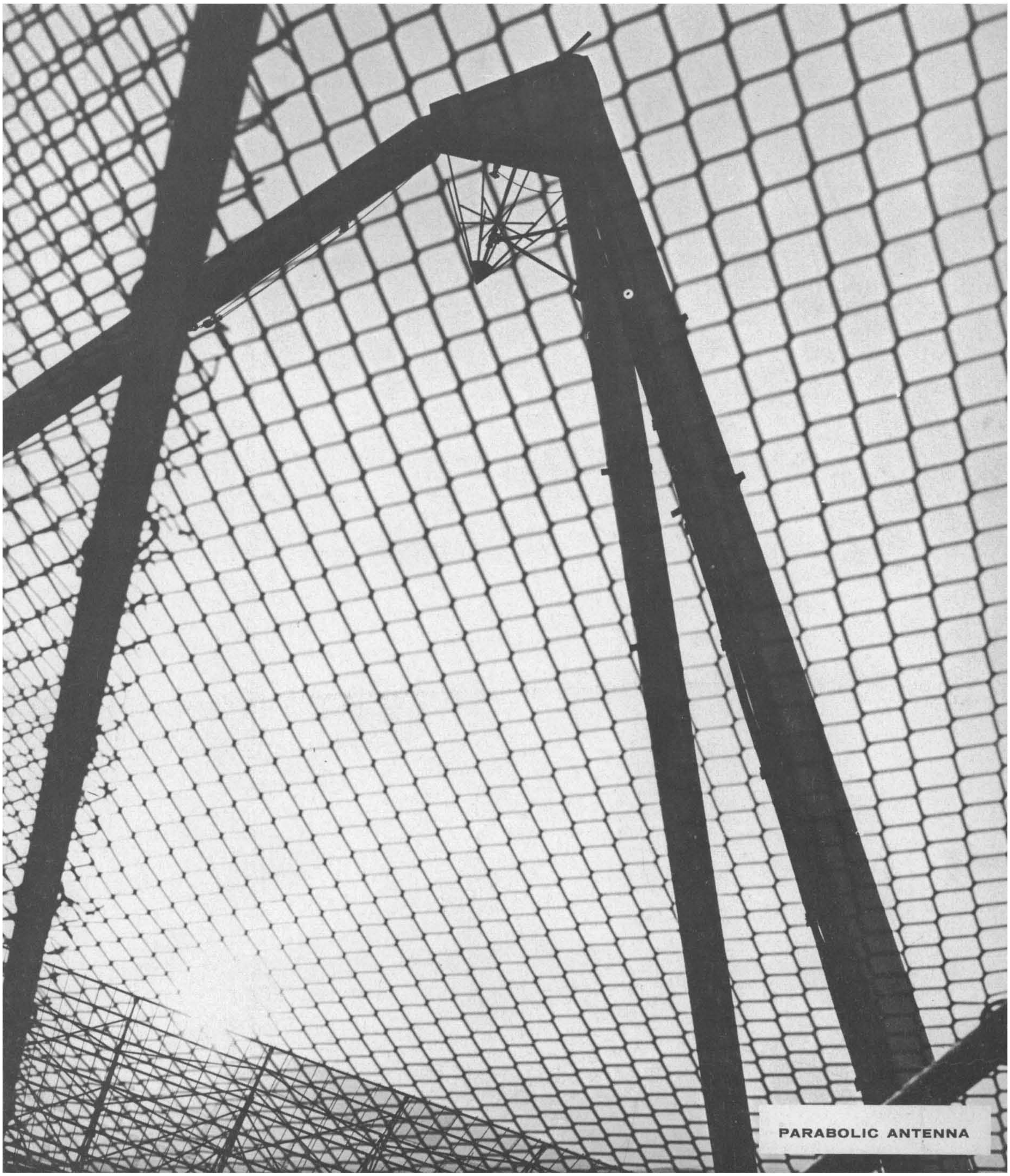
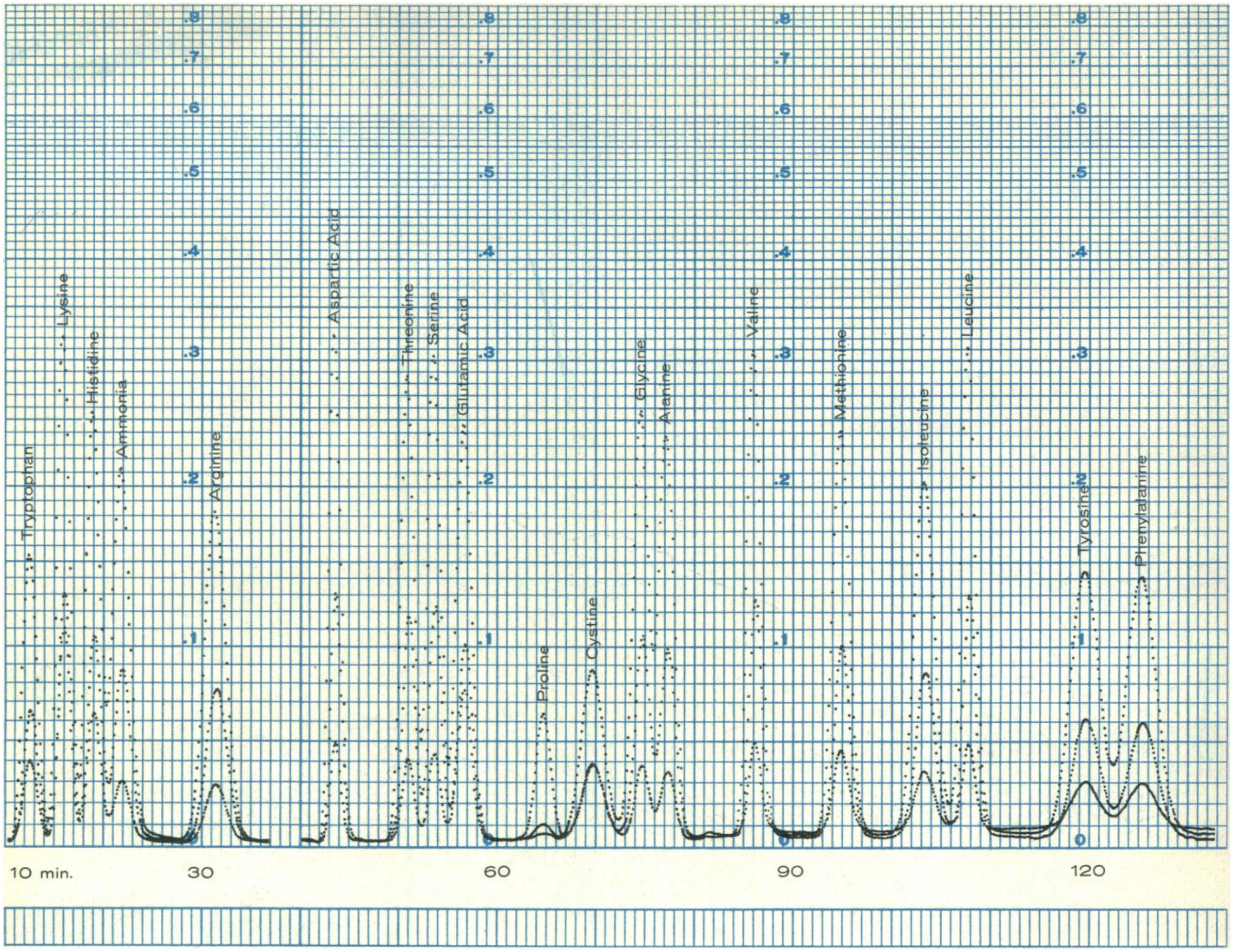
SCIENCE

18 March 1966
Vol. 151, No. 3716

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





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18 March 1966
Vol. 151, No. 3716

SCIENCE

SCIENCE is published weekly on Friday and on the fourth Tuesday in November by the American Association for the Advancement of Science, 1515 Massachusetts Av Washington, D.C. 20005. Now combined with **The Scientific Monthly®**. Second-class postage paid at Washington, D.C. Advancement of Science. Annual subscriptions $8.50; foreign postage, $1.50; Canadian postage, 75¢; single copies, 35¢, except **Guide to Scientific Instruments**, which School year subscriptions: 9 months, $7, 10 months, $7.50. Provide 4 weeks' notice for change of address, giving new and old address and zip numbers. Send a address label. SCIENCE is indexed in the **Reader's Guide to Periodical Literature.**

COVER

Parabolic antenna of the Air Force Cambridge Research Laboratories, located at the Sagamore Hill Radio Observatory, Hamilton, Massachusetts. The 150-foot (46-meter) antenna was used to study radio star scintillation during the eclipse of the sun of July 1963. It found little change of scintillation relative to normal fluctuations. See review of *Solar System Radio Astronomy*, page 1376. [V. Neumeier, Air Force Cambridge Research Laboratories]

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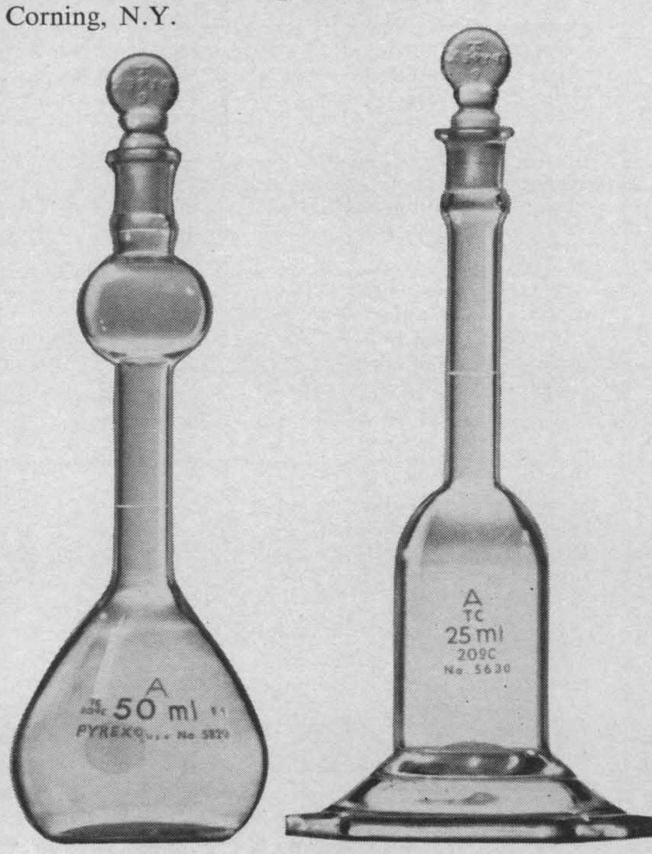

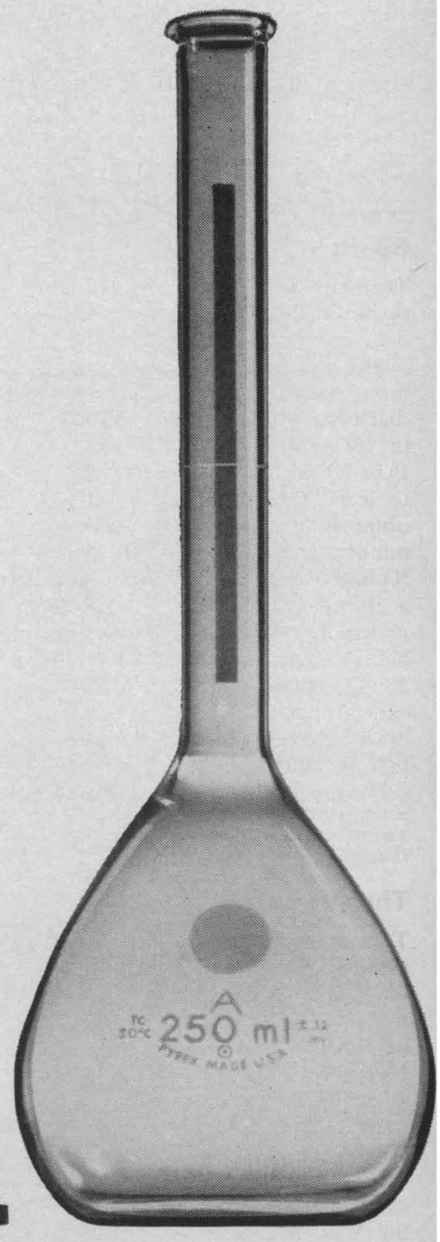

THE NEW STANDARDS COME FROM **CORNING**

Kodak reports on:

fluorescence turned on instead of off . . . a surprise about a familiar film . . . two different kinds of books on photography

Ultramicro H_2O_2

Jacques d'Alechamps, 1586

HORSERADISH

Cochlearia armoracia (horseradish) is a convenient source of peroxidase. Grind up some of the root (you'll cry and cry) and acidify to pH 4.5. The peroxidase will then take up hydrogen peroxide, such as is liberated when ionizing radiation damages cells in culture. If and only if (generally speaking) the peroxidase is H_2O_2-activated will it go to work on 6-methyl-7-hydroxy-1,2-benzopyrone, a fluorescent substrate for peroxidase. The decline of fluorescence, measured with a fluorimeter, was reported in 1961 to be capable of indicating H_2O_2 concentration as low as 5×10^{-12} mole/ml, corresponding to the absorption by cells of 5r of radiation.

Now along comes a method (*Analytical Biochemistry 11*, 1 and 6) which is reported almost as sensitive and offers the advantage of using H_2O_2 to turn fluorescence on, not off. In this one the H_2O_2-peroxidase combination oxidizes non-fluorescent, non-autooxidative *Diacetyl-2′,7′-dichlorofluorescin* (hereby announced available as EASTMAN 9846) to a fluorescent state upon activation with dilute NaOH. It may offer a useful alternative approach in studying systems that evolve H_2O_2. Still another alternative use for acidified horseradish is over boiled beef.

EASTMAN *9846 (5 grams for $15.20) is one of the* EASTMAN *Organic Chemicals that can be ordered from Distillation Products Industries, Rochester, N. Y. 14603 (Division of Eastman Kodak Company), but horseradish is not.* *Price subject to change without notice.*

60 db

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If more encouragement is desired before acting on this hint, please communicate with Eastman Kodak Company, Special Applications, Rochester, N. Y. 14650.

The thesis

Treasured recipes yield enviably fine photographic films. Nonetheless we must not underrate science. It has served us well ever since the smart move we made in 1912 in hiring brash C. E. K. Mees, aged 30, to take a new kind of job, "director of research."

He and a friend had done a joint doctoral dissertation, *Investigations on the Theory of the Photographic Process*, at University College, London, under Sir William Ramsay, co-discoverer of the noble gases and of the principle that industry need not necessarily be beneath the dignity of science. The young men had met the challenge of convincing a demanding faculty that the physical and chemical basis of the technique employed by artists who limn with light was not unduly light in academic weight. Not long after we hired Mees, he sent for his collaborator. The two of them and a growing corps of others set to deepening, elaborating, refining, correcting, and expanding the content of their thesis.

This work still goes on every working day of the year, though the two who started it are no longer living. Apart from the fallout that has had the intended effect—in combination with other talents—of making us exceedingly prosperous, the great endeavor has brought forth merciless revisions and enlargements of the frame of reference from the 1907 dissertation, first in 1942, then in 1954, and now in 1966.

The new third edition of *The Theory of the Photographic Process* has been published by The Macmillan Company, 60 Fifth Avenue, New York 10011, and priced at $25. From the 1907 rootstock it carries over the name Mees and the creed that the workings of the silver halide process merit the attention of serious contemporary scientists entirely aside from any usefulness in teaching others how to invent treasured recipes of their own.

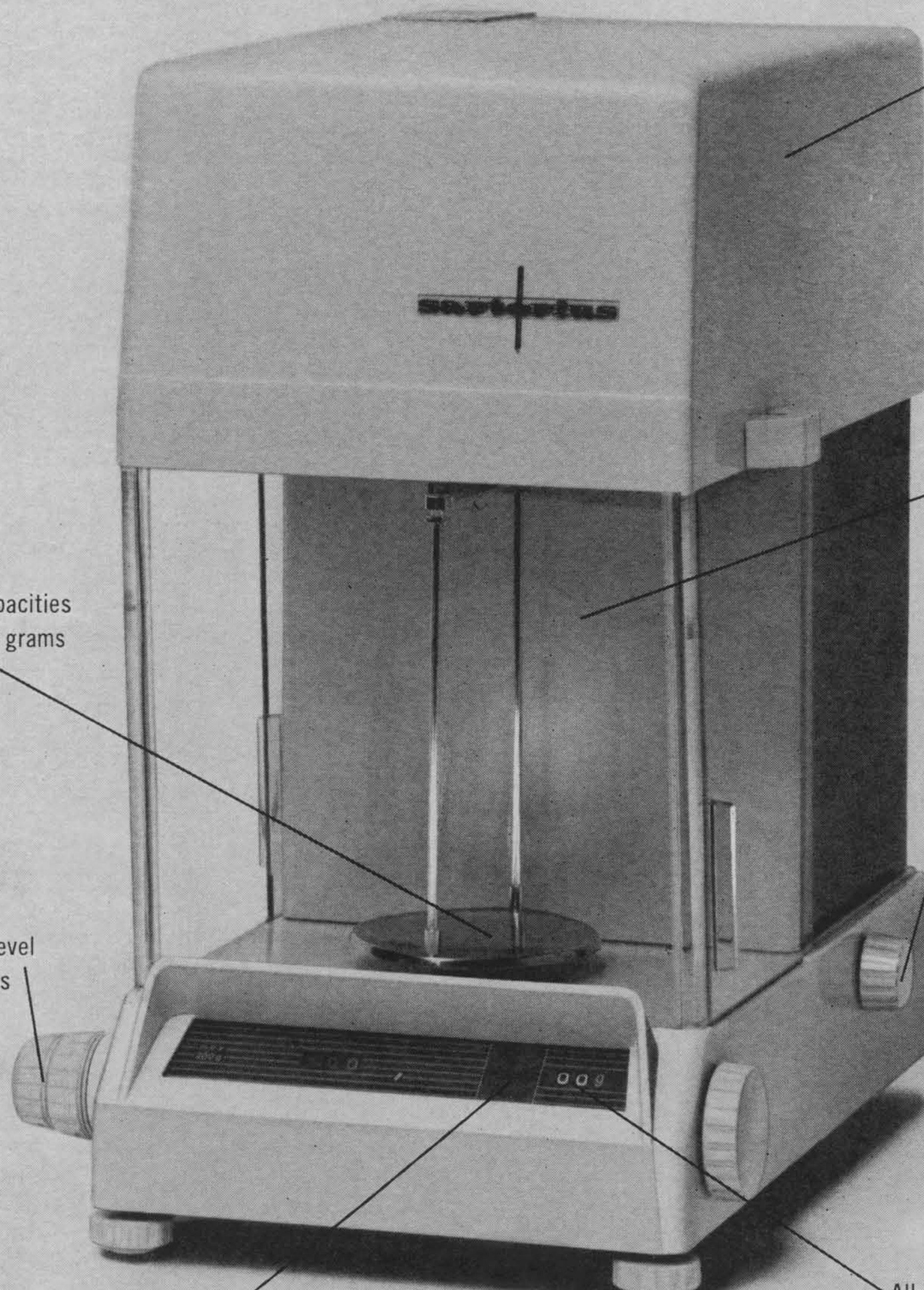
The 1966 edition was written by Kodak physicists and chemists in time stolen from their daily research tasks at Rochester, Harrow (England), and Vincennes (France). It was really no sacrifice, not even on the part of the shareowners. A book like this is at least as beneficial to the writers to write as for the readers to read. No assumption is made that the reader has eaten and slept the subject since graduate school. When the book needs to refer to excitons, nucleotides, or nucleosides, it stoops to define them.

Some there are who, while willing to concede that the photographic process could make a stimulating focus for inquiry in the physical sciences, have fish of their own to fry and publications of their own to get out. Their interest in photography, confined largely to its utilization for better communication in print, would be better served by a book which W. H. Freeman and Company, 660 Market St., San Francisco, Calif. 94104, has just issued under the title *Photography for Scientific Publication.* In introducing its bibliography this book states, "The relatively heavy dependence upon the Eastman Kodak materials is not meant to imply any particular endorsement of that firm or its products, but it does reflect two facts. These booklets are very useful, and they are all quite readily obtainable almost anywhere."

To which we respond by not particularly endorsing this publisher's product but declaring it a welcome enough representative of its kind.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Macro analytical weighings that once took 2 to 3 minutes on a conventional single pan balance...now take only 15 seconds with automatic pre-weighing



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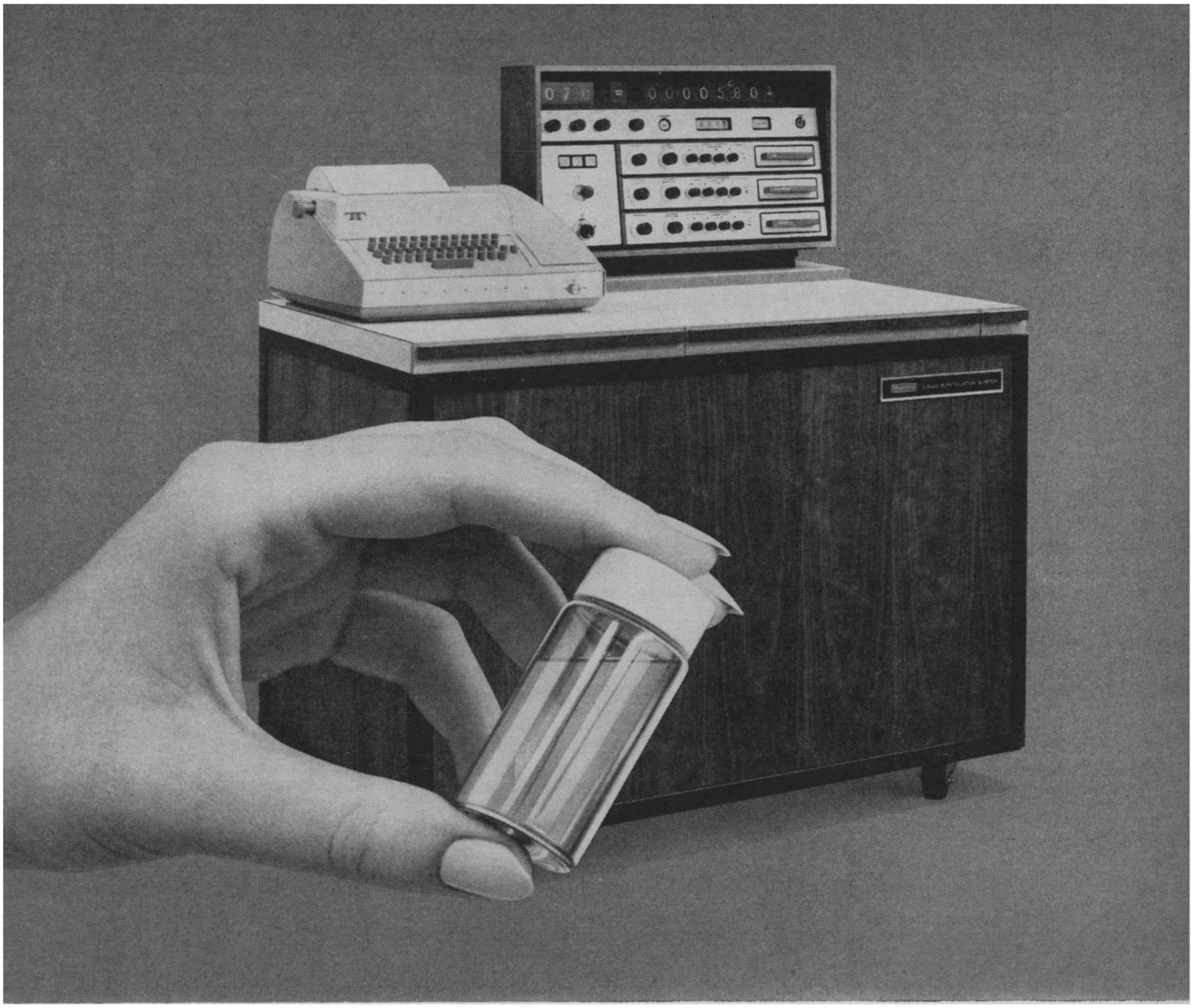

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INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPETOWN; LONDON year. One sees none of the give-and-take, letters-to-the-editor, and so forth of Sweden and Italy, and there is no "Young Turks" movement of scientists as in Switzerland and Denmark. While the Plan may not be entirely responsible for this, perhaps partly it is.

There are two other points where Quinn's emphasis was perhaps misplaced. He says that the mechanism for planning in France "militates against unwise [governmental] decisions which might draw unwarranted technical support or investment into certain politically popular fields despite overwhelming costs to other more important sectors." Actually, nearly the reverse can be the case, as De Gaulle's "force de frappe" illustrates, for this has rather considerably drained funds from other sciences. Quinn might reply that space, military, and atomic-energy research are not included in the Plan, which is true. But then can it be called consensus planning of science when over 70 percent of governmental science support is not included?

Elsewhere Quinn quotes a French industrialist's praise of the Plan, as far as private initiative is concerned, as follows: "The Plan does not tell a private research organization what to do. Nor does it tell a company what it is to sell. . . . The government will not contribute monies to private companies' research efforts. And industry would not follow the Plan into areas which did not interest it." The Fifth Plan intends to correct this. It provides (for the first time) $120 million for loans to private industry for research, the loans to be repaid only if the research results in revenues for the economy; it urges its governmental science agencies to use private industrial research by contracts when appropriate; and one of its *actions concertées* in biomedicine is in the field of "biologic and medical engineering" in order to attract more engineers and physicists to biological problems and strengthen the French instrumentation industry. These are, no doubt, laudable innovations, and certainly the government will use the program to help industrial research with the same objective skill and imagination which characterizes British and Swedish management of their somewhat analogous instruments. Nevertheless, the Plan does give the government additional tools for persuading private industry.

In short, however intellectually attractive planning is in France, both in its development and in its execution, the Plan provides the government with methods of suasion over the economy which are not commonly found in many other countries. But in France, several social and economic sectors are conspicuously lagging as compared with neighboring countries. (The Délégation Générale quite frankly exposed the retardation in biomedical research in France in *Le Progrès Scientifique* No. 83, April 1965.) Under these circumstances, perhaps France needs both the psychology of consensus planning and a rather tight governmental control over what is planned.

Nevertheless Quinn has performed a service in bringing our attention to methods of science planning in other countries.

ROBERT P. GRANT
2, rue St. Florentin, Paris 8, France

Drafting of Ph.D. Candidates

Qualified graduate students working on their doctorates in science and engineering—at Columbia, New York University, and other universities—are now being called for induction into the military service. Near the culmination of their 20 or more years of formal training they are being drafted to fill local quotas. This is a poor utilization of scarce and nationally needed talent and is certainly not in the best interest of our country, yet the scientific community has not raised its voice in audible protest. The National Science Foundation, the National Aeronautics and Space Administration, and the National Academy of Sciences have developed strong financial support for graduate education in the sciences, yet all agencies are strangely silent while some of our brightest young men have their careers interrupted at a crucial time in their training.

It is time for the agencies within and outside the government which represent the scientific community to speak out, loudly and clearly, against this. Failure to do so will cost our country dearly in the future, for all the battles are not being fought in Southeast Asia. Our future scientific strength resides with the young Ph.D.'s, and drafting them to fight, or idly pass the time as former generations of soldiers have done, is to ignore history and misinterpret the meaning of democracy.

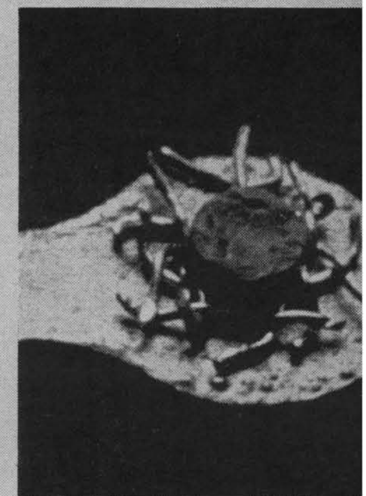
ROBERT A. GROSS
School of Engineering and Applied Science, Columbia University, New York 10027

What gives with "compliant redundancy" at Western Electric?

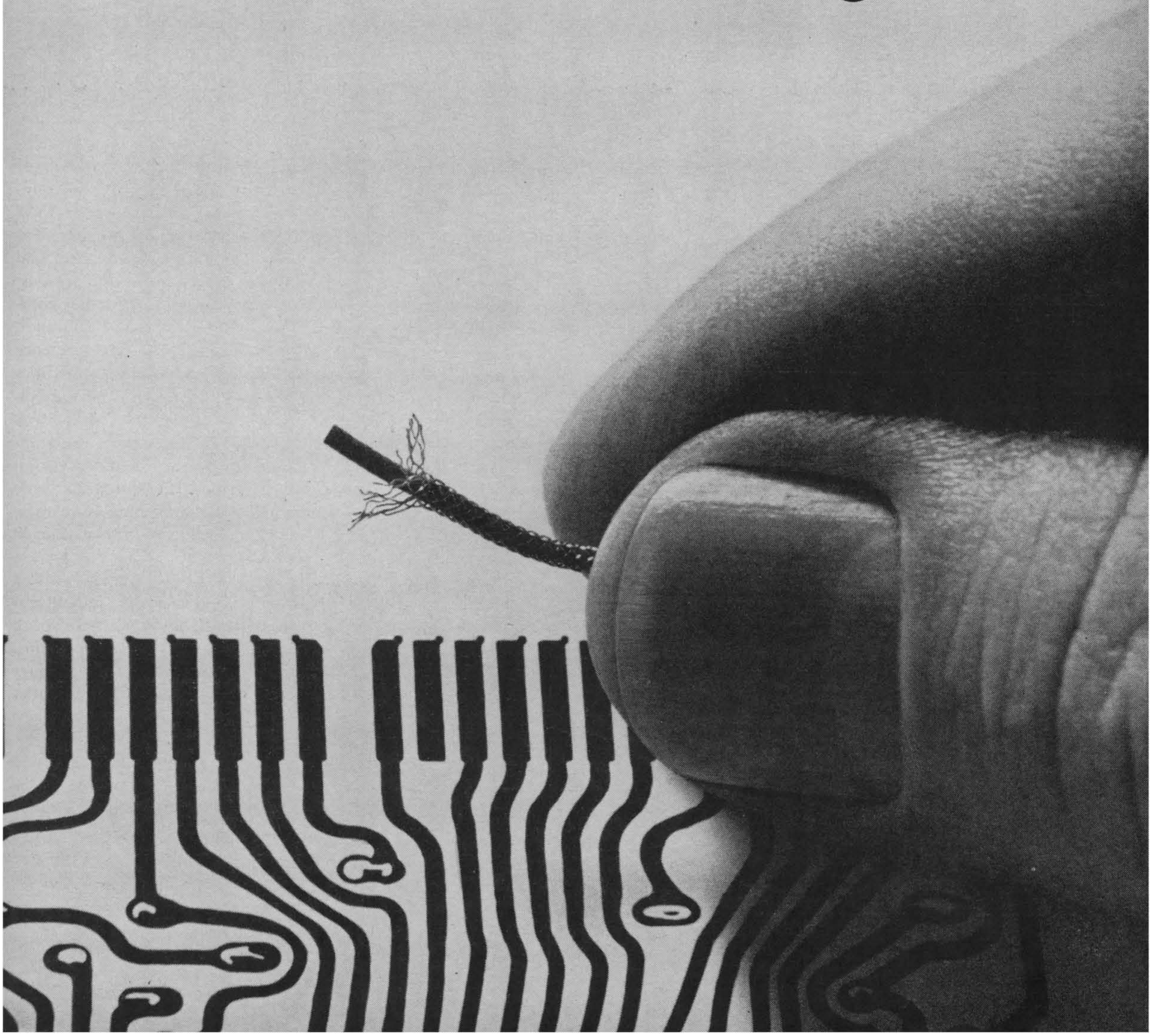
With so much going on today in communications, there are often two sides to printed circuits. Connecting them and allowing for expansion and contraction of the boards, are sizable problems. What kind of through connectors? Flanged eyelets? Plating. No. Eyelets loosen. Plating cracks. Resistance is higher than it should be. Performance is off. And so rigid are Western Electric's requirements for reliability that even the possibility of a cracked through connector is intolerable. Equally rigid, however, are our requirements for economy.

The solution worked out by engineers at W. E.'s Engineering Research Center and Bell Telephone Laboratories satisfies both requirements with elegant simplicity. Called the "compliant redundant through connector," it consists of 16 gold-plated wires braided around a silicone rubber core. Each C/R connection is cut so that about 1/16" protrudes on either side of the board; the wires are pressed down and soldered. The core keeps the solder from flowing into the hole.

Now, with each strand of wire extending through the hole at a slant, the connection accepts expansion and contraction of the boards—hence compliant. And with 16 wires, even though some may not connect properly, others will do the job—hence redundant. Thus the Bell System's equal concerns for reliability and economy (and Western Electric's as a part thereof) can, in a small but not insignificant way, be satisfied.



Western Electric
MANUFACTURING & SUPPLY UNIT OF THE BELL SYSTEM



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SCIENCE

Good Teaching

The growing emphasis on research, the availability to academic personnel of external grants which support a wide variety of activities other than teaching, the lure of "freedom from routine duties" (although teaching should never deteriorate into a routine duty), and the use by some institutions of criteria for advancement that seem to overemphasize research or even that superficial evidence, publication—all of these factors have of late tended to underemphasize the role of good teaching.

But what is a good teacher? Is he the popular teacher? Is he the one who gives flashy and spectacular lectures? Is he the one whose students average highest on departmental exams? Is he the one whose presentations are so tidy that note-taking is easy? Is he the good fellow with the best jokes? Is he a disciplinarian, or is he lax about standards and performance? Does he trouble the stupid but inspire the really able?

The answers all depend on the orientation of the one who replies. By all odds the most popular physics teacher I have ever known was a sweet gentleman who just could not bring himself to fail the letters and arts students who flocked to his sections to work off their science requirements. One of the most popular lecturers in a social science subject I have met with was a man whose smoothly presented lectures were almost as well organized as the textbook. He was famous for finishing every lecture with a polished phrase exactly as the bell rang.

On the other hand, one of my own great teachers in high school was an exceedingly strict Latin teacher. Perhaps he was not loved, but he certainly was respected—and 55 years later I can still scan Vergil.

My very greatest university teacher stopped one day, in the middle of a long and complex proof of a fundamental theorem in potential theory, looked at the confused and badly written mess he had put on the blackboard, said "Well, boys, something is wrong"—and walked out, leaving us to save ourselves.

So before you decide whether a teacher is good, ask, good for what? The purposes should vary greatly, from the broad intent of survey courses and the exploratory excitement of introductory courses to the stimulating depth of graduate courses. Is the criterion of goodness the mechanical success with which information is transmitted, the sympathy and warmth with which a young mind is led to unfold—or the influence a great character can have on the whole life of a student?

I do not think a teacher can be judged by weighing publications, but I also think no teacher can be successful unless he is alert to the new knowledge in his field. In many instances it is absurd to expect a teacher to be a scholarly producer of original research; but it is fatal not to require him to be alive to his subject.

I am sure that some evaluations of teachers by students have been made with serious purpose, but I profoundly disbelieve the results. It will not even work to ask alumni—presumably wiser, surely older, and hopefully more eclectic—which teachers they remember with greatest admiration.

I think the only useful judgment concerning university teachers comes from their immediate working colleagues. The administrators should be aware of student opinion, of course, and in some cases it may be useful. But fellow teachers, through their skillful and intimately informed judgments, will come nearest to recognizing good teaching. The immediate colleagues of a teacher will know what the students really think, for they will have obtained this information in effective informal ways, will have available the evidence of student records, will be aware of the general community opinion, and will have put all this information through the sieve of their own competence.

—WARREN WEAVER, *Alfred P. Sloan Foundation, New York*

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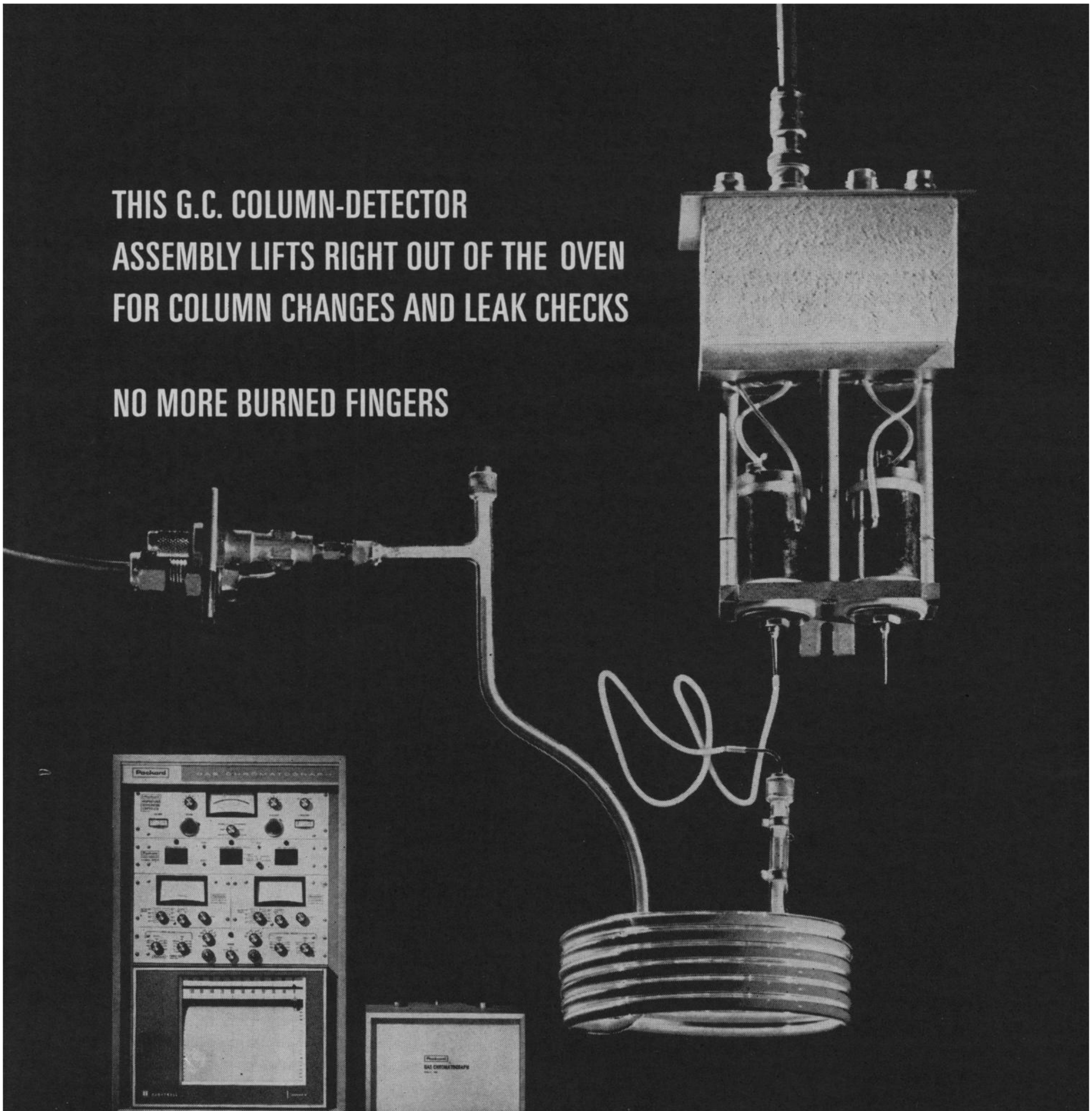

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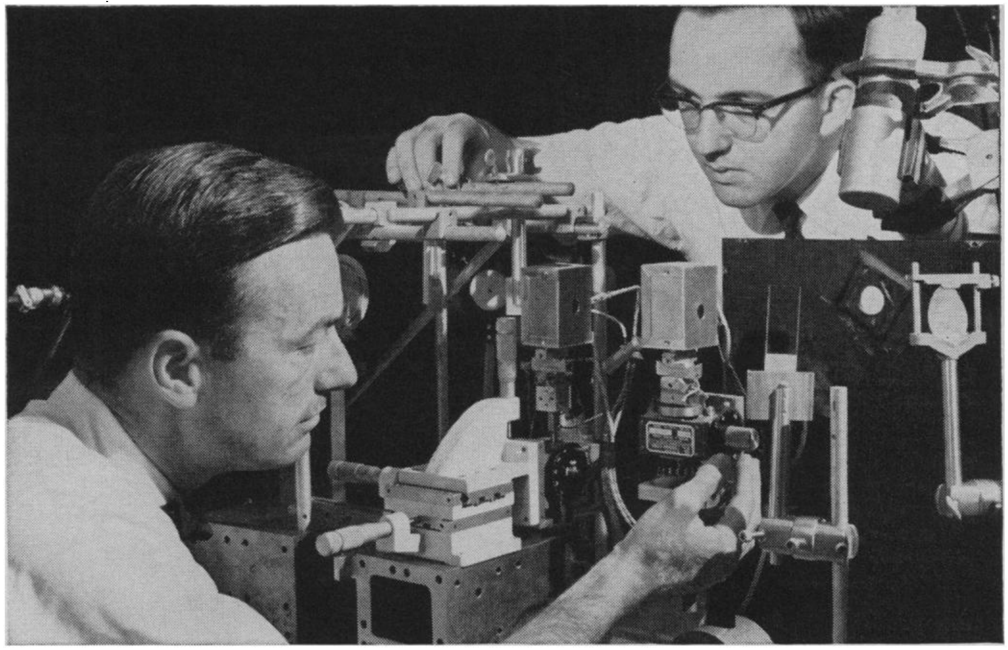


R. C. Miller (left) and J. A. Giordmaine check the alignment of the crystal in which variable-frequency, laser-type light is generated.

A Tunable Source of "Laser" Light

A narrow beam of light, as generated by a laser, appears to offer many desirable qualities as a possible medium of communication. Individual lasers, however, operate at separate, discrete frequencies. For communications, tunable sources of light comparable to the variable-frequency oscillators used in radio work are useful.

Recently, Bell Telephone Laboratories scientists J. A. Giordmaine and R. C. Miller demonstrated an experimental tunable source of this type. Operating on parametric oscillation principles at optical frequencies (see illustration below), the device uses a crystal of lithium metaniobate, which is "pumped" by a laser beam. The device emits two beams, each of which is tuned by changing the temperature of the crystal. With the present model an 11° C temperature change produces a 6 percent change in output wavelength of each of the beams.

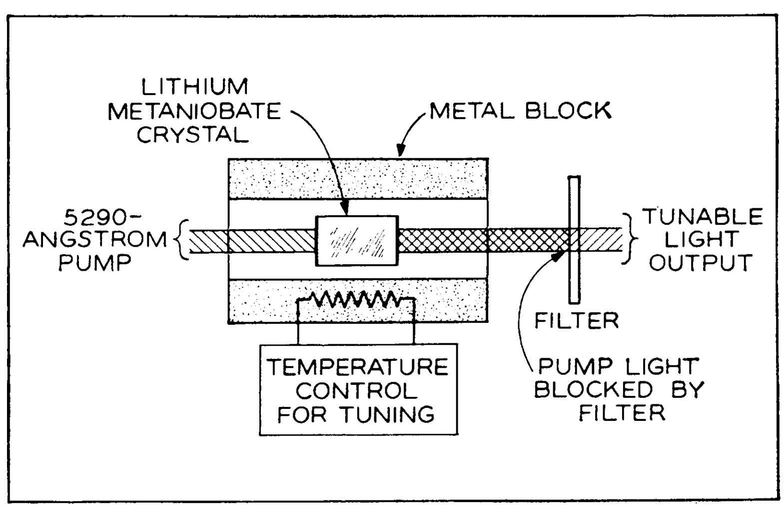
Tunable, coherent sources represent a versatile scientific tool of importance for optical spectroscopy. In other applications, they could function as local oscillators in optical-frequency superheterodyne receivers.

Operating features of tunable source based on parametric oscillation at optical frequencies: "pump" light from laser enters lithium metaniobate crystal at left, and, as a consequence of parametric oscillation, two additional beams are produced in the crystal. End surfaces of crystal, to which dielectric coatings have been applied, are partially reflecting. From right end emerge the two beams, plus the pump light, which is blocked by the filter.

The principles governing parametric oscillation include the conservation of the energy and momentum of the interacting photons. As a consequence of energy conservation, the sum of the two output frequencies equals that of the pump. These output frequencies vary with temperature since the crystal's temperature-dependent index of refraction controls photon momentum in the beams.

In current work, the second harmonic of a pulsed calcium tungstate/neodymium-doped laser provides the required 7 kilowatts of pump power. Pump frequency of 5.7 x 10^5 gigacycles (5290A wavelength) produces output frequencies ranging from about 2.6 x 10^5 gigacycles (11,500A) to 3.1 x 10^5 gigacycles (9700A), depending on temperature.

Lithium metaniobate, whose unique optical properties are essential to this effect, was first investigated in detail at Bell Laboratories where, also, large optical-quality crystals for this experiment were grown.



Sciama's small galactic radio sources) lie probably at great distances consistent with the Hubble law applied to their redshifts. Their variability implies smaller internal concentrations, possibly super-massive stars or super-dense nuclei with flares or jets or short pulsation periods. The optical spectra indicate low-density gas highly excited by radiation, and the radio spectra indicate highly ionized gas in a magnetic field. Their energy store is probably gravitational and magnetic, possibly with contributions from turbulence and nuclear reactions in supernovae. The synchrotron mechanism can account for radio emission and its variability, but the optical properties are less well understood.

Radiation, Primordial Material, and Cosmology

In addition to optical and radio observations, it has recently become possible to observe x-rays and γ-rays from astronomical sources (as well as the high-energy cosmic rays studied for more than 40 years). E. A. Spiegel (New York) noted that high-speed motion of a star (or of any other massive body such as Terrell's fragments from the Milky Way nucleus) through low-density gas will be supersonic, producing a high-temperature jet. He had calculated that an elliptical galaxy moving at supersonic speed through intergalactic hydrogen (assumed density, 10^{-5} atoms/cm^3) will produce a detectable x-ray source. Another possible source of high-energy background radiation is photon-photon interaction in empty space, discussed by R. J. Gould (San Diego), who pointed out that the interaction probability is significantly high for energies greater than 10^{14} ev during 10^{10} years. J. Felton (San Diego) expects a γ-ray background-intensity proportional to 1/(energy)$^{1.3}$, due to high-energy electrons ejected by quasars in an intergalactic magnetic field of 10^{-6} gauss.

The radiation density and material content of intergalactic space depend strongly on the past history of the universe and on the cosmological model adopted to interpret current observations. Quanta emitted billions of years ago, for instance, have suffered large redshift and possible absorption by intergalactic gas, but still reflect conditions that may have been the same as those today (in steady-state cosmology) or very different (in evolutionary cosmologies). R. W. Wilson (Bell Laboratories) described the accurate measurement of background radiation at 4300 Mc/sec ($\lambda = 7$ cm) with a corner-reflector antenna of 97-percent efficiency. After making accurate corrections for Earth's atmospheric effects, instrumental noise, and such, he and Penzias obtained a sky background temperature of 3.1°K ± 0.3°. P. Roll (Princeton) extended this to 9370 Mc/sec ($\lambda = 3.2$ cm), where $T = 2.5$°K ± 0.5°. George Field (Berkeley) pointed out that recent measurements of interstellar CN-absorption bands in star spectra imply a radiation temperature of 3°K at $\lambda = 0.254$ cm in interstellar space.

P. J. E. Peebles (Princeton) discussed two theoretical explanations of the background radiation: one based on the high temperature of all matter in the universe shortly after the "big bang" in evolutionary cosmology (the Einstein-de Sitter model), the other based on radiation from hot interstellar hydrogen. The first leads to a predicted abundance of helium about twice as great as that observed; the second leads to a predicted variation of background T with λ, contrary to the measurements of Penzias, Wilson, and Roll.

At $t = 0.01$ second after the big bang, according to Peebles' calculations, the temperature was (10^{11})°K and the radiation density was 10^3 quanta/cm^3 in thermodynamic equilibrium with a high-density gas of proton and electrons. At $t = 10^3$ second, $T = 3 \times 10^9$, and nuclear reactions had built up neutrons, neutrinos, deuterium, and helium (alpha particles). As time went on, the relative abundances changed: neutrons decreased in number, deuterium went through a maximum, and helium increased. At some moment the material became transparent to radiation and halted the changes in abundances. The temperature at that moment was the "fireball" temperature responsible for background radiation, which has decreased adiabatically as the universe has expanded ever since, resulting in a low background temperature, T_r, today, which is the same at all wavelengths. Peebles had expected $T_r \cong$ 10°K, which temperature is associated with a helium abundance of 15 percent by weight and deuterium abundance of 10^{-4}. The observed value for T_r, 3°K, implies 30 percent helium and no deuterium in the primordial gas from which present galaxies and stars were formed.

David Layzer (Harvard) had reached a different conclusion; taking account of quantum statistics in the early stages of expansion, he had found that T_r varies with λ, and that early values of T changed in a different way, probably leading to different abundances. Later condensation of galaxies he can explain by gravitational instability in an expanding homogeneous medium.

Peebles' second calculation concerns the effect of absorption and emission of quanta, by ionized hydrogen, due to free-free transitions (changes of an electron's energy near a proton), which absorption and emission occurred mainly during the early, high-temperature stage of evolutionary cosmology. Assuming that the free electrons were then at a temperature of 10^6, he and R. H. Dicke (Princeton) showed that background-radiation quanta detected today were emitted when the density of the universe was about 10^{-15} g/cm^3, about 1000 years after the "big bang," and that T_γ should be proportional to $\lambda^{4/5}$. That is, 7-cm quanta observed today were 1400-Å quanta emitted about 10^{10} years ago in larger numbers than 500-Å quanta now detectable as 0.25-cm background radiation. If $T_\gamma = 3°K$ at $\lambda = 7$ cm, Dicke and Peebles predict $T_\gamma = 0.2°K$ at $\lambda = 0.25$ cm, instead of the 3°K observed.

Although the calculations of early intergalactic absorption are not well confirmed, there was interest in possible intergalactic absorption of light from quasars more than 10^9 light years distant. J. E. Gunn (Caltech) showed that the partial absorption (about 40 percent in 3C9), at wavelengths shorter than the redshifted Lyman-alpha line in Schmidt's and Burbidge's spectra, imply no more than 6×10^{-11} atoms of intergalactic hydrogen per cubic centimeter (10^{-34} g/cm^3), whereas evolutionary cosmology requires about 10^{-28} g/cm^3, with cosmological constant zero. Of course, if the intergalactic material were at high temperature, $T \approx 100{,}000°K$, most of the hydrogen would be ionized, and the density could be 10^{-28} with the observed Lyman-alpha absorption. But in this case Thompson scattering by free electrons would be noticeable at redshift $z > 2$, and would obliterate images for $z \geqq 5$. J. N. Bahcall (Caltech) noted that intergalactic gas in a cluster of galaxies should have less velocity dispersion than gas along the line of sight; the spectrum of a quasar behind a cluster may show fairly sharp absorption lines at the resonant absorption wavelengths of H, CIV, CIII, and MgII ($\lambda\lambda$ 1216, 1550, 1909, and 2789, respectively, with the cluster redshift).

Finally, N. Woolf (Texas) summarized evidence from the last 30 years of astrophysical research that the universal helium abundance is less than the value of 30 percent calculated by Peebles from the background-radiation measurements. Helium abundance is measured directly only in the atmospheres of hot, young, Population-I stars where the abundance Y is about 40 percent. One hot, B2, Population-II star in the globular cluster M13 has $Y = 20$ percent, and the plot of temperature versus luminosity for old Population-II stars in another globular cluster, M3, is consistent with $Y = 13$ percent. Since helium is found in stellar interiors and is returned to the interstellar medium by supernova explosions, it is generally concluded that the primordial gas clouds, from which the first stars were formed, were pure hydrogen ($Y = 0$). Woolf noted that these first-generation "Population-III" stars in our galaxy were probably large (10 solar masses) and short-lived (about 10^7 yr). They returned material to the interstellar medium with various amounts of helium added, and thus obscure the original helium abundance. He thinks that smaller Population-III stars would have been formed in dwarf galaxies or in intergalactic globular clusters, where abundances measured today may reflect the original amounts of helium more accurately.

In summary, recent observations of background radio radiation and strongly redshifted ultraviolet spectra of quasars have provided new data for checking cosmological theories; the data show fairly serious inconsistencies. One central set of questions concerns the intergalactic medium: What is its density? Temperature? Composition? How has it affected the background radiation from a primordial "fireball"? Most attempts to answer these questions are based on the Einstein-de Sitter evolutionary model, which starts about 10^{10} years ago with a big bang. Other cosmologies, such as Dicke's with time-dependent gravitation, would give different answers, and in steady-state cosmology some of the questions themselves disappear.

THORNTON PAGE
Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

Forthcoming Events

March

26–27. Arizona **Chest Disease** Symp., Tucson. (E. A. Oppenheimer, P.O. Box 6067, Tucson 85716)

27–30. American Assoc. of **Dental Schools**, Miami Beach, Fla. (R. Sullens, 840 N. Lake Shore Dr., Chicago, Ill.)

28–30. **Great Lakes Research**, 9th conf., Chicago, Ill. (B. M. McCormac, IIT Research Inst., 10 W. 35 St., Chicago 60616)

28–31. Collegium Intern. **Neuro-Psychopharmacologicum**, 5th biennial mtg., Washington, D.C. (M. K. Taylor, 3636 16th St., NW, Washington 20010)

29–31. **Airborne Infection**, 2nd intern. conf., Illinois Inst. of Technology, Chicago. (E. K. Wolfe, U.S. Army Biological Laboratories, Fort Detrick, Frederick, Md.)

29–31. **Applied Meteorology**, 6th natl. conf., Los Angeles, Calif. (B. N. Charles, Booz-Allen Applied Research, 6151 W. Century Blvd., Los Angeles 90045)

29–31. **Chemical** Soc., anniversary mtgs., Oxford, England. (General Secretary, Burlington House, London W.1)

29–31. **Surface-Active Substances**, intern. conf., Berlin, East Germany. (Inst. für Fettchemie, Deutsche Akademie der Wissenschaften zu Berlin, Rudower Chaussee 5, 1199 Berlin-Adlershof)

29–31. **Symbolic and Algebraic Manipulation**, symp., Assoc. for Computing Machinery, Washington, D.C. (J. E. Sammet, I.B.M. Corp., 545 Technology Sq., Cambridge, Mass. 02139)

29–1. American Assoc. for **Contamination Control**, 5th annual technical mtg., Houston, Tex. (W. T. Maloney, The Association, 6 Beacon St., Boston, Mass.)

29–1. Ultraviolet and X-ray **Spectroscopy of Laboratory and Astrophysical Plasma**, conf., Abingdon, England. (Inst. of Physics and the Physics Soc., 47 Belgrave Sq., London, S.W.1, England)

30. **Oral Cancer**, 4th symp., St. Francis Hospital, Poughkeepsie, N.Y. (M. A. Engelman, 1 E. Academy St., Wappingers Falls, N.Y.)

30–1. **Magnetohydrodynamics**, 7th symp., Princeton, N.J. (R. G. Jahn, Guggenheim Laboratories, Forrestal Research Center, Princeton, N.J. 08540)

31–2. Michigan **Acad. of Science, Arts, and Letters**, Wayne State Univ., Detroit. (E. A. Wunsch, Dept. of English, Univ. of Michigan, Ann Arbor)

April

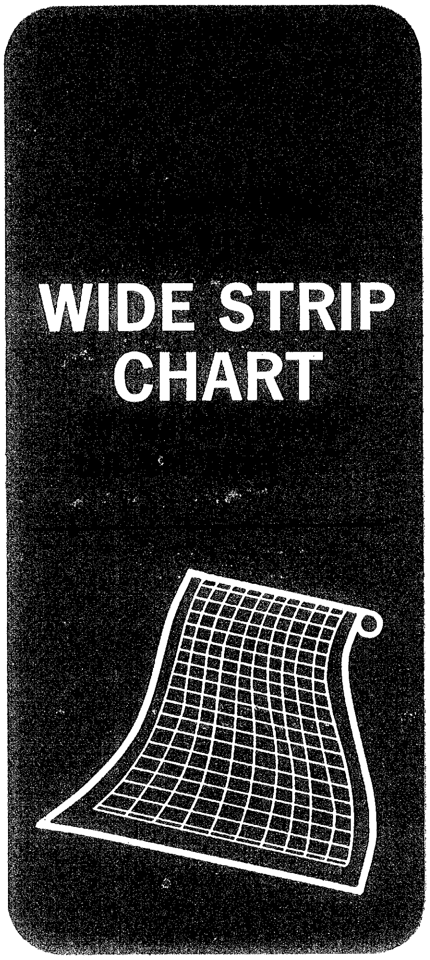
1–2. Alabama **Acad. of Science**, Birmingham-Southern College, Birmingham. (W. B. DeVall, Dept. of Forestry, Auburn Univ., Auburn, Ala.)

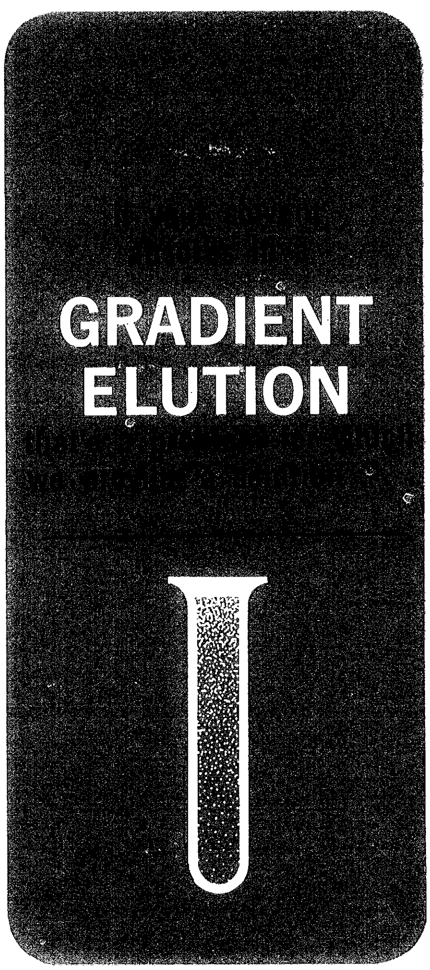
1–2. Arkansas **Acad. of Science**, Little Rock. (G. E. Templeton, Univ. of Arkansas, Fayetteville)

1–5. National **Science Teachers** Assoc., New York, N.Y. (R. H. Carleton, 1201 16th St., NW, Washington, D.C. 20036)

1–7. American Acad. of **General Practice**, Boston, Mass. (M. F. Cahal, Volker Blvd. at Brookside, Kansas City 12, Mo.)

4–6. **Atomic Energy** Soc. of Japan, annual mtg., Tokyo. (M. Masamoto, Japan





Atomic Energy Research Inst., 1-1, Shibatamura-cho, Minato-ku, Tokyo)

4–6. **Exobiology**, conf., Ames Research Center, Moffett Field, Calif. (Letters and Science Extension, Univ. of California, Berkeley 94720)

4–6. American Assoc. of **Physical Anthropologists**, Berkeley, Calif. (F. E. Johnston, Dept. of Anthropology, Univ. of Pennsylvania, Philadelphia 19104)

4–6. **Biomedical Communication**, conf., New York, N.Y. (J. Lieberman, Public Health Service Audiovisual Facility, Atlanta, Ga. 30333)

4–7. Federation of European **Biochemical** Soc., 3rd mtg., Warsaw, Poland. (T. Klopotowski, Polish Biochemical Soc., Freta 16, Warsaw)

4–7. Advances in **Water Quality Improvement**, conf., Univ. of Texas, Austin. (Special Lecture Series, Engineering Laboratories Bldg. 305, Univ. of Texas, Austin)

4–8. International **Biological Program**, 2nd general assembly, Paris, France. (F. W. G. Baker, 2 via Sebenico, Rome, Italy)

4–10. **Psychology**, 10th inter-American congr., Lima, Peru. (Intern. Soc. of Psychology, 2104 Meadowbrook Dr., Austin, Tex.)

5–7. Middle East **Neurosurgical** Soc., mtg., Jerusalem, Jordan. (F. S. Haddad, Orient Hospital, Beirut, Lebanon)

5–8. American Assoc. of **Anatomists**, San Francisco, Calif. (R. T. Woodburne, Dept. of Anatomy, Univ. of Michigan, Ann Arbor 48104)

6–7. **Phlebology**, 6th intern. mtg., Aix-en-Provence, France. (F. Beurier, 94, cours Sextius, Aix-en-Provence)

6–8. **Electron and Laser Beam Technology**, Univ. of Michigan, Ann Arbor. (G. I. Haddad, Electrical Engineering Dept., Univ. of Michigan, Ann Arbor)

6–8. Recent Advances in **Phytochemistry**, intern. symp., Univ., of Texas, Austin. (T. J. Mabry, Dept. of Botany, Univ. of Texas, Austin 78712)

6–8. **Plant Phenolic** Group of North America, 6th annual mtg., Austin, Tex. (V. C. Runeckles, Imperial Tobacco Co., Montreal, P.Q., Canada)

7–8. **Histochemical** Soc., 17th annual mtg., Atlantic City, N.J. (J. Y. Terner, College of Physicians and Surgeons, Columbia Univ., New York, N.Y. 10032)

7–8. Southern **Sociological** Soc., annual mtg., New Orleans, La. (J. J. Honigmann, Dept. of Anthropology, Univ. of North Carolina, Chapel Hill)

7–9. **Developmental Biology**, Northeast regional conf., Univ. of Connecticut, Storrs. (H. Laufer, Dept. of Zoology, Univ. of Connecticut, Storrs 06268)

7–9. Southern Soc. for **Philosophy and Psychology**, New Orleans, La. (G. R. Hawkes, U.S. Army Medical R&D Command, Washington, D.C. 20315)

8–9. American Soc. for **Artificial Internal Organs**, Atlantic City, N.J. (B. K. Kusserow, Dept. of Pathology, Univ. of Vermont College of Medicine, Burlington)

8–11. **Animal Toxins**, intern. symp., Atlantic City, N.J. (F. E. Russell, Box 323, Los Angeles County General Hospital, 1200 N. State St., Los Angeles, Calif. 90033)

9. **Paleontological Research** Inst., semiannual mtg., Ithaca, N.Y. (The Institution, 109 Dearborn Pl., Ithaca, N.Y. 14850)

10–11. **Microcirculatory Soc.**, 14th conf., Atlantic City, N.J. (H. J. Berman, Dept. of Biology, Boston Univ., Boston, Mass. 02215)

11–13. Institute of **Electrical and Electronics Engineers**, Region 3, conv., Atlanta, Ga. (M. D. Price, Dept. 72-14, Zone 400, Lockheed-Georgia Co., Marietta, Ga.)

11–13. Comparative **Hemoglobin** Structure, intern. symp., Salonika, Greece. (Secretary, P.O. Box 201, Salonika)

11–15. **Aeronomic Studies of Lower Ionosphere**, conf., Ottawa, Ont., Canada. (W. Pfister, Air Force Cambridge Research Laboratories, Upper Atmosphere Physics Laboratory, L. G. Hanscom Field, Bedford, Mass.)

11–15. American Assoc. of **Cereal Chemists**, New York, N.Y. (R. J. Tarleton, The Association, 1955 University Ave., St. Paul, Minn. 55104)

11–16. Federation of American Societies for **Experimental Biology**, 50th annual mtg., Atlantic City, N.J. The following societies will meet in conjunction with the FASEB; information may be obtained from FASEB, 9650 Rockville Pike, Bethesda, Maryland 20014:

American Physiological Society
American Soc. of Biological Chemists
American Soc. for Pharmacology and Experimental Therapeutics
American Soc. for Experimental Pathology
American Inst. of Nutrition
American Assoc. of Immunologists

12–13. Frontiers in **Food Research**, symp., Cornell Univ., Ithaca, N.Y. (W. F. Shipe, Dept. of Dairy and Food Science, Cornell Univ., Ithaca)

12–14. **Generalized Networks**, intern. symp., New York, N.Y. (H. J. Carlin, Polytechnic Inst. of Brooklyn, 333 Jay St., Brooklyn, N.Y. 11201)

12–14. **Remote Sensing of Environment**, 4th symp., Univ. of Michigan, Ann Arbor. (Extension Service, Conference Dept., Univ. of Michigan, Ann Arbor 48104)

12–15. **Quantum Electronics**, intern. conf., Phoenix, Ariz. (J. P. Gordon, Bell Telephone Laboratories, Murray Hill, N.J.)

12–16. Society for Applied **Mathematics and Mechanics**, annual scientific mtg., Darmstadt, Germany. (F. Reutter, Gesellschaft für Angewandte Mathematik und Mechanik, Templergraben 55, 51, Aachen, Germany)

12–29. **Soil Conservation**, 1st Pan American congr., São Paulo, Brazil. (J. Abramides Neto, avda. Francisco Matarazzo 455, Caixa Postal 8366, São Paulo)

13–15. Institute of **Environmental Sciences**, 12th annual tech. mtg. and equipment exp., San Diego, Calif. (The Institute, 34 S. Main St., Mount Prospect, Ill.)

13–15. Use of **X-Rays in Medicine and Industry**, public health conf., Univ. of Miami, Coral Gables, Fla. (M. Dauer, Div. of Radiological Physics, Jackson Memorial Hospital, Univ. of Miami, Miami, Fla.)

13–16. **Geological Soc.** of America, southeast section, Univ. of Georgia, Athens. (L. D. Ramspott, Dept. of Geology, Univ. of Georgia, Athens 30601)

13–16. American **Orthopsychiatric** Assoc., 43rd annual mtg., San Francisco, Calif. (M. F. Langer, The Association, 1790 Broadway, New York 10019)