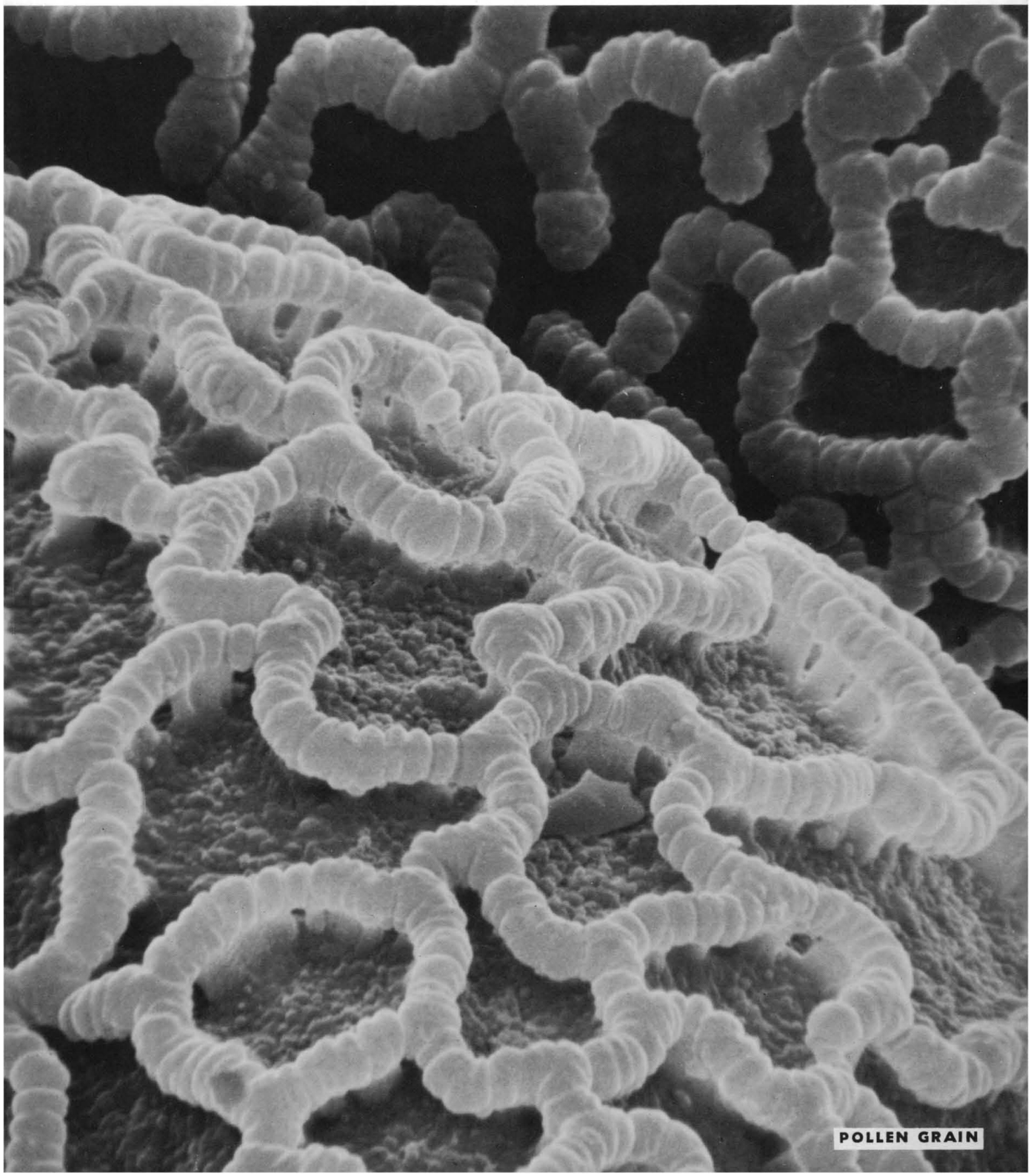
SCIENCE

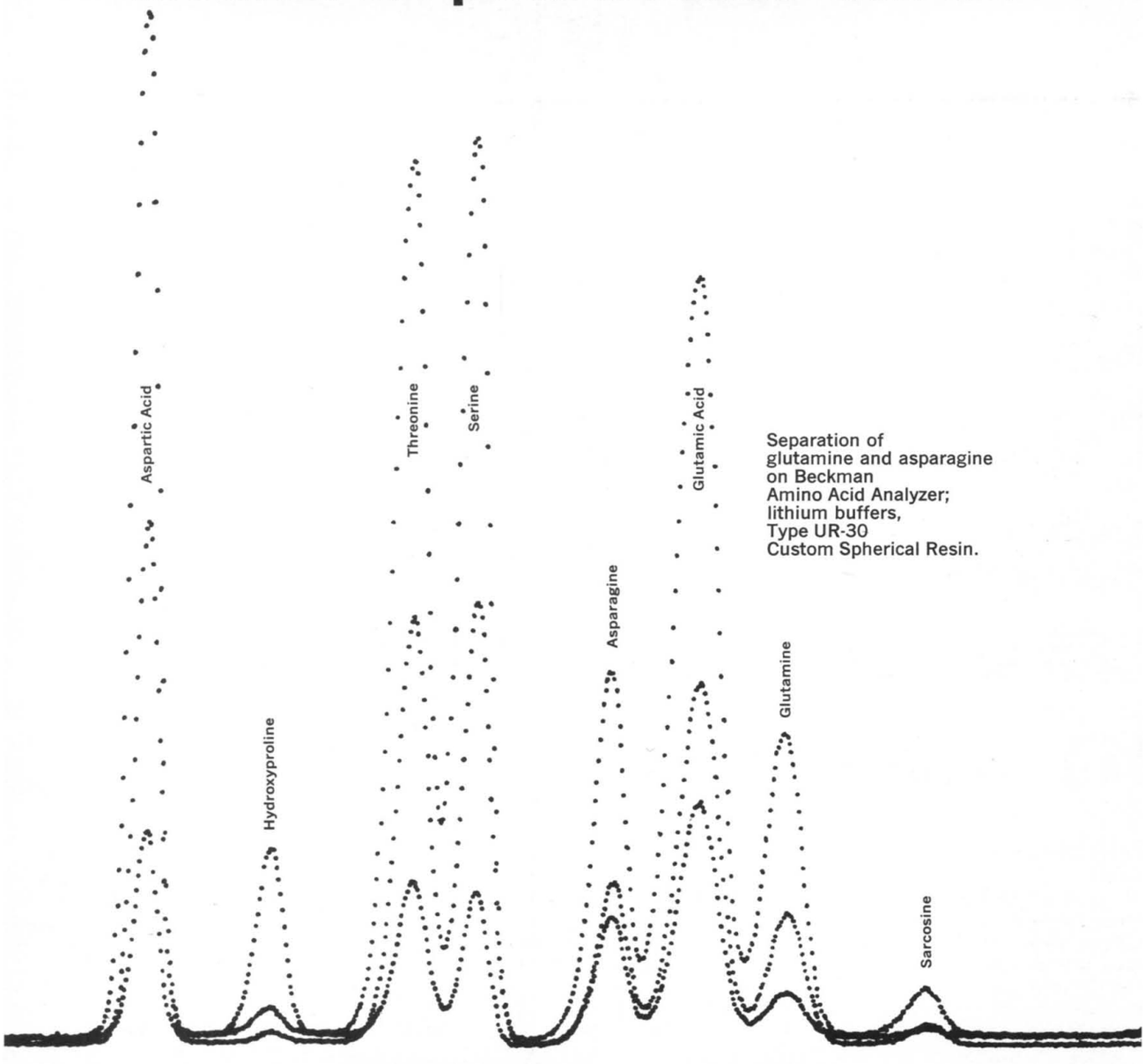
19 July 1968

Vol. 161, No. 3838

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



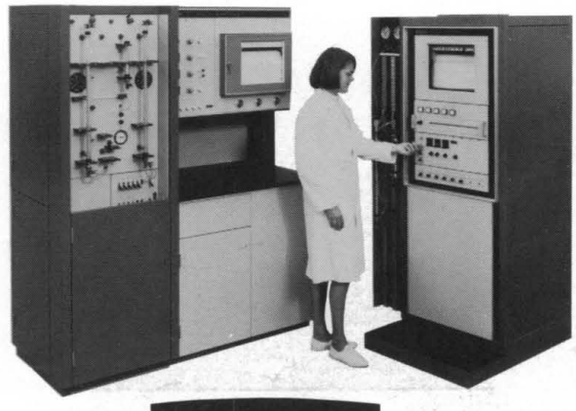
Resolved: Two peaks are better than one



Separation of glutamine and asparagine on Beckman Amino Acid Analyzer; lithium buffers, Type UR-30 Custom Spherical Resin.

It took three things to split the glutamine/asparagine peak in analyzing physiological fluids: new methodology, Custom Spherical Resin, and a superb amino acid analyzer. All three of these are developments from Beckman.

And now Beckman gives you a choice of two analyzers. The classic Model 120C is the premier instrument in the field —the logical choice for volume of analyses and for built-in capabilities. The new Model 116 Analyzer is a modular unit so you can order only the capabilities you need at present and can add additional capabilities later. The resolution shown above is typical of both instruments.



To get more information, and representative chromatograms, write for Data File 2016-5.

Beckman® INSTRUMENTS, INC.
SPINCO DIVISION
PALO ALTO, CALIFORNIA • 94304

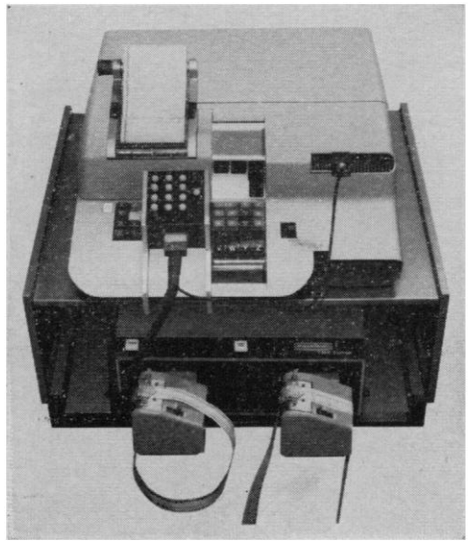
INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPETOWN; LONDON; MEXICO CITY

Omega™:

computes and prints out data from up to 10 liquid scintillation counters in any data format in seconds.

Unlike on-line types, Omega is not electronically wired to any one L.S. counter. Nor to any specific data format. It converts raw measurements to final data in seconds *right in your own lab.* No more farming out for interpretation, or waiting for shared-time service. And no confinement to any one math computation. Omega solves anything from basic algebra to exotic formulas—anything you've been computing with a table, slide rule, calibration curve or desk calculator. Answers come automatically—in seconds—and absolutely error-proof. ■ Omega also reduces your set-up time. No dials to set. No knobs to turn. No mysterious programming language to learn. With one day's training, an operator can write involved programs up to 120 steps long. Programs involving quench-corrected DPM for single or multi-label samples. Data averaging. Quench-corrected isotope ratios. Half-life decay corrections. Constant efficiency results for varying quench samples. ■ The Omega two-unit system is *not* the most expensive one you can buy. Nor the least. It *is* the most utilitarian system—and the most practically priced.

Beckman's new off-line data reduction system: more capability per dollar than anything in the field.



For information on this exciting new system—write for Data File #401N or call your Beckman Sales Representative. Omega, the desk-top *off-line* data reducer.

Another reason why Beckman leads the liquid scintillation field on every count.

Beckman

INSTRUMENTS, INC.

SCIENTIFIC INSTRUMENTS DIVISION

FULLERTON, CALIFORNIA • 92634

INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPETOWN; LONDON; MEXICO CITY

19 July 1968
Vol. 161, No. 3838

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 Ave., NW, Washington, D.C. 20005. Now combined with **The Scientific Monthly**®. Second-class postage paid at Washington, D.C. Annual subscriptions $12; foreign postage: Americas $3; overseas $5; single copies, 50¢ (back issues, $1) except **Guide to Scientific Instruments**, which is $2. School year subscriptions: 9 months, $9; 10 months, $10. Provide 4 weeks notice for change of address, giving new and old address and zip codes. Send a recent address label. SCIENCE is indexed in the **Reader's Guide to Periodical Literature.**

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

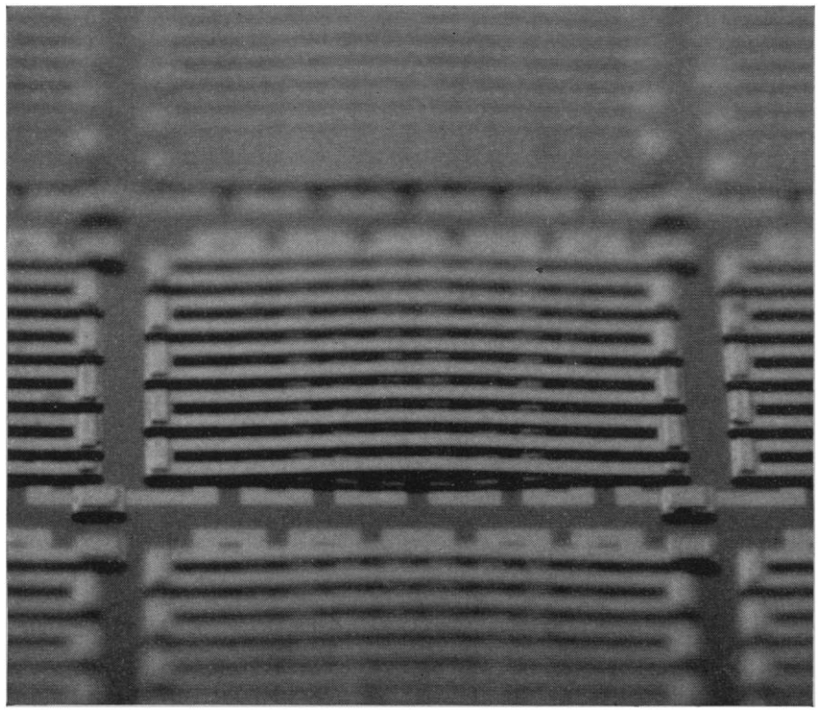
COVER

Surface of an acetolyzed pollen grain of *Lilium longiflorum*. The acetolysis has removed all of the remaining primexine matrix material, exposing the bacula and the rough surface of the nexine 1. The heads of the bacula are connected to produce a system of walls or muri. See page 230. [J. Heslop-Harrison, University of Wisconsin, Madison]

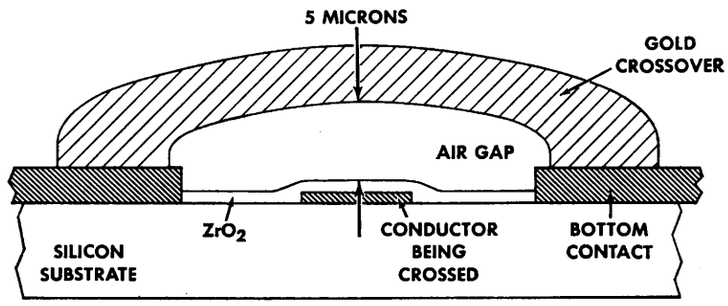
Report from

BELL LABORATORIES

Microbridges for electrons



Part of an experimental test pattern. This pattern, with 13,700 microbridge crossovers on a silicon substrate, has been fabricated without a short circuit. Each of the crossovers is less than 1/16 in. long. The combination of air and solid insulation can withstand 200 volts.



Cutaway view showing formation of the new microstructure: First, layers of titanium and platinum are deposited over the substrate to form both the conductors to be crossed and the bottom contacts. A layer of zirconium is then put down. Next copper, a spacer for formation of the crossover, is evaporated overall. Windows are etched through the copper so the crossover can reach the lower-level contact. The crossover is then applied in position by gold-plating the copper spacer; the spacer is then etched away. The zirconium layer is oxidized to act as protective insulation. Any pinholes present do not become short circuits.

As integrated circuits become more complex, designers are faced with something akin to the old puzzle: "without crossing any lines or lifting your pencil from the paper, connect so-and-so-many points." In a puzzle, it's just for fun, but with circuits it has been a design requirement.

Until now, most conductors have been crossed in virtually the same plane, separated only by extremely thin insulators. Such crossovers are undesirable because of the danger of leakage through pinhole imperfections in the insulator. As integration technology evolves, hundreds of crossovers may be needed on a single substrate. A short in any one means rejection of the entire substrate. For such integrated circuits to compete economically, the integrity and manufacturing yield of crossovers must approach perfection.

Obviously, the designer would like to "lift his pencil". . . make the crossing conductor rise above the one beneath it.

Recently, Martin P. Lepselter of Bell Telephone Laboratories has done just that. He has invented a process for making "microbridges"... integrated-circuit leads which cross others through the air, without touching (photo, left).

This new technique solves the insulation problem; because of the air gap, pinholes in the insulator do not cause leakage. It also reduces capacitance between the conductors. Finally, by separating the various materials, it eliminates stresses due to unequal thermal expansion.

The key to the technique (drawing, left) is a layer of a material like copper that can be selectively etched away, leaving an air gap between the conductors. Thus the combination of air gap and insulating layer provides a degree of insulation protection not previously available. Insulated circuits with microbridge crossovers will be used in a wide variety of communications equipment in the Bell System.

Bell Telephone Laboratories
Research and Development Unit of the Bell System

velopment, a rocket based upon a metal heat exchanger-reactor was also investigated. In this design heat conduction was canceled by opposing gas convection (which is the same means by which a cold bunsen burner maintains a hot flame). By this strategy gas temperatures up to and including the melting point of tungsten (3600°K) were reliably achieved without risk of failure. A sizable fraction of the output of gas was atomic hydrogen, and the power density in the exchanger, as compared to that in the flame of an atomic hydrogen torch, yielded a very favorable power-to-weight ratio. Exchanger modules were run at full power and heat for as long as 2 hours and restarted repeatedly hundreds of times in 1/10 second without visible deterioration. The problem of thermal neutron capture, which Spence mentions, proved far less formidable than had been feared; actual rocket designs which were submitted to nuclear mock up became critical with very modest uranium loadings (*1*). In brief, feasibility had been widely demonstrated for a device with performance far beyond the potential of graphite. Design was rapidly maturing and construction of the first model had already started when we were given a directive to use the Kiwi-A nozzle. This meant cutting back the hydrogen flow to 3 kilograms per second. At this miniscule flow rate, the buffering effect of gas convection was gone, and the entire project was scrapped for the single reason that the design would not tolerate an unrealistically *low* power. Had Spence's criteria been well appreciated at the time, the decision would have been different. As an old space buff, I can daydream quite wistfully on what the scientific fruits of a post-Apollo program might have been.

BRUCE KNIGHT

Rockefeller University, New York 10021

Reference

1. B. W. Knight, *Nucl. Sci. Eng.* **19**, 393 (1964).

Federal Funds Mean Federal Control

Abelson's editorial (17 May, p. 721) about federal support of universities was apropos concerning reductions in federal funds. It suggests how a mere threat of reduced funds can enslave the recipient. But it seems to me he missed the *major* point about federal control. Obtaining funds by means of the power to tax is appealing, to be sure, as against our having to sell our programs to willing "buyers" as voluntary purchasers or supporters. But we must never forget that the overriding point comes from the highest judiciary (law) of the land:

> It is hardly lack of due process for the government to regulate that which it subsidizes. *United States Supreme Court Wickard v. Filburn*, 317 U.S. 111, p. 131, October 1942.

One wonders what the course of finance for education would now be if this ruling decision had been on the desk of every university administrator continuously over the past quarter century. It is a stern discipline for all who yearn for easy money from this source and at the same time hope to be free from political control.

F. A. HARPER

Institute for Humane Studies, Inc., 1134 Crane Street, Menlo Park, California 94025

Orwellian Parody

My letter (15 Mar.) was written as a parody. Several of my friends and colleagues understood it as such, without prompting from me. Did Herz (Letters, 24 May)?

My parody was inspired by another parody which, like the sentence I objected to, was a paraphrase of Scripture. In his essay "Politics and the English language," George Orwell used an example to show what he felt was wrong with the writing of his day. He obtained it by translating Ecclesiastes 9:11 as follows:

> I returned and saw under the sun, that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favour to men of skill; but time and chance happeneth to them all.

into what he called "modern English of the worst sort":

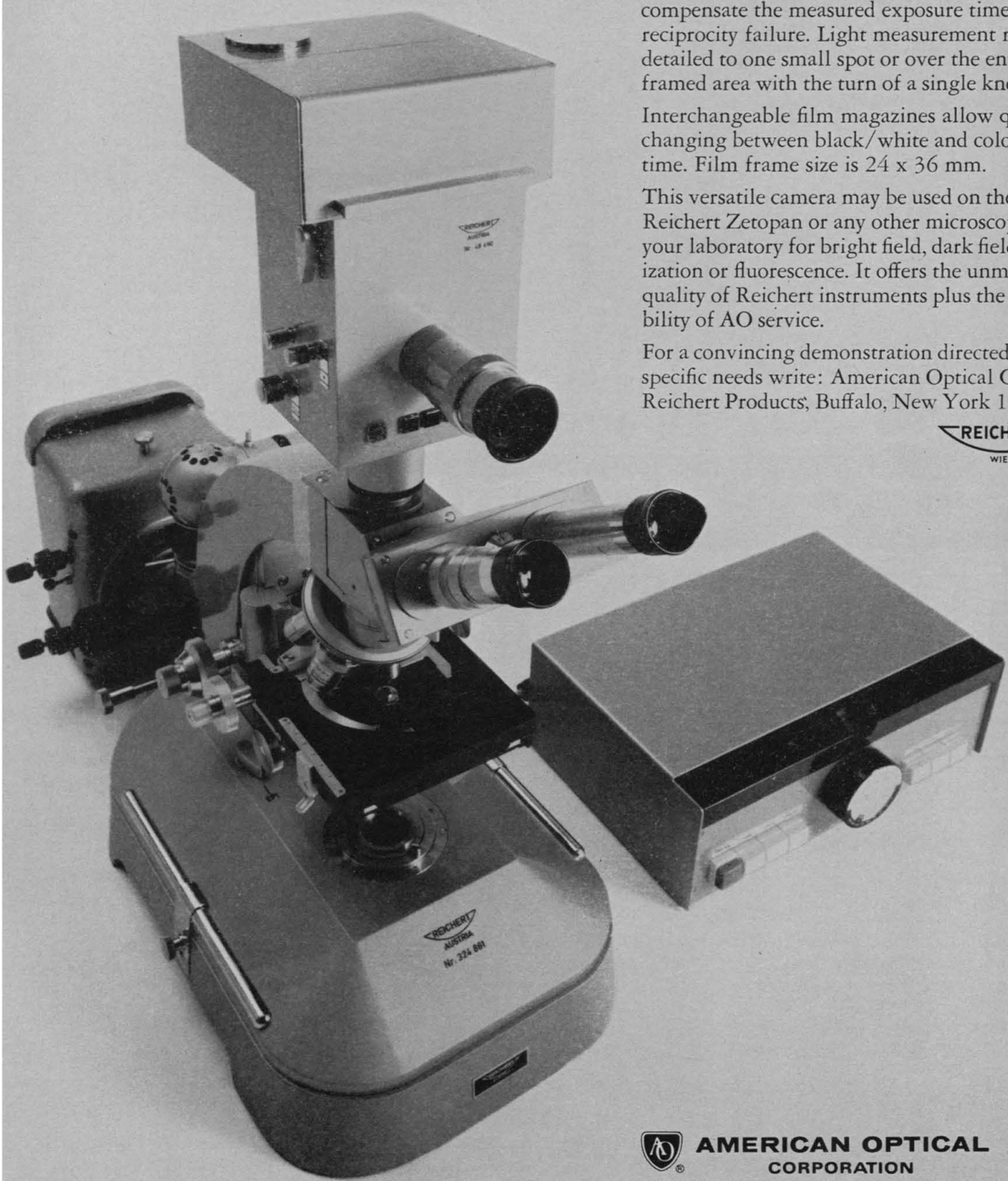
> Objective consideration of contemporary phenomena compels the conclusion that success or failure in competitive activities exhibits no tendency to be commensurate with innate capacity, but that a considerable element of the unpredictable must invariably be taken into account.

Clearly Orwell's essay applies as well to science as it does to politics.

KENNETH MANLY

Department of Biology, Massachusetts Institute of Technology, Cambridge 02139

Reichert Automatic Camera: first to give you direct exposure read-out.



The Reichert Automatic Camera is the only automatic camera available with direct exposure read-out. Built-in factor keys allow you to compensate the measured exposure time for film reciprocity failure. Light measurement may be detailed to one small spot or over the entire framed area with the turn of a single knob.

Interchangeable film magazines allow quick changing between black/white and color at any time. Film frame size is 24 x 36 mm.

This versatile camera may be used on the Reichert Zetopan or any other microscope in your laboratory for bright field, dark field, polarization or fluorescence. It offers the unmatched quality of Reichert instruments plus the reliability of AO service.

For a convincing demonstration directed to your specific needs write: American Optical Corporation, Reichert Products, Buffalo, New York 14215.

REICHERT
WIEN

AMERICAN OPTICAL
CORPORATION
SCIENTIFIC INSTRUMENT DIVISION • BUFFALO, N.Y.14215

finger-printing

separate:

POLYPEPTIDES

ALL AMINO ACIDS

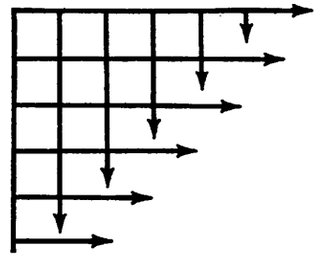
NUCLEOTIDES

MANY OTHER COMPOUNDS

MODEL D

high-voltage

ELECTROPHORATOR



ELECTROPHORESIS IN ONE DIMENSION

on 18¼" x 22½" sheets of filter paper (Chromatography may be done in second dimension). Many complex mixtures can be rapidly resolved by electrophoresis in one dimension on papers up to 4 feet long.

Developed in the Laboratory of Cellular Physiology and Metabolism, National Heart Institute, National Institutes of Health, Bethesda, Maryland. Special thanks are due to Dr. William J. Dreyer, whose co-operation and suggestions are gratefully acknowledged by Gilson Medical Electronics.

- ★ Easy loading with folding rack
- ★ 5,000 volts at 300 ma.
- ★ Paper immersed in bifurcated fiberglass tank containing Varsol
- ★ Varsol, a light petroleum fraction, has a high flash point (over 100° F.), does not conduct electricity, and has the proper degree of volatility
- ★ Cold tap water run through stainless steel coils at top of tank is only coolant necessary

- ★ **Safety features:**
- ✓ Strong, joint-free fiberglass tank eliminates electrical and fluid leaks
- ✓ High voltage connected to inside of tank by Nylon and stainless steel plugs attached to edge of tank
- ✓ Highly reliable interlock provided by an extension of the cover handle
- ✓ When cover is removed, high voltage is ipso facto turned off
- ✓ No capacitors to sneakily store electricity in apparatus

GILSON

GILSON MEDICAL ELECTRONICS

Middleton, Wisconsin 53562 • Telephone 608/836-1551

GILSON products are also manufactured in Europe:
GME • 69, Rue Gambetta — 95, Villiers-Le-Bel, **FRANCE**

19 July 1968, Volume 161, Number 3838 **SCIENCE**

The Paradox of Science in the Universities

Educational institutions are facing severe, unsettling effects as a result of changing patterns in federal funding. Many have concluded that this state of affairs is due to mounting government expenditures arising principally from the Vietnam war. The war has brought us to this confrontation earlier than might have been expected otherwise. Nonetheless it must be recognized that the pace of growth of R and D support over the past 20 years has been far greater than the rate of increase in the gross national product, a situation which could not long endure. An inevitable decline in the rate of growth of funds for science has been accentuated by heavy competition from other claimants on the national budget.

A principal difficulty is that we have arrived at this state of affairs without a clear picture of the proper role or a sound strategy for science, especially for research in the universities. Confusion and what can be called the paradox of science are resulting. We view modern science as one of mankind's most remarkable intellectual attainments. We recognize its contributions to economic growth, national security, health, and general well-being. At the same time, we are bombarded with questions and statements such as: "Is science misshaping our world?" "There is danger in growing technology." "Science, the pursuit of truth, is in serious trouble."

This paradox and the present pattern of government funding of science have come about as a result of many different, and often independent, decisions, not as the intended result of coordinated planning. Mission-oriented agencies needed research support and wanted to maintain contacts with academic laboratories. Funds for education were justified on defense grounds. Fellowship programs were designed to help meet national shortages. We have benefited from a multiplicity of programs, but we have not established priorities or paid sufficient attention to the best means of achieving our primary goals.

It is no longer adequate to ask support for basic research largely on faith. In these troubled times, the less friendly members of Congress look at many types of basic research with suspicion. There is real danger of overreaction. Accordingly we must seek a clearer understanding of the role of basic research as it relates to our present and future priorities.

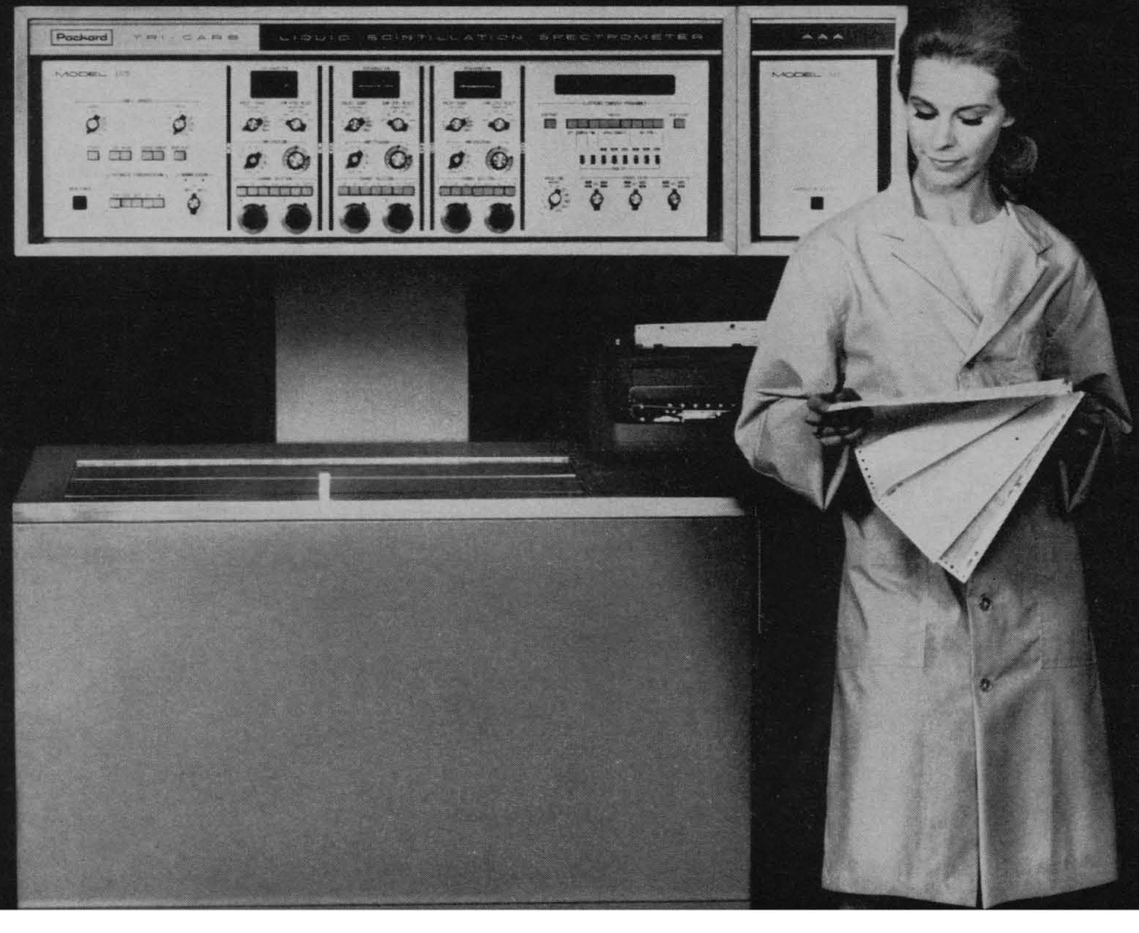
In making such an assessment one has little difficulty in recognizing that the acquisition of new knowledge is only one of the values of basic research. It also makes important contributions to teaching and especially to the development of trained scientific manpower. Here the needs are great indeed for burgeoning education programs; for public sector programs in health, transportation, environmental control, and many others; and for the maintenance of a strong and viable industrial community, without which there would be no support for any of these activities.

Does this not suggest a need for change in viewpoint as well as in emphasis on the role of research in our educational institutions? The oft-repeated question of recent months, "What is going to happen to my research program?" has not stirred the Congress and is addressed to only one of the values of basic science. On the other hand, it is doubtful if even the most hostile members of Congress would quarrel with the real purposes of education, question our enormous requirements for trained scientific manpower, or argue that research is not essential to the education of future scientists. Is the academic world thinking as well as telling the Congress the right things?—MILTON HARRIS, *Chairman of the Board of Directors, American Chemical Society*, and DAEL WOLFLE

New Model 3380
Tri-Carb® Liquid Scintillation Spectrometer... it's the only one with all the answers!

The *right* answers: absolute sample activities computed automatically with a precision impossible to achieve either manually or with any other on-line or off-line computer. ■ The secret is in our new Absolute Activity Analyzer. With it, the Model 3380 Tri-Carb Spectrometer gives you the right answers regardless of the type or degree of sample quenching . . . whether samples are single or double-labeled. ■ Counting conditions are optimized automatically for each sample, and background is held constant for *all* degrees of quenching. Of course, counting performance—whether in terms of E^2/B, tritium efficiency or isotope separation—is unequalled. Call your Packard Sales Engineer for complete details, or write for Bulletin 1057U to Packard Instrument Company, Inc., 2200 Warrenville Road, Downers Grove, Illinois 60515; Packard Instrument International S.A., Talstrasse 39, 8001 Zurich, Switzerland.

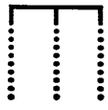
Packard



In hope of doing each other some good

Peanut sprouting

Oil-bearing seeds store energy as fat. To release the energy for the seedling, enzymes must first split off the fatty acid chains from the supporting glyceryl structure.



Those fat-splitting enzymes, the lipases, are a big subject. Many a biochemist devotes his days to detecting, identifying, or measuring lipases.

In recent years we have been able to help a bit by making Fluorescein Dibutyrate for them as EASTMAN 8965. The lipases split it as though it were a real fat. Its fluorescein moiety plays no physically supporting role, as does the glyceryl structure in a seed or in a man's adipose tissue, but serves by fluorescing when set free of its two butyryl radicals and thus signals to the biochemist that a lipase is at work.

Last year T. J. Jacks and H. W. Kircher at the Seed Protein Pioneering Research Laboratory of the U. S. Department of Agriculture in New Orleans reported that the biochemist could get much more lipase sensitivity with a brighter phosphor than fluorescein, namely 4-methylumbelliferone which, without that unmellifluous name, may at one time have been plugged by laundry-detergent makers on their operas as "brightener." It split best from fatty acid chains six to nine carbons long.

The report in *Analytical Biochemistry, 21,* 279 (1967) caught the eye of an M.D. chemist who thinks that there would be much wider use of serum lipase level of the blood and urine as an indicator of pancreatitis if the tests for it were faster and more sensitive. So he wrote to us.

Before Fluorescein Dibutyrate came in, the usual procedure took up to 24 hours of incubation. To our correspondent, what the seed protein people had found looked like a comparable gain over Fluorescein Dibutyrate. He asked us to make him some 4-Methylumbelliferone Butyrate, and we have. Before and after and whether or not he sheds his anonymity by making known his findings on how well it works, other investigators who order it as EASTMAN 10462 can check it out for themselves if it is important to them.

From **B & A / CURTIN / FISHER / HOWE & FRENCH / NORTH-STRONG / SARGENT / VAN WATERS & ROGERS / WALKER / WILL**—*well-known laboratory suppliers all.* EASTMAN *Organic Chemicals List No. 44 and its Cumulative Supplement 44-4 are sent on request by Distillation Products Industries, Rochester, N.Y. 14603.* EASTMAN *10462 is too new to be found therein.*

7,000 persons of influence

In hope of doing each other some good on a cold, rain-swept morning at Atlantic City in March, we in company with two other equally well known technology corporations entertained 7,000 of the most influential people in the country, all wearing convention badges of the Association for Supervision and Curriculum Development. This pallid appellation identifies professionals who tell teachers what to teach and how. The parents dutifully send the kids to school, trusting that these people will know why.

The three of us put on a big multimedia show for them. Not the least of the media was the art of the dance: competent teeny-bopping by youthful personnel from Atlantic City High School helped convey the message that the li'l red schoolhouse had been knocked down by a bulldozer and is not about to be rebuilt, not even in spirit.

To our guests this was hardly news. They understand our position. They can see that we, too, want to be influential in a large way but have only technology —in which we have placed all our faith —to win us a sense of participation.

A tour of the exhibits at the convention was reassuring. Photography, the technology in which we happen to specialize, need no longer plead hard. It is accepted. It shows the child the great and real world direct, not just the way the teacher sees the world. The machinery which this technology brings into the schoolhouse now gets less in the way also, having been recently shrunk physically. On exactly how to use the film image, our powerful friends have not yet endorsed any one line of sales talk. Standardization seems far off. Bless them.

Seeing it if it's there

X-rays were announced in 1895. Alarm arose lest x-ray machines be carried into theaters for indecent purposes. As things turned out, this problem never came up. Instead, aside from the medical and dental benefits, x-rays made it safe to ride in large groups at high speed across the sky in huge metal vehicles. This came about because, while x-rays proved impractical for penetrating garments and stopping at the skin, they proved extremely practical for finding small but sometimes sinister discontinuities inside metal.

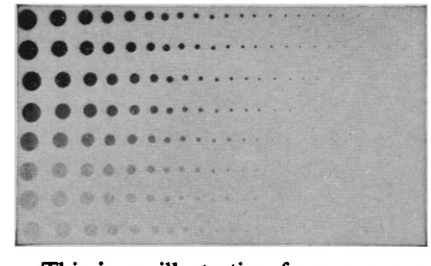
Kodak

The novelty has worn off x-rays (though some recent Nobel honors were won with them). The men who radiograph airframes and other structures for soundness go about their beneficent work with little notice. It is easy to forget about their craft and turn to newer, perhaps more elaborate, and perhaps less sensitive methods when facing a need to seek small discontinuities nondestructively inside metal or other light-opaque substances.

Just how sensitive can radiography be made to how small a discontinuity?

X-ray quanta are big. Therefore it takes fewer of them to expose film. Therefore the statistics are important. Entirely aside from other factors, the fewer the quanta the coarser the image structure and the larger a discontinuity must be for detection. But other factors indeed there are. The same radiation that casts the desired shadow picture also excites an invisible glow in the whole body that is all too visible to the film.

Enough complication is thereby introduced to make the problem interesting but not hopeless. Further complications crop up in the human visual apparatus around the relationship between contrast and image size for threshold visibility, viz.:



This is an illustration from a paper in which H. R. Splettstosser of the Kodak Research Laboratories describes reasoning and experiments to determine how long you must expose to earn a given probability of seeing something as small as a given size if it's there. If you have such a problem and you do the experiments with the various types of KODAK Industrial X-ray Film and your results beat his results, be suspicious.

For a copy of "The Visibility of Detail Obtainable with Industrial X-ray Film," write Eastman Kodak Company, Dept. 740, Rochester, N.Y. 14650.

EASTMAN KODAK COMPANY

An equal-opportunity employer

AAAS Socio-Psychological Prize

Through the generosity of the late Arthur F. Bentley the AAAS offers an annual prize of $1000 for a theoretical and experimental essay that furthers understanding of the psychological-social-cultural behavior of human beings. The prize is intended to encourage studies and analyses of social behavior based on explicitly stated assumptions or postulates leading to conclusions or deductions that are tested by systematic empirical research; or, stated in other terms, to encourage in social inquiry the development and application of the kind of dependable methodology that has proved so fruitful in the natural sciences.

Entries should present a completed analysis of a problem, the relevant data, and an interpretation of the data in terms of the postulates with which the study began. Unpublished manuscripts and manuscripts published after 1 January 1967 are eligible. *The deadline for receipt of entries in the 1968 contest is 1 September.* For instructions on how to submit an entry, write to Socio-Psychological Prize Contest, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.

NASA Bioscience Experiment Survey

The National Aeronautics and Space Administration is conducting a survey of potential biological experiments to evaluate the need for and to aid in establishing more definite plans for future bioscience flight experiment programs. Planning is now beginning for future flights of follow-on biosatellites, major bioscience experiment payloads for Apollo applications missions, and flights of opportunity on manned or unmanned missions. Those interested in developing experiments for future Earth-orbital flights are requested to submit their formal proposals by *1 October 1968*. A description of the current biosatellite spacecraft and the AAP components, as well as information concerning proposal format, preparation, and submission procedures, is shown in NHB 8030.-1A, "Opportunities for Participation in Space Flight Investigations." This handbook is available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Fellowships

The medical section of the National Tuberculosis and Respiratory Disease Association, American Thoracic Society, offers fellowships for training in the field of the respiratory system and its disorders.

Training Fellowships: (i) Physicians entering the 2nd or 3rd year of residency in internal medicine, pediatrics, thoracic surgery, or other specialty; (ii) holders of doctoral degrees interested in advanced work in this field; (iii) graduate students with a bachelor's or master's degree who are to work on a research project in this field for an advanced degree other than an M.D.

Edward Livingston Trudeau Fellowships: A few fellowships are offered to physicians who have completed their formal training in respiratory diseases and are now ready to assume responsibility for medical school programs in this field of medicine. They must be assured of a teaching or research faculty appointment during the fellowship year.

Each applicant for an NTRDA–ATS fellowship must have been accepted by the head of the department under whom he expects to work during his fellowship. Fellowships usually begin on 1 July. Training fellowships are renewable for a total of 3 years; Trudeau fellowships, for 4 years.

All applicants must be submitted by 1 November. (American Thoracic Society, Director of Medical Education, 1740 Broadway, New York 10019)

Courses

Neutron Activation Analysis—"Atomic Fingerprinting," Oak Ridge, Tenn., 12–30 August. This course will cover methods of identifying submicroscopic quantities of materials by analyzing their radiation spectra after they have been made artificially radioactive by bombardment with neutrons. Is designed for those with at least a bachelor of science degree and a general background in isotope techniques. (Special Training Division, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge 37830)

IR, GC, and UV-F-AA, .Nashville, Tenn., 19–30 August. *Gas-Liquid Chromatography* (basic theory and techniques) and *Infrared Spectroscopy* (basic theory and techniques), 19–23 August. *Interpretation of Infrared Spectra* and *Ultraviolet, Fluorescence, and Atomic Absorption Spectroscopy*, 26–30 August. The lectures of the two-course programs held during the same week are so arranged that persons enrolled in either course, may, if they so desire, audit the lectures of the other course without extra charge. Fee: $150 per course plus $10 registration fee. Enrollment is limited to 50 participants in each course. Scholarship aid is available. (Institute Director, Box 8, Fisk University, Nashville 37203)

Current Trends in Automatic Control Theory, St. Louis, Mo., 19–24 August. The course will begin with an introduction to the foundations of linear control theory. This will be followed by a discussion of developments in the approach to control system theory through algebraic methods. Lectures on topics in the qualitative theory of differential equations and operator theoretic methods will treat the problems of nonlinear systems, including developments on stability theory, from both differential equation and functional analysis viewpoints. The numerical solution of optimal control problems will be discussed in detail. *Deadline for applications: 12 August.* Fee: $295. Is intended for electrical, mechanical, aerospace, and chemical engineers, and other working in the fields of systems, aerospace control and guidance, process control, manufacturing and service control. (Dr. G. L. Esterson, Box 1048, Washington University, St. Louis 63130)