SCIENCE

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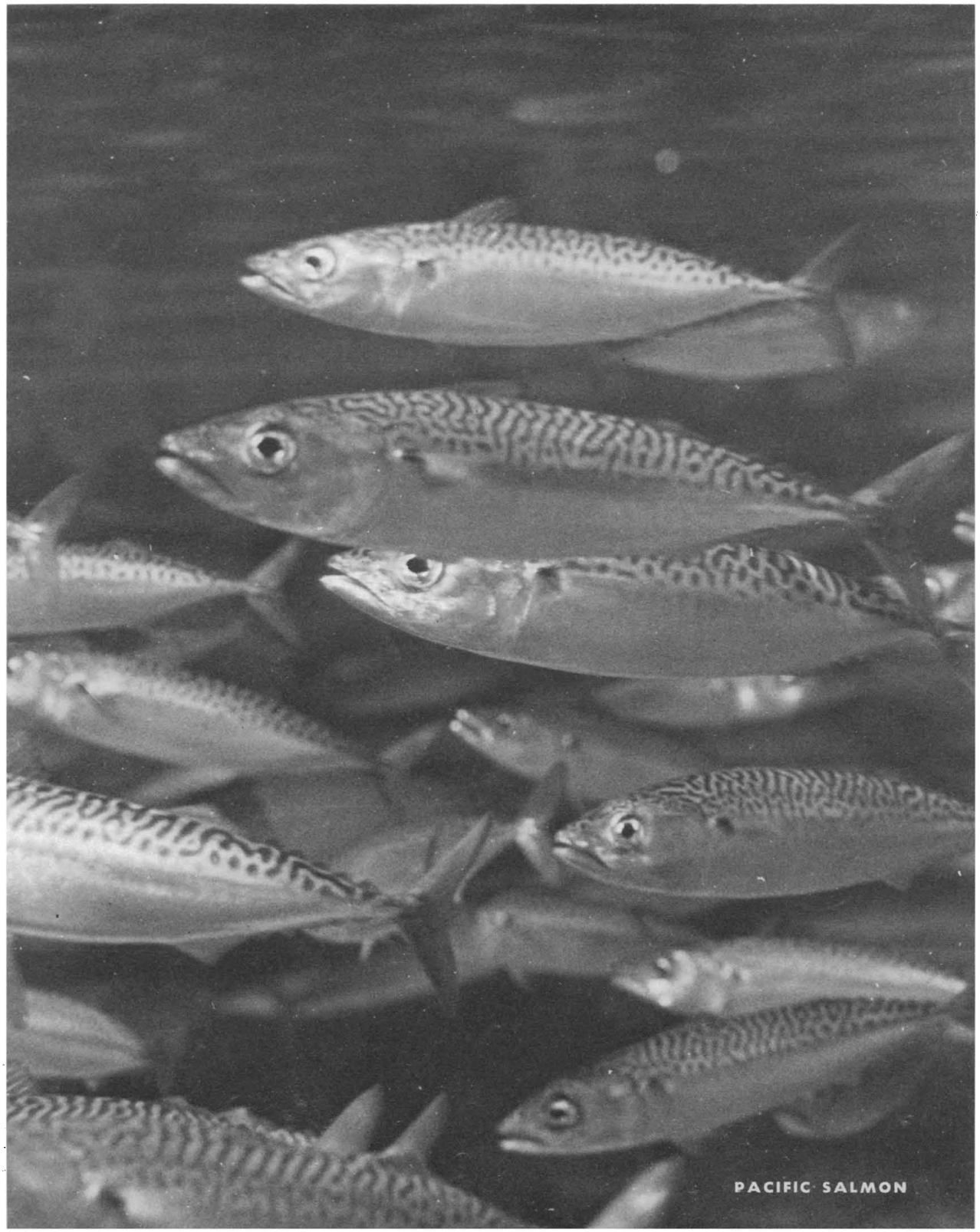
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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Sharper separations are just one of the many advantages you enjoy with new Sartorius electrophoresis strips. Faster separations are another. Made of pure cellulose acetate and available in all popular sizes, these strips assure distinct, clearly differentiated bands. Their homogenous, sponge-like structure does not retard molecular migration, and there is virtually no adsorption of protein.

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sartorius acetate strips

13 September 1968
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SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Fish reared at the Bureau of Commercial Fisheries Laboratory at La Jolla, California. Mackerel were hatched on 20 May 1966 and had grown in 6 months to 80 millimeters in length. See page 1098. [George Mattson Bureau of Commercial Fisheries, La Jolla, California]

If you're in physical or occupational therapy, you can step up to a great career in the Army.

The coupon across the page could make a big difference in your plans.

It's the fast way to find out about rewarding Army opportunities in physical and occupational therapy, both short-term and long-term.

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The physical therapy program for college graduates.
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Department of the Army
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Please send me full details on my opportunities in the Army Medical Specialist Corps.

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☐ I am a qualified physical therapist.

☐ I am a qualified occupational therapist.

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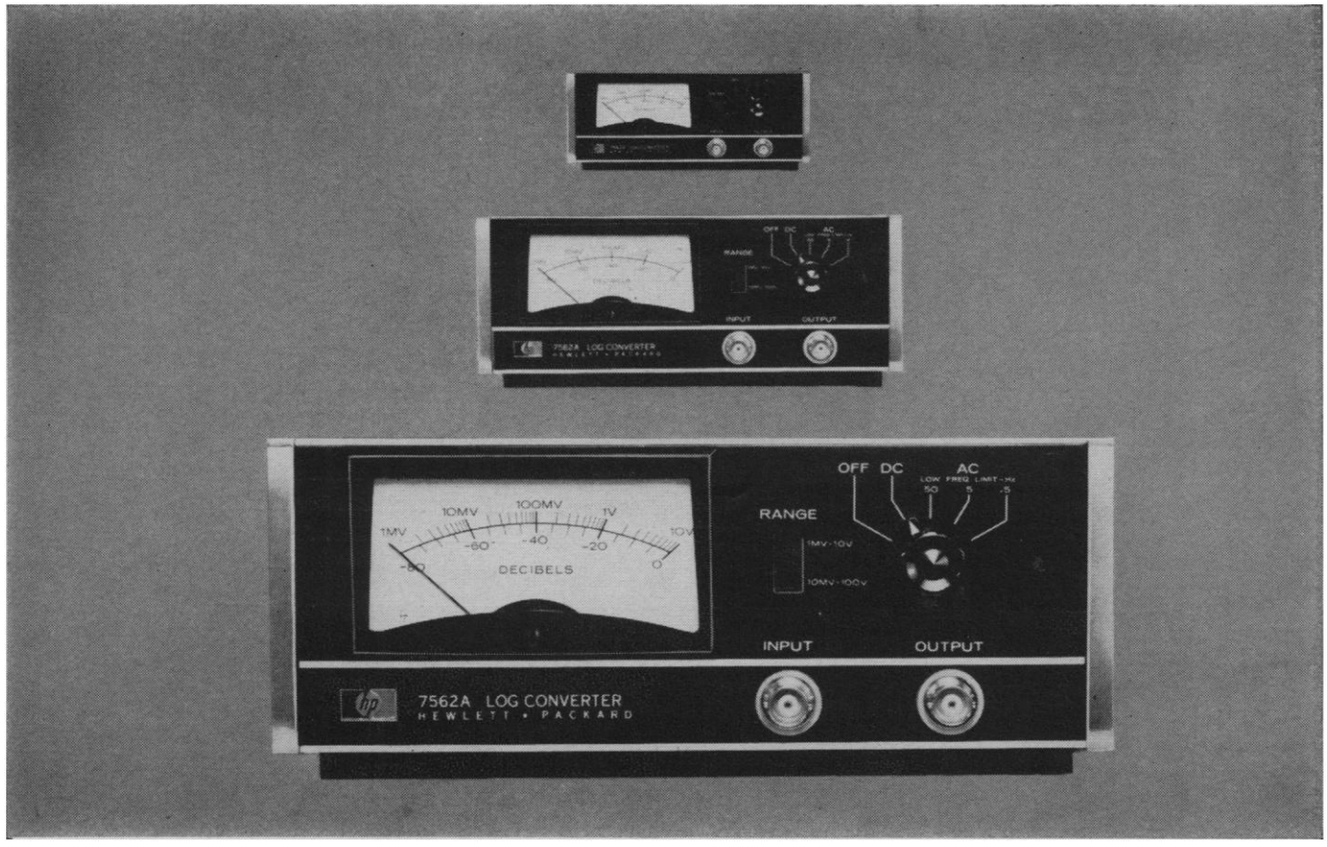

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You get more with the Hewlett-Packard 7562A Logarithmic Converter than with any other instrument of its kind. It provides DC logarithmic voltage output from AC or DC input signals, with 80 dB dynamic range, true RMS detection for increased accuracy and unprecedented 0.5 Hz to 100 kHz frequency coverage, in three ranges. Two input voltage ranges 1 mv-10 V or 10 mv-100 V. Fast response to 2 μs DC rise time and 60 dB/sec AC slewing speed.

The 7562A is ideal for a wide range of demanding applications such as gain-frequency plotting with X-Y recorders, vibration analysis and semi-log or log-log plotting. Reliability is assured with rugged, compact, solid-state construction (including use of IC's). Use with scopes, X-Y and strip-chart recorders. A perfect companion for the new HP 3305A Logarithmic Sweep Oscillator. Price: $995.

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In hope of doing each other some good

Kodak

Great little saleslady

Wilma F. Kujawski had had much to do with making vitamin E a big thing and putting us in the middle of it as a bulk producer of the vitamin for pharmaceutical houses and for making animal agriculture more efficient. She has proved what a good research librarian can do for an employer.

Her just-published *Annotated Bibliography of Vitamin E, Volume VII* covers all the 1500 publications on the subject that she has been able to find in the world's scientific literature for '65, '66, and '67. In this, as in the preceding volumes by which she extended the record back to 1940, the goal has been to cover all published work, whether favorable or unfavorable to our commercial cause. Otherwise Miss Kujawski's endeavors would have been in vain.

This world-recognized authority on the literature of vitamin E receives her mail at Distillation Products Industries, Rochester, N.Y. 14603 (Division of Eastman Kodak Company).

Emulsion omitted

Cellulose nitrate or cellulose acetate quite devoid of photographic emulsion can record tracks of decelerating ions above a certain energy loss rate threshold. This selectivity and an insensitivity to photons— to γ-radiation or light that would utterly obliterate a silver halide image— have stirred action lately among those interested in α-particle autoradiography, cosmic-ray studies, neutron radiography, and neutron dosimetry. (Fast neutrons by knock-on proton tracks, thermal neutrons by the aid of fissile material over the cellulosic sheet.) A multitude of tracks scatters specular light and acts in a photographic enlarger like a density.

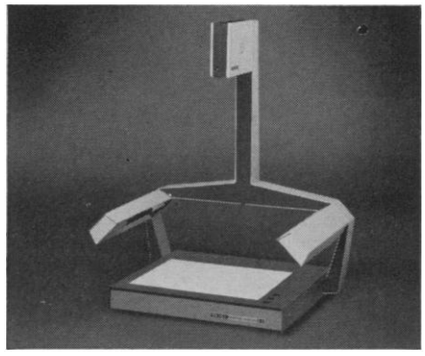
Passage of a charged particle does something to the polymer that opens it to attack by strong alkali, something apparently akin to what happens in mica and other minerals to permit reagents to develop particle tracks left as fossils from Earth's youth. Cellulose nitrate works better than cellulose acetate, but we rid ourselves of the dangerous stuff years ago and don't like it. Yielding to this new track trade, we now offer a 10μ coating of cellulose nitrate on ESTAR Base.*

This product has been acclaimed as the best thing around by those who need it. We foresee its early obsolescence. The replacement could conceivably come out of the work of an earnest acquaintance of ours. He has undertaken a chemical investigation of just what the charged particle *does* do to the polymer. We have sent him free samples of some of the cellulose acetate formulations and sheetings that we find hard to take seriously in less than skid-load quantities. We have outlined their composition and wished him luck.† This we have done with our right hand while the left hand works on a few ideas of our own concerning those particle tracks.

*KODAK Special Film, Type 106-01. The thinness of the coating, the paucity and prudence of customers interested in particle tracks, and a minimum-order requirement of several hundred dollars all combine to keep risk tolerable. Direct inquiries to E. J. Hahn, Mail Code 916, Eastman Kodak Company, Rochester, N.Y. 14650.

†Others as well qualified who want equal treatment might try addressing themselves to W. J. Seaman, Eastman Chemical Products, Inc., Kingsport, Tenn. 37662 (Subsidiary of Eastman Kodak Company).

STARFILE Microfilmer



Not only starkly dramatic in appearance but also microfilms documents up to 11½" x 15" on 16mm film. This general-purpose type preferred for highest quality results. Now redesigned and simplified for use on site. Man who can talk price and optional features glad to call. Signify interest to Eastman Kodak Company, Business Systems Markets Division, Rochester, N.Y. 14650.

Strike forth water

Three cheers for the U.S. Geological Survey and one cheer more for its Water Resources Division!

More acclaim than commonly bestowed is deserved by those who labor under interdisciplinary yoke to strike forth restorative waters from beneath parched land. In hope both of the general welfare and of a more specific welfare for those of us who deal in photographic goods and services do we point to the Survey's recent work with aerial color photography. The sense of it:

1) High aloft, cameras record the patterns in the big picture.

2) Down on the ground the elements of the patterns that differ in color are studied—why they differ, why they differ between simulatory color systems and systems which purposely distort color rendition in a way to extend man's color sense into the infrared.

3) Often as not, the differences turn out to be botanical.

4) Plant species distribute themselves to reflect their different adaptation to moisture, salinity, and geochemical conditions. Even species set out by the hand of man can exhibit subtle differences in vigor so caused and perceptible only from aloft, as patterns.

5) Hydrologists interpret the patterns to advise where and how to strike.

A hydrologist who has written on this work and might be tempted into correspondence is William J. Schneider, U.S. Geological Survey, Washington, D.C. 20242.

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Not so long ago a highly respected organization in Amersham, England, joined with a leading U.S. pharmaceutical firm to create a new radiochemical company.

And they used your specifications.

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The first was the international character of their equal partnership in Amersham/Searle.

The second was the way they worked to a set of specifications, written (in a sense) by radiochemical users themselves.

Here then are those specifications and how they are fulfilled by Amersham/Searle Corporation:

1

Product availability. Of prime concern when you're talking labelled compounds. Amersham/Searle promises the maximum variety of products. And variety means a host of labelled compounds (C-14, H-3, P-32, S-35) at a range of specific activities, plus standards, reference sources, radionuclides, and industrial radiation sources. All available *now* from Amersham/Searle.

2

A level of performance. Amersham/Searle Corporation is the successor to the Special Products and Radiochemical Divisions of Nuclear-Chicago Corporation. So Amersham/Searle immediately began operations on a level of proved performance already established by these divisions. But Amersham/Searle goes beyond that established high level. For proof of which, read on.

3

A range of resources. It's not enough to be a manufacturer and supplier of labelled compounds *et al.* Your world of radiochemicals is wider. And so is Amersham/Searle's. We draw on the resources of G.D. Searle & Co., who are actively engaged in pharmaceutical research, especially steroids. And the technological resource that is The Radiochemical Centre, Amersham, (operated by the United Kingdom Atomic Energy Authority) has no peer.

4

A reputation for delivery. You want a minimum time differential between the placement of your order and its receipt. You'll get that from us. We're set up for rapid order processing. And we're less than a mile from O'Hare International Airport. Wherever you are, we try to make the miles meaningless.

5

An outlook attuned to you and your work. This final and most vital of all specifications can be fulfilled only by the radiochemical company that's fulfilled all the preceding ones. Only a company with the products, the performance, the resources, and the reputation for delivery can be the one that sees things the way you do.

Call us. Write us. Ask us. About radiochemicals, radiopharmaceuticals, radioactivity standards, supplies and accessories, and radiation sources. Discover that Amersham/Searle is all you could ask for — because it's the company you asked for. 8-213

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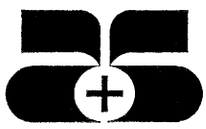

Amersham/Searle

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AN ACTIVITY OF G. D. SEARLE & CO. AND THE RADIOCHEMICAL CENTRE

On the bench or on the rack or on the go, Honeywell Lab/Test Recorders go where you want them to.

They have the features and functions you need whether your application be chromatography, spectroscopy, thermal analysis, electronic circuit testing, machine testing or physical property measurements.

One's the portable *ElectroniK 193*, the other the wide-chart *ElectroniK 194*.

The smaller has a six-inch chart, the larger a ten-inch chart. Both offer you one- or two-pen models, multi-range or single-span options.

"Zero" is at the right. The final record can be viewed with time increasing from left to right along the abscissa, and the measured variable increasing from bottom to top.

Chart platens tilt out to give you a writing surface. Charts automatically reroll or—for bench analysis—drive out beneath the front bar.

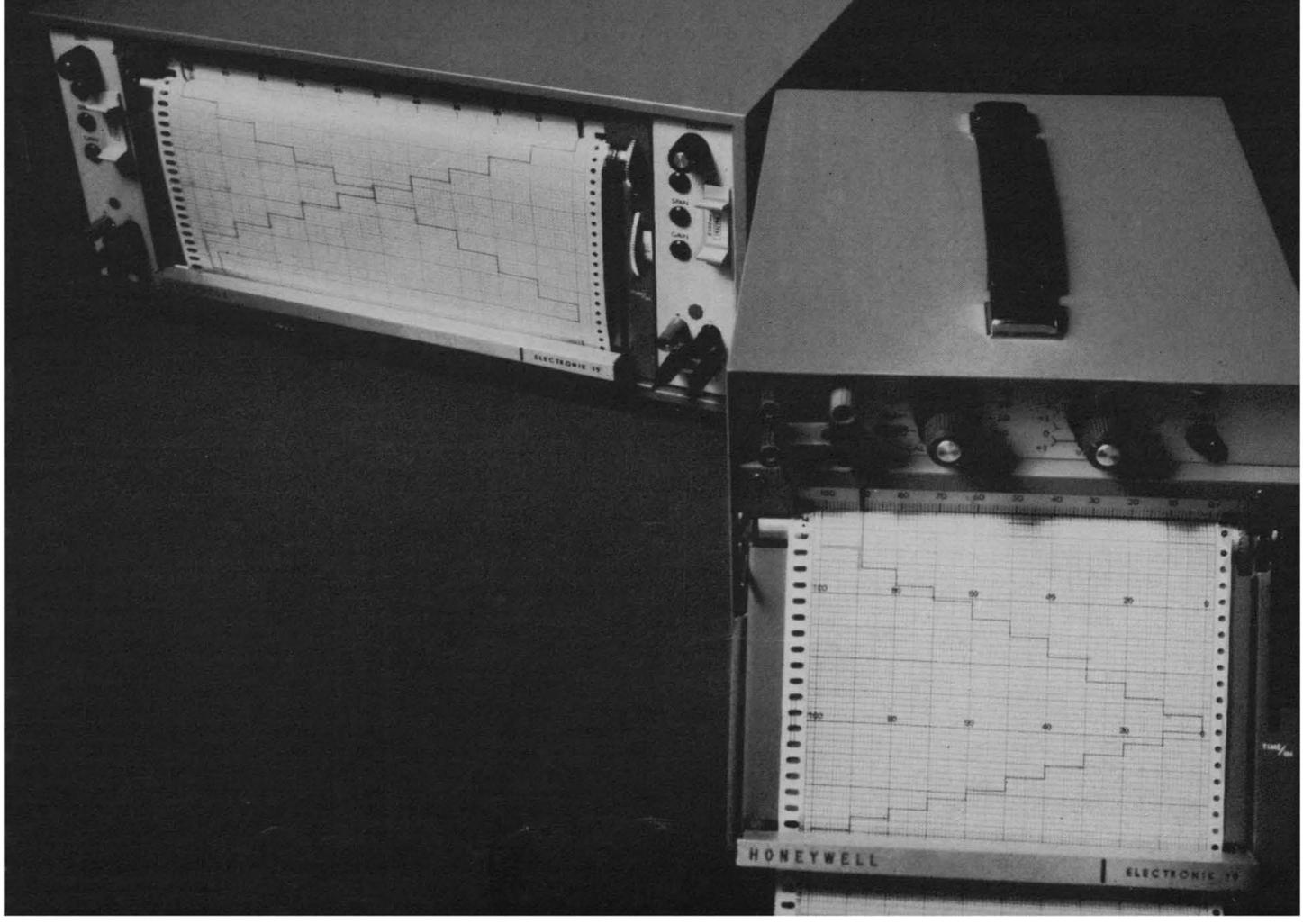
Honeywell's "193" weighs less than 20 pounds with one pen, less than 29 with two. One "194" requires only seven inches of vertical space in a 19-inch relay rack. The bench model "194" is so strong you can stack 300 pounds of lab equipment on top of it.

With both you can get interchangeable plug-in span cards for single-range operation from 500 microvolts full span to 100 volts full span. Multi-range models offer ranges from 100 microvolts full span to 100 volts full span.

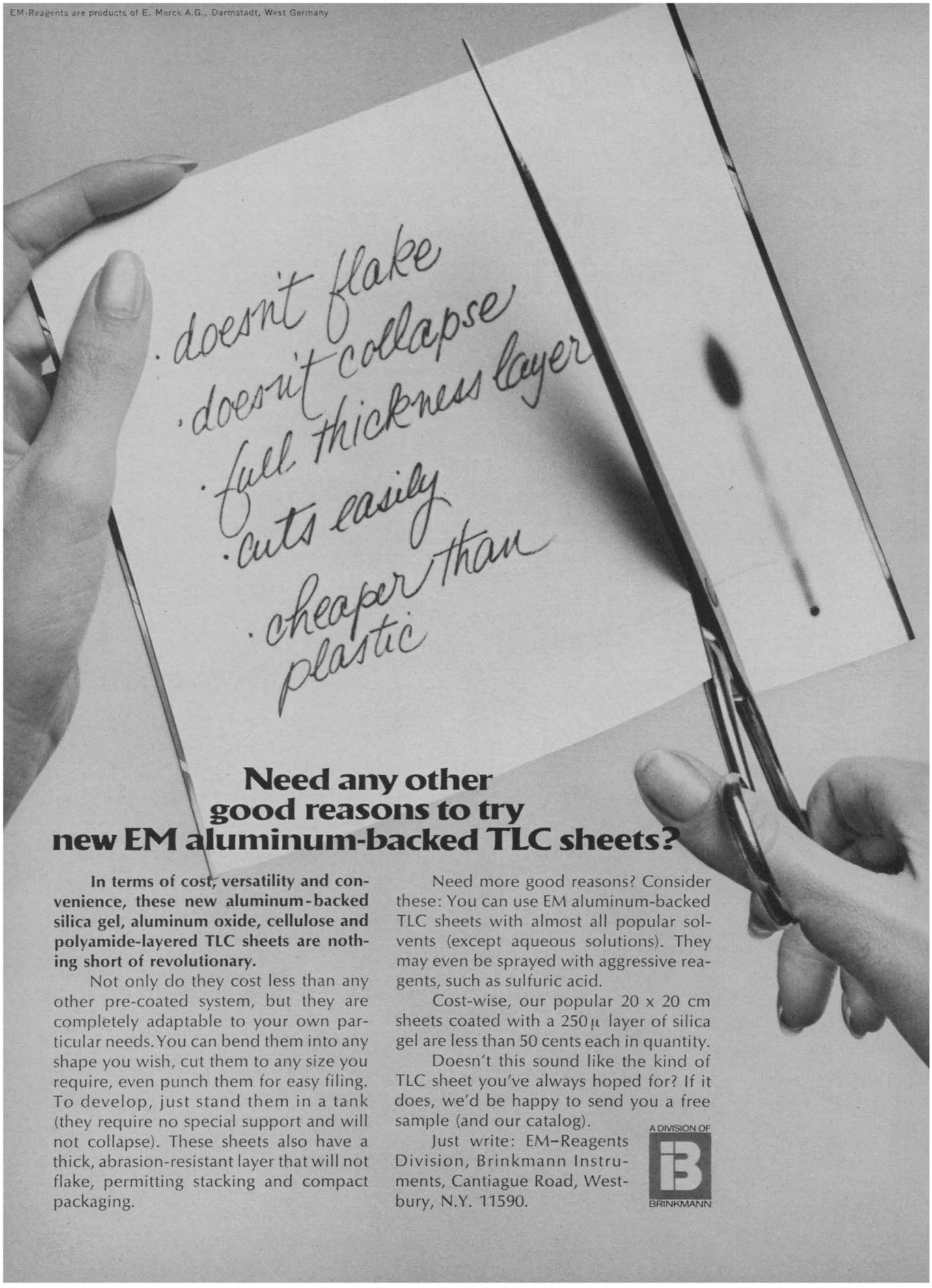
The power requirement for all models is 110-130 volts, 60 Hz. You can also get an option to operate from 50 Hz power at 120, 220, or 240 volts.

To learn more about recording better, write for sheets 193-3a, 194-1a and 194-2a to Honeywell Inc., Industrial Division, Mail Station 440-E, Fort Washington, Pa. 19034.

Honeywell
AUTOMATION



EM-Reagents are products of E. Merck A.G., Darmstadt, West Germany



Need any other good reasons to try new EM aluminum-backed TLC sheets?

In terms of cost, versatility and convenience, these new aluminum-backed silica gel, aluminum oxide, cellulose and polyamide-layered TLC sheets are nothing short of revolutionary.

Not only do they cost less than any other pre-coated system, but they are completely adaptable to your own particular needs. You can bend them into any shape you wish, cut them to any size you require, even punch them for easy filing. To develop, just stand them in a tank (they require no special support and will not collapse). These sheets also have a thick, abrasion-resistant layer that will not flake, permitting stacking and compact packaging.

Need more good reasons? Consider these: You can use EM aluminum-backed TLC sheets with almost all popular solvents (except aqueous solutions). They may even be sprayed with aggressive reagents, such as sulfuric acid.

Cost-wise, our popular 20 x 20 cm sheets coated with a 250 μ layer of silica gel are less than 50 cents each in quantity.

Doesn't this sound like the kind of TLC sheet you've always hoped for? If it does, we'd be happy to send you a free sample (and our catalog).

Just write: EM–Reagents Division, Brinkmann Instruments, Cantiague Road, Westbury, N.Y. 11590.

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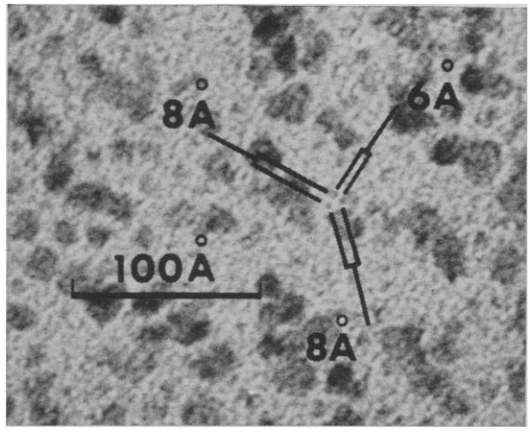
The new Model HS-8: The most electron microscope for your money.

If you need a high-performance instrument, the new Hitachi Perkin-Elmer Model HS-8 is for you. Its guaranteed resolution is 8 Angstroms, and it costs under $30,000.



Evaporated gold specimen shows a point-to-point resolution of 6 to 8 A. Magnification is 2,500,000X.

Here's an instrument that's so easy to align, so easy to use, so compact and reliable, that it far surpasses all other instruments in its price class. It offers high resolution and automatic operation.

Features you've been wishing for

The Hitachi Perkin-Elmer HS-8 is the only instrument in its price range that gives you two accelerating voltages—25 KV for high contrast and 50 KV for general purpose use—at the touch of a button.

It's the only instrument in its class that has a double condenser lens. The double condenser and objective-intermediate lenses are unitized and pre-aligned.

The HS-8 gives you 20 precalibrated steps of magnification with direct console readout —1000X to 100,000X direct . . . over 1,000,000 photographically. A special, small, fine-grain screen makes focusing easy.

The HS-8 has a new pushbutton vacuum system that practically eliminates specimen contamination. It uses a new non-backstreaming pump oil and a new built in anti-contamination device that traps contamination before it reaches the specimen.

The camera system is also pushbutton. Correct exposure is automatic. You get a pre-pump chamber that can keep 54 photo plates under vacuum, ready for use.

We'd like you to know more about this fine new microscope. In its price range, you won't find an instrument with more consistent high performance or more of the outstanding features you would expect only in high-priced electron microscopes. Write to: Perkin-Elmer Corporation, Ultek Division, San Antonio Road, Mountain View, Calif. 94303.

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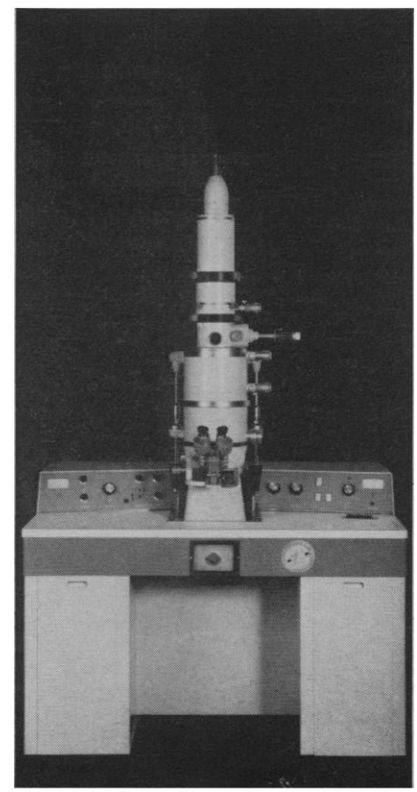


This instrument is instantly available to you under Perkin-Elmer's low cost lease plan.

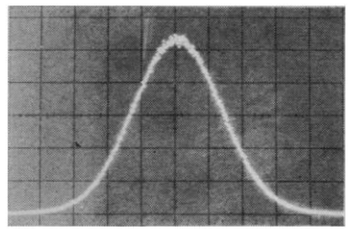
Tame complex scientific data... produce useful information directly

How to See Through 1000 Windows at a Time

Since the early days of the Manhattan Project, the study of nuclear phenomena has been on a steep rise. Not surprisingly, this started a train of responses by the instrumentation industry to answer the need of research scientists for analytical data about radiation. Of most service have been instruments to measure the gamma radiation that originates in the unstable nuclei of radioactive isotopes as they decay to stable states.

It's not really difficult, with today's more sophisticated electronic instrumentation to measure accurately the energy of a discrete gamma ray and the time of its occurrence. But that's only a small part of the information that the nuclear scientist needs to know. Usually the radiation 'signature' that identifies a material consists of a variety of gamma rays at characteristic energy levels, and it's precisely the knowledge of this *variety*—or spectrum—that interests the scientist.

Initially the nuclear scientist measured the gamma spectrum by looking at voltage pulses derived from the overall radiation through a series of energy "windows", one window at a time. He built the "frame" for each window using a high and a low voltage discriminator, each with adjustable threshold, thus being able to look only at pulses whose peak value fell between the two levels. Since an adequate measure of the gamma spectrum may require that the scientist look at it through more than a thousand different windows, this one-at-a-time procedure is often inadequate. Not only is it laborious, it is also so slow as to be useless where the decay rate (half-life) is very short.



Probability density display of Gaussian noise

Enter the multichannel analyzer (MCA), newest of which is the H-P 5400A. The MCA looks at gamma radiation through as many as 1024 windows, *simultaneously* sorting the pulses into as many amplitude groups. It counts and totalizes the pulses in each group and stores the results in memory for live or static display on the built-in cathode ray tube, for readout on a paper record or for input to a computer.

Speed, the essential characteristic of an MCA, reaches its peak in the 5400A. Employing a new analog-to-digital converter with a clock rate of 100 MHz, the 5400A sorts and digitizes input signals into one of 1024 categories in no more than 13 microseconds.

In its present state of refinement, the 5400A MCA has not only met the nuclear scientist's need for a gamma spectrum analyzer, but has also attracted the attention of analytical scientists in other disciplines. Biochemists for example have used it as a multichannel scaler to accumulate time/rate curves of activity for uptake/clearance studies in nuclear medicine. Design engineers have performed probability density analysis of continuous input signals with the 5400A to isolate signal and noise characteristics. Other solutions of complex measurement problems are described in the March 1968 issue of the *Hewlett-Packard Journal*, yours on request.

Designing for the Electronics-Shy Analyst

Natural strangers to the complex world of electronics, chemists and other analysts have long since been trapped in it because of their seemingly insatiable appetite for analytical instruments that are essentially electronic creations. Both readily admit the impossibility of doing their analytical work at today's speed and accuracy standards without electronics. But upon introspection they also acknowledge a deep yearning somehow to exclude the whole complicated world of transistors, diodes and integrated circuits from their laboratories.

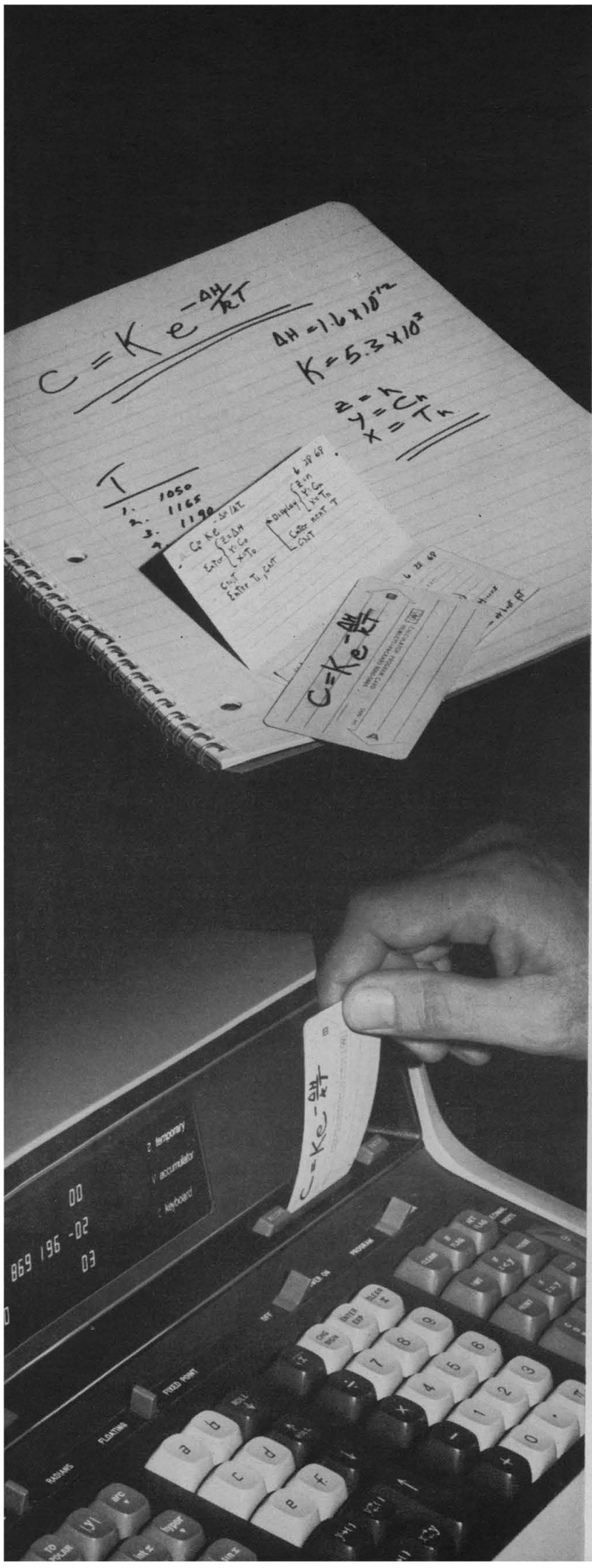
Yet exactly the reverse is happening: as the scientist uses more and more instruments in his quest for analytical speed, he produces greater and greater quantities of analog chart recordings, each of which he must laboriously interpret if he is to decode its analytical message. Bogged down in this task, the analyst once again has had to turn to the electronic designer . . . this time for a device which automatically interprets the *analog* output of such analytical instruments as the ubiquitous gas chromatograph, and translates it into *digital* data, the stuff of which quantitative analysis is made.

The device which does this job best—the digital integrator—employs even more complex electronic circuits than does the gas chromatograph. And it requires frequent adjustments of a dozen or more programming controls, each somewhat mysterious to the electronics-shy analyst.

For many, this is the last straw. Consequently they have refused to admit into their laboratories the one electronic device that, ironically, can do more than any other to speed their analyses and simplify their routine.

Aware of this problem in human engineering, a team of H-P chemists and electronic engineers together have recently completed the design of an integrator that can be programmed for an almost unlimited variety of analytical conditions just by pushing buttons. No longer must the recalcitrant analyst make the difficult choice of plunging into the strange world of integrator programming, or living in a world bereft of the benefits of digital integrators. The H-P 3370A lets him have the best of both worlds.

For electronics-shy chemists and other scientists who want to know how this was accomplished, we offer a new Bulletin 3370A, on request.



Restoring the Balance Between Analysis and Computation

Time was when the scientist enjoyed sitting at his desk to manipulate the raw analytical data that he had accumulated while standing at the bench. Somehow complex computations with classical formulae created a pleasant interlude between creative sessions at the bench.

During the post-war period, this somewhat romantic attitude has gradually disappeared. Backed by a seemingly endless parade of new automatic instruments for analysis, the scientist has become such a prodigious producer of analytical data that the balance between his analytical and computational loads has been destroyed. One of the top technical management problems of the day is to release the scientist from the time-consuming drudgery of massive computations and return him to creative work.

Obvious solutions are not always satisfactory. The typical electronic desk calculator is simply not up to the job: many of the commonest mathematical routines of science and engineering are beyond its scope. On the other hand, the computer is often too imposing for the problem immediately at hand, too inconvenient of access or too expensive to justify, and always relatively difficult to program and use.

What is needed is a machine that combines the accessibility of the calculator and the capacity and speed of the computer. Such is the H-P 9100A computing calculator. It not only resembles but even surpasses the computer in its ability to handle very large (10^{99}) and very small (10^{-98}) numbers at the same time. In practical terms, for example, the 9100A allows the scientist to use Avogadro's number (6×10^{23}) and Planck's constant (6.6×10^{-27}) in the same computation without risk of overflowing its capacity, and without requiring the scientist to keep orders of magnitude in his head.

The 9100A also shares with the large computer the ability to solve complicated computations in fractions of a second. This stems from its ability to store as many as 196 program instructions, some of which may be decisions based on conditional branching and looping commands. But the 9100A is far easier to use than any computer because of two unique characteristics which bring it within easy reach even of the scientist who has no knowledge of computer programming techniques. First, all programming is carried out in English or common math symbols, not in special computer language. Second, even the most complex program can be stored on wallet-size magnetic cards and entered into the 9100A simply by inserting the card in a slot (as in the photo at left) and pushing a button.

As a result the 9100A can, for example, determine the straight line that best fits a set of experimentally obtained X-Y points in seconds. The scientist need only insert the appropriate program card and enter the data points on the keyboard. The 9100A then carries out the entire 'least squares fit' computation and displays the slope (m), intercept (b), and correlation coefficient (r). It will even plot the line itself when equipped with the forthcoming H-P X-Y plotter.

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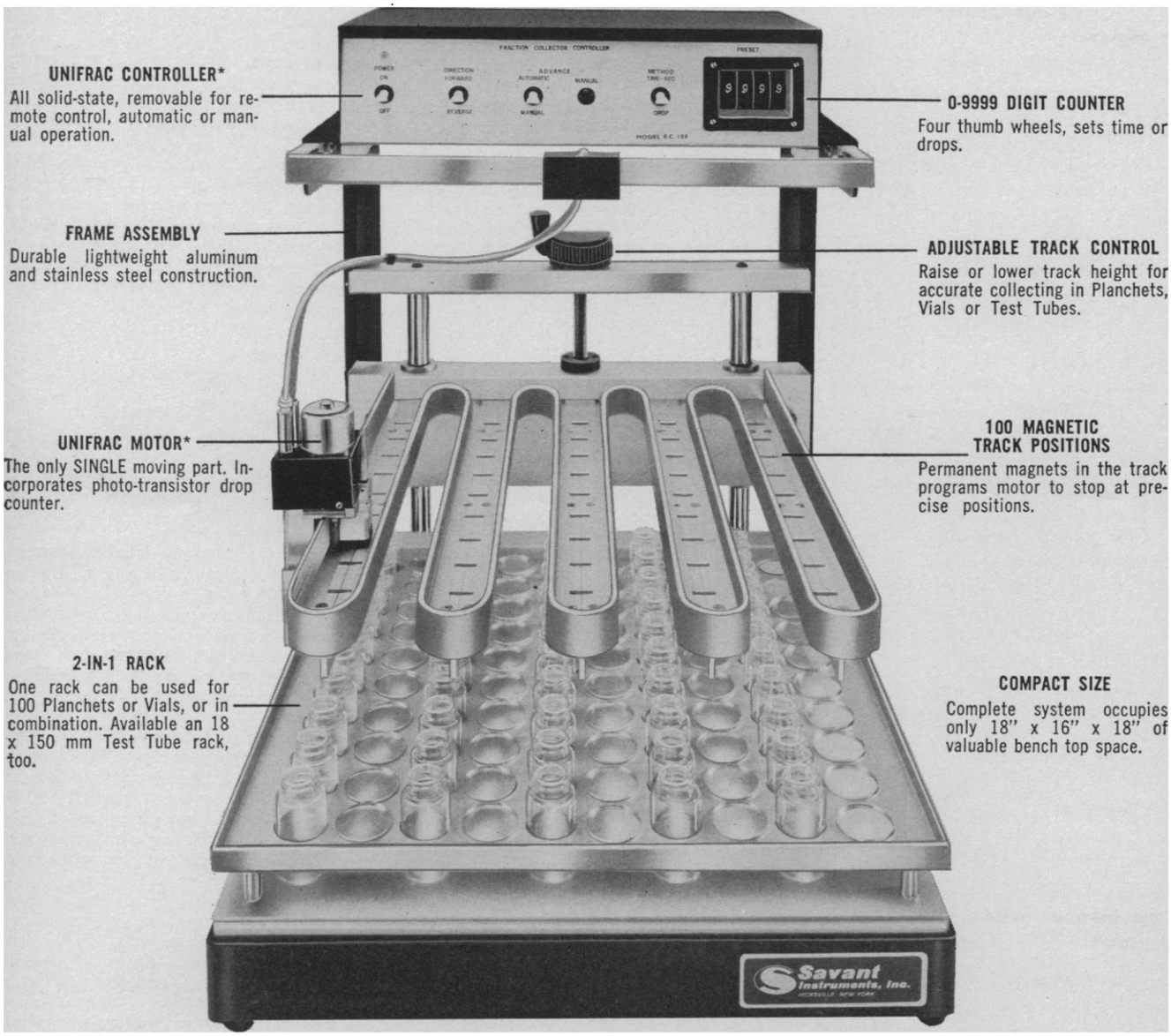

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be a misconception of the democratic principle. Ideally the responsibility of the governing majority is for the whole people. It seeks to reduce the differences in the common interest. Through use of the best possible intercommunication with the minority and the individual, it strives to dissipate tensions and win compromise, if not understanding.

Conceding a moral right to break the law would appear to be a confession of the failure of democracy. Our country has already yielded too much of the democratic ideal in the case of the "conscientious objector."

. . . But whether it is the legal exemption of the conscientious objector or the moral exemption of the self-justifying lawbreaker, the individual citizen becomes not only an independent moral authority but something of a lawmaker as well—all of which appears a bit anarchic to my mind. . . .

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It is surprising to encounter solecisms in Wolfle's editorial. Justice Fortas, whose recent essay *Concerning Dissent and Civil Disobedience* stimulated the editorial, is permitted such legerdemain: Fortas is a lawyer, and lawyers are trained to confound and to employ logic dialectically.

1) The freedom "to speak freely and protest effectively" (*ex Fortas*) is activity and entails further activities. So it makes no sense to say that exercises of First Amendment rights must be judged by the consequent actions "rather than motives or thoughts." To imagine such a disjunction between motives, thoughts, and behavior is not only to subscribe to a passé legal fiction, but also to consign science and the intelligentsia to the status of a bauble.

2) Actions which "endanger others and infringe on their rights" are of course, *ex def.*, "unlawful" if reference is to positive law. (That is not quite accurate, since official action that endangers people *is* lawful, except in cases where subsequently it is officially decided to have been unlawful.)

3) To assert next that "the [legal] consequences must be accepted" by those who disobey laws which they deem to be immoral is to beg the question altogether—the question being, under what circumstances, if any, should the law be set aside to satisfy the claims of morality? The reasoning of the edi-

torial could not distinguish Eichmann from Dr. Spock, because it values legal coercion for its own sake.

4) "The rule of law" is offered as the logical and ethical underpinning of this line of thought. To be sure, the rule of law is not a term of art among jurists. It is a political slogan which celebrates the values of compliance and due process. What it means is that disputes should be settled according to rules agreed upon in advance of the dispute, administered impersonally, and stated sufficiently precisely for people to be able to anticipate the risks of liability. Hence, "the rule of law" is procedural, has no substantive contents, and cannot possibly be relevant to political disputes in which the interpretation or validity of a particular law is in issue. . . .

Those who agreed with the sentiment behind Wolfle's editorial will be protesting to themselves that it was never intended to be understood in this way. That means that it was never intended to be understood, period; it was meant to be agreed with.

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The editorial stated that "the term *civil disobedience* is widely misapplied." That term can be defined as the refusal to obey civil laws, especially, as Webster's puts it, "as a nonviolent collective means of forcing concessions from the government." The alleged crimes of Messrs. Sirhan, Ray, Oswald, and Eichmann are in a different domain.

Bagnall briefly, and Rhine more fully, hope we can rely on majority rule. So does the true civil dissenter (but not the violence monger who may come along at the same time). He accepts the principle of majority rule; he wants the majority to change a law; when he concludes that other means of persuasion will not succeed, he uses civil disobedience to emphasize and dramatize his case. He is saying, "I believe this law to be morally wrong. I believe it so strongly that I violate the law and expect to be punished. But I hope thereby to convince you that the law is wrong and that you should change it." Although he is violating a particular law, he accepts what Strickland called "rules agreed upon in advance" or the editorial called "the rule of law."

The sentiment behind the editorial was, I thought, clear and cogent. It is the desirability, in a period of much

controversy—which concerns a variety of issues and is expressed in a variety of ways—of understanding the constitutional principles concerning dissent and civil disobedience, and of discriminating among the various means by which disagreements are expressed. I am sorry Strickland misunderstood.

DAEL WOLFLE

Funding: Long-Term or Annual

Two recent articles ("The status and problems of high-energy physics today," 5 July, p. 11; and "Government agencies preparing to reduce spending," 12 July, p. 143), and an editorial (28 June, p. 1400) have all emphasized how costly national scientific efforts become when there is uncertainty as to the actual amount of federal support forthcoming in a fiscal year. Perhaps the most spectacular instance of this was Project Mohole on which large sums were spent until Congress abruptly cut off further funds, and thus wasted the efforts of the scientists and all the money previously expended.

Under present appropriation procedures many projects are authorized by legislation which contains a specific dollar ceiling and expires every year. The ceiling must thus be reviewed annually on each extension by the House and Senate. Following this, appropriations must be considered in each house. This involves four separate instances when the fate of the program is at stake. In a 4-year program, this amounts to 16 reviews. The impact of such uncertain funding is obvious. Few businesses can operate on a short-term basis, and scientific research specifically requires long-term advance planning.

The present practice is not constitutionally required. Under many programs, funds may be voted to remain available until expended, as is done under long-term contracts in the federal highway program. Some authorizing statutes permit the appropriation of such funds as Congress may from time to time find necessary. There is no requirement for the present practice of specifying dollar amounts in authorizing legislation. The difficulty caused by the existing practice of enacting short-term authorization statutes with dollar limits on federal appropriations creates instability in research work and insecurity among researchers. With such uncertainty, many qualified experts have been reluctant to participate in a new

field. A proposal (H.R. 16729) now before a House-Senate conference committee would permit funding during one year for expenditures for the following year under certain education programs.

The Committee on Federal Legislation of the New York County Lawyers' Association recently recommended long-range funding and stated:

> . . . [it] is not novel. Whenever it has become clear that long-range planning with knowledge that funds are available is indispensable to the effectiveness of a program, methods have been found to achieve this. Any other course is wasteful and amounts to throwing away a large part of the funds spent, because they cannot be effectively used without long-term planning. . . .

Scientists might well join forces with those working in other fields to further the cause of long-term funding.

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A Matter of Judgment

Conservation controversies are disputes in viewpoint. Porter (Letters, 5 July), argues that the proposed mining in Glacier Bay National Monument is desirable because greater benefits would result than would by leaving the Monument inviolate. I would argue the opposite, but for exactly the same reason. The point of disagreement is not one which can be resolved by "objective analysis" of the "facts." These are differences in value and judgment. . . . Most resource allocation problems are not ones of "right" versus "wrong," of conservationists fighting greedy exploiters, but rather they are disputes over what constitutes the best kind of conservation. Certainly scientists can point out the danger of pesticides, but how can they decide the Glacier Bay mining dispute? Does the recent article on coast redwood ecology by Stone and Vasey (12 Jan., p. 157) resolve the Redwood National Park question? I think not.

Criteria for decision-making in conservation controversies (use versus preservation of landscapes) is needed. . . . The search for answers must start with defining the goals, values, and purposes of society. Science does not claim to answer questions of civil rights; is the problem of mining in Glacier Bay National Monument really any different?

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13 September 1968, Volume 161, Number 3846 **SCIENCE**

Financial Problems of the Private Universities

Friendly competition among the private and public universities of this country has fostered innovation and progress. In contrast, the monolithic European system has been slow to meet changing conditions.

Our dual system now seems threatened. Many of the private universities are finding themselves in a financial squeeze that may become crippling. Income has been increasing, but costs have been rising faster. These trends have been analyzed by Provost Bowen of Princeton.*

The major contributor to the financial bind is not general inflation or greater enrollments. The essence of the problem is that cost per student has been increasing at a rate of about 7.5 percent per year. A major factor is faculty salaries, which have been growing at the rate of 5 percent per year. At the same time, the size of classes at private universities has not increased very much, and a growing proportion of the student body has been engaged in graduate studies. At public universities the cost per student has not risen so fast. Greatly increased enrollments have been accompanied by a trend toward larger classes, and the proportion of graduate students has not changed much.

Some of the factors leading to increased costs are common to both types of institutions. For example, the costs of maintaining adequate libraries are advancing at a rate of more than 15 percent per year. Computer facilities, now so important to many studies, are a financial burden. The increasing complexity of fields of scholarship requires that larger staffs be recruited to provide adequate coverage. Looking to the future, Bowen suggested that cost per student will continue to advance at a rate of about 7.5 percent per year and that enrollment will grow by 3.4 percent per year. Thus the costs of operating a typical private university will nearly triple in a decade.

In attempting to increase income correspondingly the private universities face a difficult task. At one time endowment income supplied almost half of their needs. Today only about 10 percent of their funds come from endowments. Prime sources are tuition, annual giving, and the federal government. Private universities have already increased tuitions as much as is feasible, sometimes more. The total cost of attending a private university is more than twice the cost of attending a public one. This is true at a time when the private schools are attempting to democratize their student bodies. Prospects for large increases in annual giving are not good. An important factor has been a change in policy by some of the foundations, notably the Ford Foundation. Private giving is no longer growing at the rate of former years, and a significant part of it is being channeled to public universities. In principle, the government could and should help the private universities through mechanisms that would not destroy their independence. In practice, the government tends to behave capriciously while harassing its grantees with bureaucratic regulations.

If the current financial squeeze intensifies, as predicted, the private universities will cease to compete successfully with public institutions. Should this occur, higher education will lose much of its vitality and the nation will suffer accordingly.—PHILIP H. ABELSON

*W. G. Bowen, *The Economics of the Major Private Universities* (Carnegie Commission on Higher Education, Berkeley, Calif., 1968)

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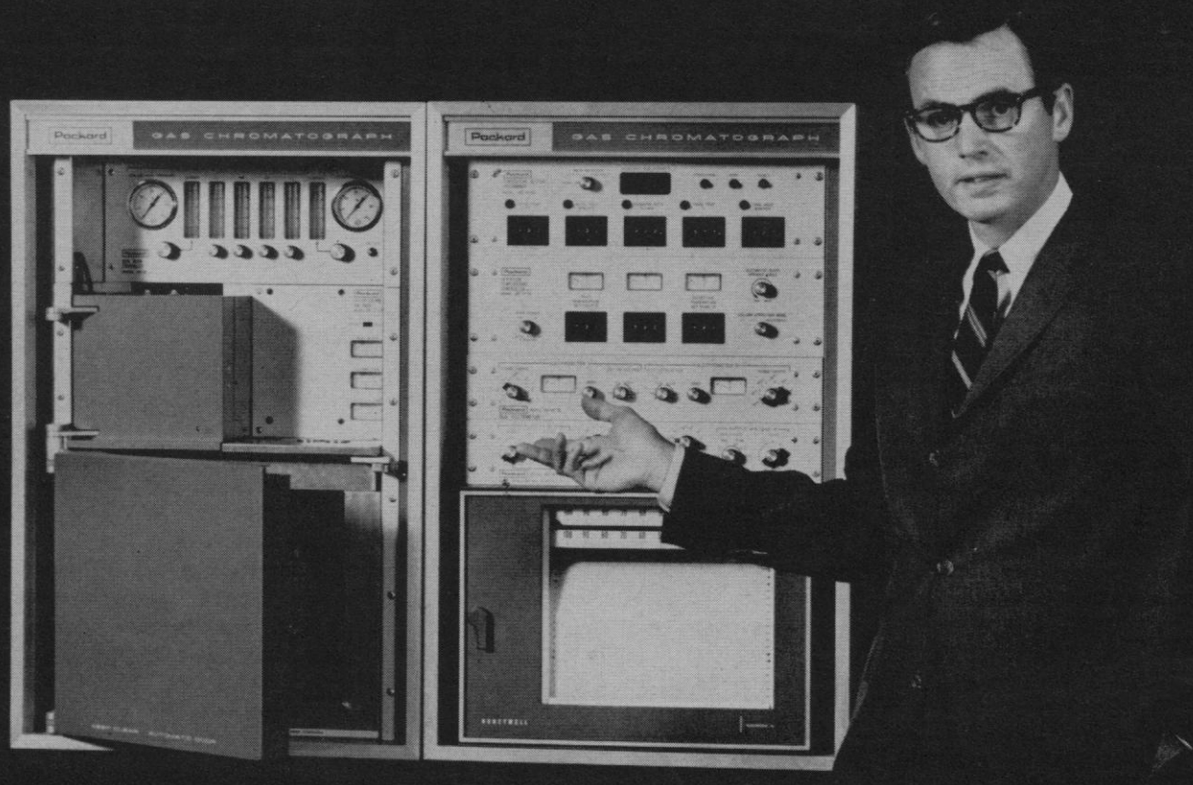

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