SCIENCE

26 August 1966

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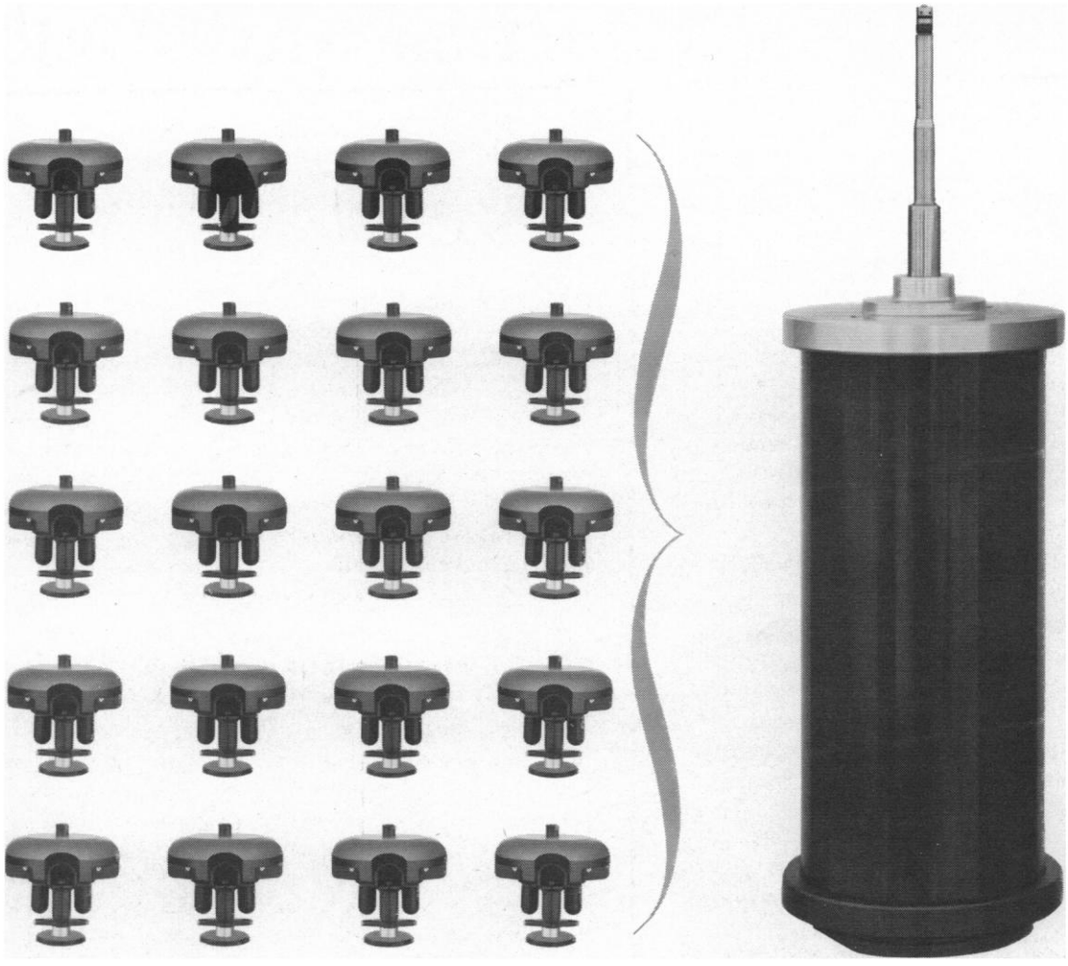
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



20 density gradient runs in one with the L4 Ultracentrifuge

Here is the ultracentrifuge for investigators who want very large volume separations at very high forces: the Model L4 from Beckman. It's the only zonal ultracentrifuge—for large volume density gradient separations. It's the only continuous flow ultracentrifuge. In addition it can spin standard swinging bucket and fixed angle rotors at 65,000 rpm. You actually get three ultracentrifuges in one.

The Model L4's large scale zonal rotor centrifuges 1725 ml (20 times as much sample as the big SW25.2 swinging bucket rotor) at 40,000 rpm and 90,000 *g*—and fractions are recovered during rotation.

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With these large volumes you might expect some loss of resolution, but just the opposite proves to be the case. Resolution is better because particles sediment in ideal sector shaped compartments to minimize convection.

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SCIENCE

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COVER

The structure of the meteorite, which has 16 percent nickel (by weight) is intermediate between a fine octahedrite and an ataxite. The large kamacite plates make up the well-defined Widmanstätten pattern typical of the octahedrites. The interior areas between the kamacite plates of the major pattern are regions of transformed taenite (plessite) which contain a micro-Widmanstätten pattern sometimes found in the ataxites. This micropattern formed late in the meteorite's cooling history (about × 35). See pages 975 and 976. [J. I. Goldstein and R. Soules, NASA]

We approach

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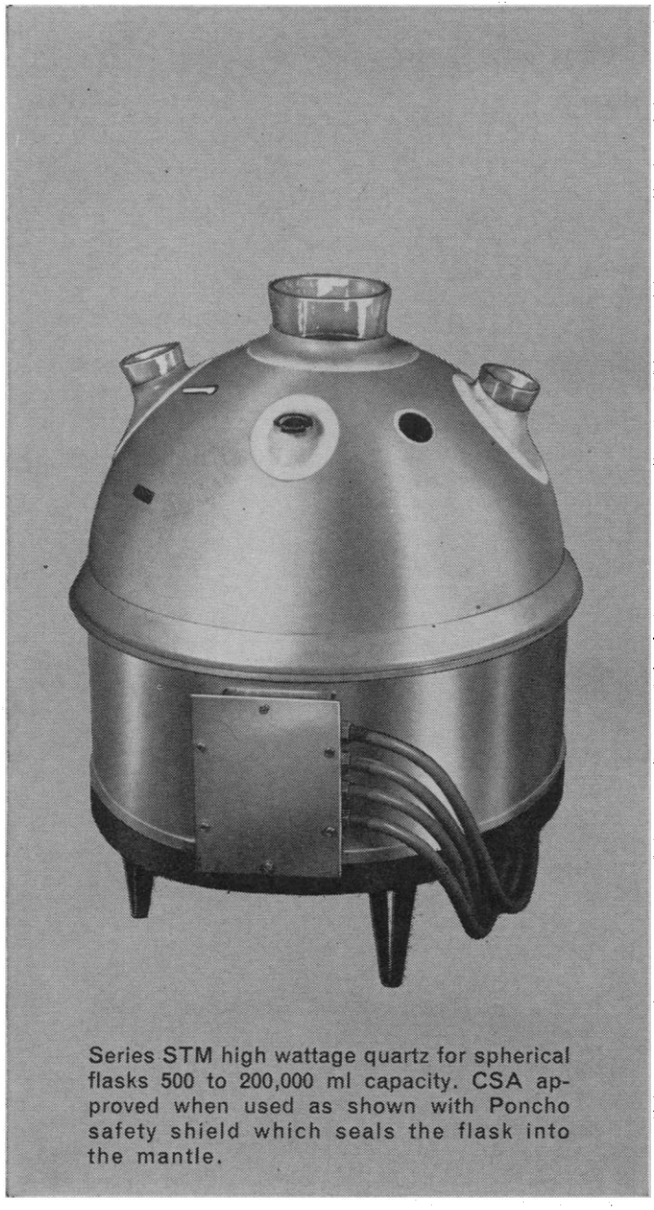

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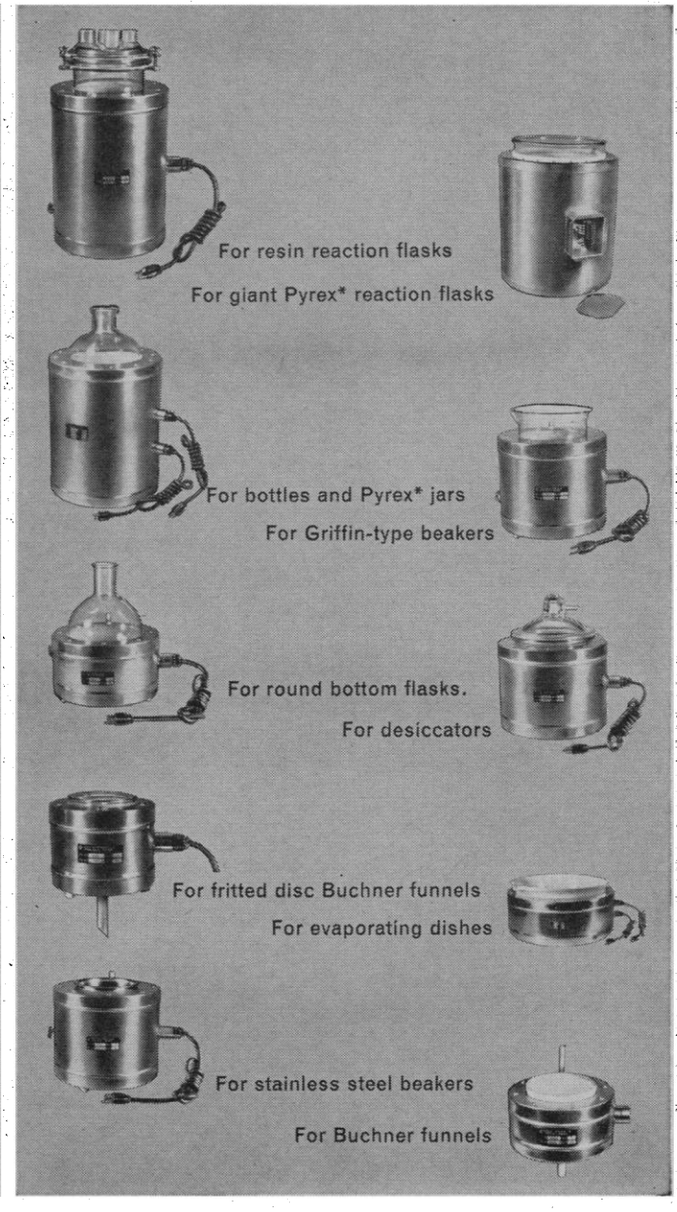

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ANALOG MONOLOGUE

On Means for Modelling, Measuring, Manipulating, & Much Else

ANALOG ELECTRONICS & OPERATIONAL AMPLIFIERS

Surely we are at least thirty years too late to justify the use of electronics — in *measuring* almost any physical or chemical parameter; in *manipulating* the measured data; or in *computing, simulating,* or otherwise *predicting* the behavior of a physical system. After three decades, however, the outlines of any discipline become blurred — hence this refresher.

One process is at the root of every contribution electronics ever made to its sister sciences: *Amplification.* There are many ways to characterize this effect, but perhaps the most general is to say that electronic circuits raise the energy level of data — that they are inherently very *sensitive* — and can be made to respond, with *reliability* (stability) and fidelity (accuracy) to very small changes in the input parameter. If the input is not already an electrical signal, it must be converted to an equivalent electrical parameter, by a "transducer."

The need for amplification — for high sensitivity — is apparent from first principles. For example, we may restate Heisenberg's Exclusion Principle as follows: *"The accuracy of a measurement is a direct function of the observer's ability to make it with a minimum of disturbance to the system observed."* If we read "loading", or "burden" for "disturbance", the need for sensitive circuits is apparent. Unfortunately, electronic amplifiers are not ideal. Left to itself, the sensitivity of a simple electronic amplifier circuit will vary so much (in response to both external influences and the instability of its own component parts) as to render it useless for all but the crudest of applications. For this reason, among others, we have had to invent ways of stabilizing amplifier gain. The most convenient, powerful, and successful of these ways is called *Feedback.*

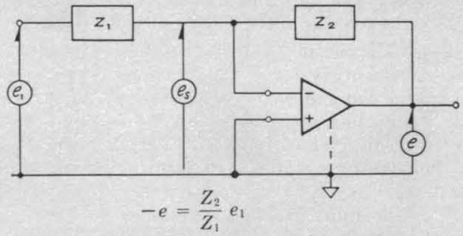
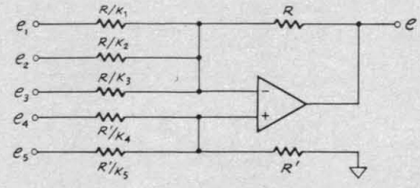


Fig. 1

$$-e = \frac{Z_2}{Z_1} e_1$$

There are many ways to describe feedback. We shall use a simple example. To obtain a particular value of amplification, with a specific degree of stability and fidelity, one first designs an unstabilized amplifier having much higher "raw" amplification than is required; then one interconnects the output and input circuits of the amplifier by means of a more-readily-stabilized electrical circuit, called a feedback loop, or feedback network (see Figure 1) in such a way that this feeding back of output energy *reduces the apparent amplification, but gives to that modified amplification characteristic the inherently-higher stability of the feedback network.* Thus, we can trade excess amplification for superior stability — *and* superior fidelity, by the way. Because this kind of feedback *reduces* the apparent amplification, it is called "negative" feedback.

The feedback "network" may be as simple as a pair of resistors. The cost of such a circuit is modest, and its data-measurement and data-manipulation capabilities are impressive. . . but it is only the beginning.



$$e = k_4e_4 + k_5e_5 - (k_1e_1 + k_2e_2 + k_3e_3)$$

Fig. 2

By modifying the feedback network, so as to include *reactances* (capacitors or inductors) as well as resistances, you may create circuits that perform important and useful *mathematical operations* on a signal; for example one can differentiate or integrate it. Differentiation will convert velocity signals into acceleration, or position into velocity; or, with two differentiators, in cascade, position into acceleration. By integrating, one may reverse the process.

There is almost no limit to the ingenious behavioral variations one may create and control, merely by choosing appropriate feedback network configurations. Nowadays, using inexpensive standard "hardware", one may quickly assemble circuits that respond logarithmically, exponentially, or trigonometrically and circuits that multiply and divide too — almost as faithfully as the circuit of Figure 2 adds and subtracts.

Remember — all of this is done with equipments that cost, generally, hundreds of dollars or less, and not the thousands or more one might expect, from their capabilities and potential usefulness.

The kind of amplifier required for performing these operations with accuracy and fidelity is a very special beast, called (naturally) an Operational Amplifier, and we have devoted much of our time and energy over more than 20 years to its development and refinement.

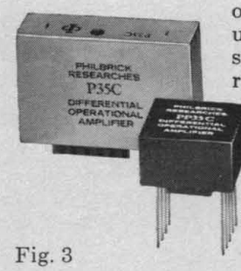


Fig. 3

We manufacture several "generations" of this very special device in large volume at surprisingly low cost . . . considering the care we take and the resultant state-of-the-art performance and reliability. Several sell for less than $20.00. Each year, we send many tens of thousands of them into service, to do thousands of different jobs, in hundreds of different applications across the entire spectrum of Science and Engineering. Figure 3 shows two of the 107 standard Philbrick Operational Amplifiers.

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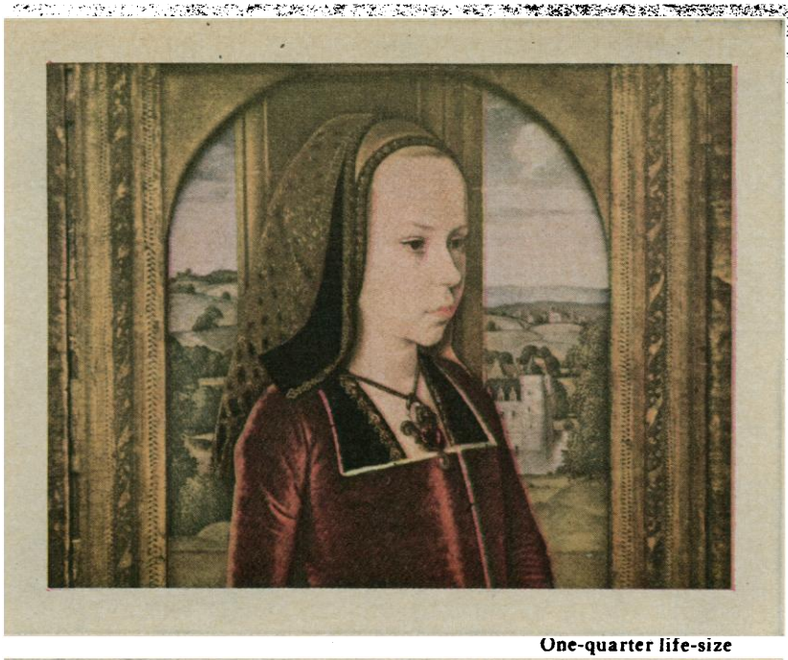
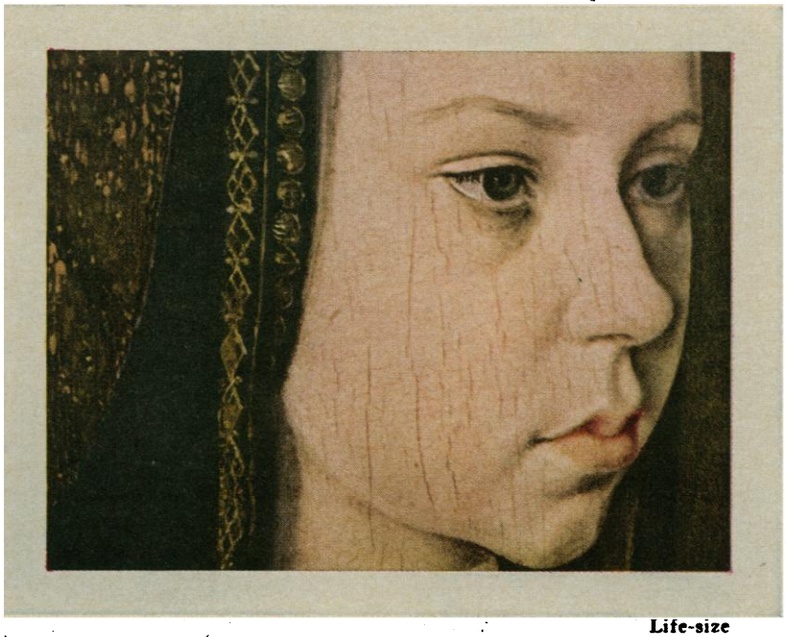


One-quarter life-size



Life-size

*Courtesy of the Lehman collection.

Twice life-size

Just aim and squeeze the trigger. That's it.

One minute later you can peel off a perfect color close-up. Or 10 seconds later a perfect black and white.

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You can take four kinds of close-ups with the camera. Interchangeable lenses and attachments make it possible to take ¼ to 1, 1 to 1, 2X and 3X pictures. (In our three close-ups of a 15th-century oil by the Master of Moulins,* you can see the sharpness of detail you get in the close-up images. The close-ups go from one-quarter life-size to twice life-size.)

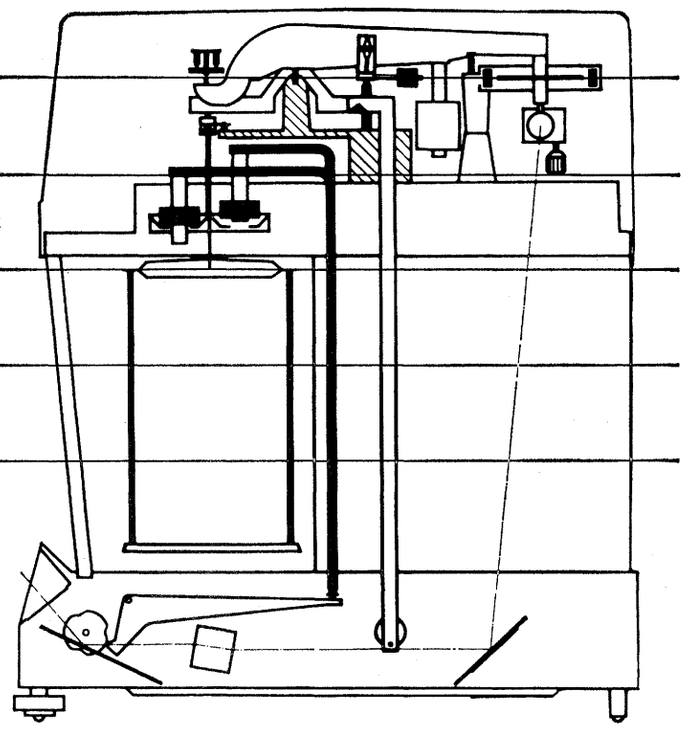
The camera is compact, designed for pistol-grip, hand-held operation. And it uses Polaroid Land pack films which drop easily into the camera back in seconds.

This remarkable new camera will have a wide range of scientific, industrial and professional applications. (And hobbyists, such as collectors and model makers, will be able to put it to good use on weekends as well.)

Think you'd like working with it? For more information, write to: Sales Department, Polaroid Corporation, Cambridge, Mass. 02139.

The Polaroid CU-5 Close-Up Camera

In 10 minutes Matheson Scientific can show you which Balance is best



Sartorius

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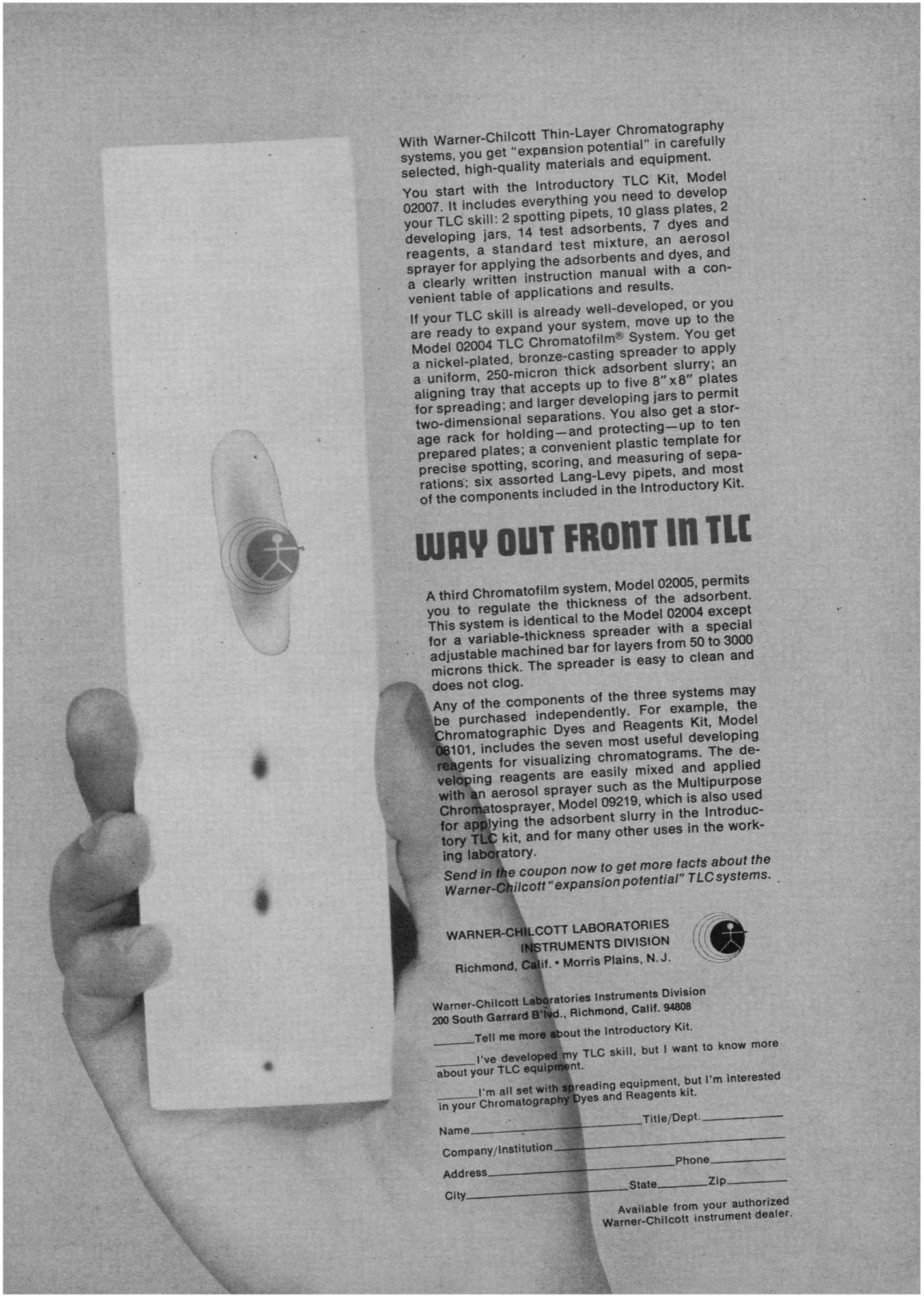

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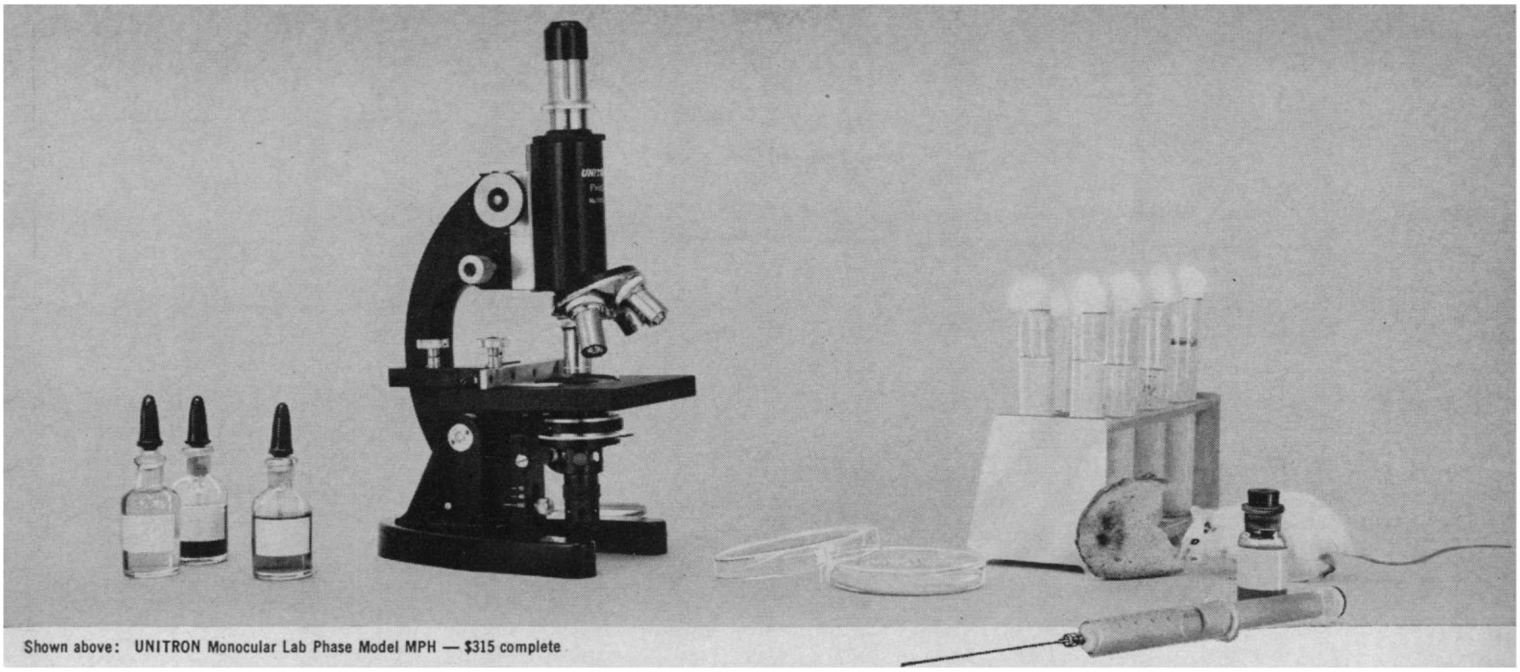

Shown above: UNITRON Monocular Lab Phase Model MPH — $315 complete

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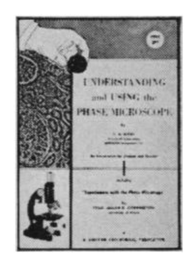

Ask for a free 10-day trial. Please specify whether you want to try Model MPH or BPH. A phase booklet is shipped with each microscope . . . or, you may request the booklet separately.

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FISHER PRODUCT REPORT

News about instruments, apparatus and reagent chemicals that make your work quicker, surer, safer and easier.

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You could almost spell the name on the cap "P-U-R-I-T-Y."

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MODEL CW-1
BOXCAR INTEGRATOR

The Model CW-1 Boxcar Integrator is a gated signal averaging device useful for the recovery of either complete repetitive waveforms or incremental portions thereof from noise. The input to the Boxcar Integrator is sampled by a variable width, variable delay gate which can be fixed at any point on, or slowly scanned across, the repetitive waveform. The sampled portion of the input waveform is averaged by a variable time constant integrator, displayed on the panel meter, and made available for external recording or other use. Because the mean value of random noise is zero, the output of the integrator will asymptotically approach the average value of that portion of the input waveform being sampled at any moment, with a corresponding suppression of the accompanying noise. The Model CW-1 may be used in such widely varied applications as pulsed nuclear resonance, laser excitation decay, and biological evoked response experiments. In general, this instrument should be of value in any application where noise interferes with the recovery of repetitive waveforms.

SPECIFICATIONS

SIGNAL CHANNEL —

Input Sensitivity: ±.2 volt to ±100 volts in 1, 2, 5, sequence for ±10 volts output.

Dynamic Range: Will accept inputs 15 times full scale requirement without overloading.

Integration Time Constants: 100 microseconds to 100 seconds in 1, 3, 10 sequence.

Holding Time: At least 10^6 times integration time constant for 10% F.S. change in output, up to 10^5 sec.

Output: (a) ½% Panel Meter, ±10 volts.

(b) ±10 volts provided at front panel at an impedance of 1 K.

(c) Recorder Output — suitable for most galvanometric and servo recorders.

GATE TIMING CIRCUITS —

Operating Modes: (a) Ext. Trigger

(b) Ext. Gate

(c) Recurrent: Time Base triggered automatically and repetitively.

(d) Continuous: Gate on continuously.

Time Base Widths: 10 microseconds to 1 second in 1, 2, 5 sequence.

Gate Pulse Width: Continuously adjustable from 1 microsecond to .11 second.

Delay: (a) Manual adjustment from 0% to 100% of Time Base Width.

(b) Automatic scanning from 0% to that % of Time Base Width selected by setting the Manual Delay Dial.

Automatic Delay Scan Periods: 1, 2, 5, 10, 20, 50, and 100 minutes.

GENERAL —

Power Requirements: 105-125 volts or 210-250 volts; 50-60 Hz; approximately 15 watts.

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al courses of study. Yet in most areas of modern astronomy there is already too much effort invested in theoretical research, considering the lack of observational data to test the theories. (Exception: planetary physics.) The authors of the Whitford report have indeed emphasized that astronomy today is data limited. It is dangerous for any field of science to be overladen with theories, which in the absence of checks can freely degenerate into wild speculation and eventually breed dogmas. Only 2 years ago, for instance, the remoteness of quasi-stellar galaxies was accepted dogmatically by most astronomers, and a host of theories were advanced to explain their (apparent) enormous luminosity. Acceptable cosmological theories were identified on the basis of a few spectrum wavelength shift measurements interpreted as Doppler shifts. The remoteness of the quasars is at this time seriously in doubt, so many of the well publicized theories concerning these objects may well be irrelevant.

As Irwin has pointed out, the nation's various programs in space astronomy will be less effective and more costly than necessary unless a large number of experienced observational astronomers are available to plan these programs. I agree that NASA should eventually fund the training observatory construction program, but only after the major expansion of ground-based research facilities is effected and more efficient use is made of current astronomical manpower. Irwin's training observatories will not likely begin to produce observing geniuses until 10 years from now at the earliest, yet strategic planning of space astronomical research is needed now and throughout the intervening years.

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How To Police Pollution

As a former chemist for what is now the Federal Water Pollution Control Administration, I would like to comment on certain aspects of the ninth conference on Great Lakes research (24 June, p. 1773).

How can the FWPCA expect to conduct a fair and equitable enforcement program largely based on "informal discussions"? Such a practice could easily lead to flexible enforcement. Although federal water pollution control machinery has been established for over 3 years, there are, as yet, no formal procedures for conducting hearings. I have attended such informal pollution control conferences in the past in which the government has presented an overwhelming amount of "scientific" data by "experts" who gave proof-positive conclusions about the cause, amount and source of pollution. There was no provision for cross-examination, and industry, unprepared to refute such "evidence," was reluctant to argue its side for fear of being cast in the role of an active supporter of pollution.

Finally, I disagree that it is "hazardous to swim, fish [in], or even get water spray in the face" from lake water bearing *Salmonella* bacteria. This is a half-truth, at best. Certainly no one would advocate swimming in grossly polluted water or would support the willful insult to the human body by unnecessary exposure to any harmful agent. *Salmonella* are ubiquitous microorganisms, as we know from the reported difficulty controlling them in hospitals. The alleged hazard to a fisherman or boating enthusiast by the presence of *Salmonella* in surface waters can only be labeled conjectural.

WILLIAM S. COX
2350 Beecher Circle, S.W.,
Atlanta, Georgia 30311

Simplifying the Formula

The discussion (Letters, 1 April and 8 July) of N. O. Calloway's proposal (Letters, 31 Dec.) for distributing the ages of experimental animals has been made unnecessarily complicated. If A is the age of the youngest animal to be used, and B is the age of the oldest animal to be used, and $n + 1$ is the number of animals to be used, the problem is simply that of inserting $n - 1$ geometric means between A and B. This requires merely determining R such that

$$B = AR^n$$

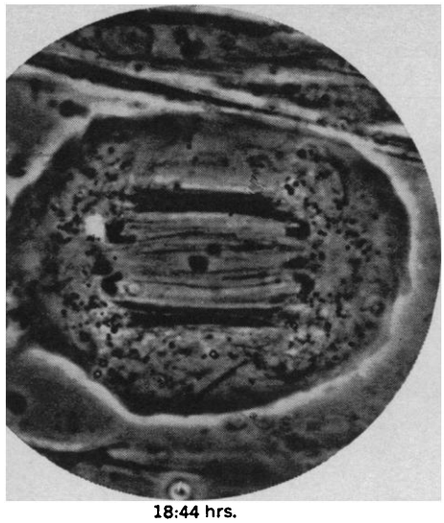
Then

$$\log R = \frac{\log B - \log A}{n}$$

and the $n + 1$ ages are

$$A, AR, AR^2, \ldots AR^n.$$

IRVING ADLER
North Bennington, Vermont



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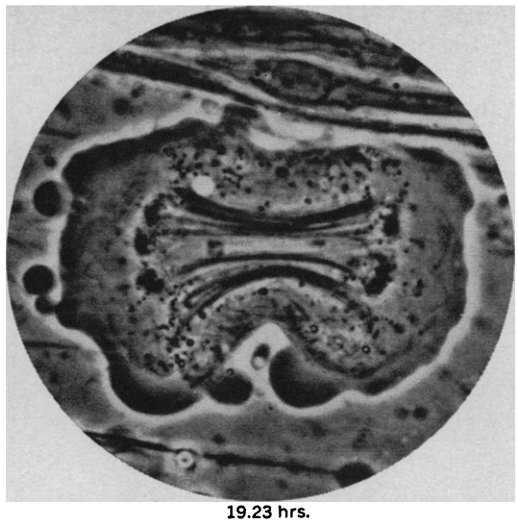

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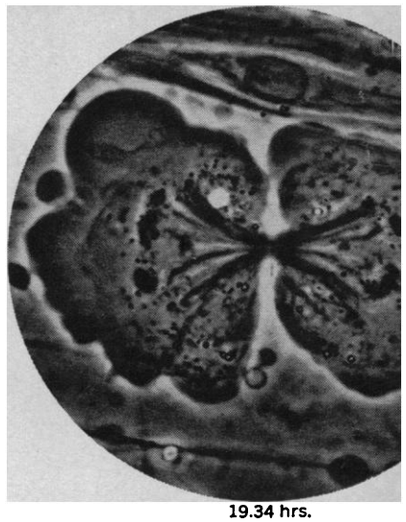

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Anaphase: bivalents of homologous chromosome pairs moving to opposite poles during spermatogenesis in Pales ferruginea (Tipulidae).

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26 August 1966, Volume 153, Number 3739 **SCIENCE**

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The National Bureau of Standards

The recently issued *1965 Technical Highlights of the National Bureau of Standards** is an excellent report. The document, which contains 113 pages of text and 90 pages of appendixes, provides convincing evidence that NBS is serving essential functions and that it is responding to new needs. Appropriations for NBS of $33 million and total expenditures of $69 million are more than amply justified.

For 65 years the National Bureau of Standards has been the nation's central measurement laboratory. It has had responsibility for developing and maintaining the National Standards of Measurement. This is no small task. In addition to the six basic international qualities of length, mass, time, temperature, electrical current, and luminous intensity, there are some 36 derived quantities for which standards are needed. With developments such as the maser and laser, new methods of obtaining better accuracies become available. This requires continual updating of standards. Scientific developments such as ability to obtain higher pressures, a better vacuum, and new and purer materials have correspondingly increased the need for additional standards.

In response to the challenges of the times, NBS has become the focus of scientific and technical competence, covering the entire spectrum of the physical sciences. The accuracy with which measurement standards can be reproduced and disseminated limits the reliability and accuracy of all exchanges derived from standards. NBS must provide leadership in the science of measurement. This requires a staff of high-caliber scientists. The Bureau's scientific activity has been particularly distinguished in atomic and molecular physics, chemical physics, thermodynamics, theoretical physics, crystallography, analytical chemistry, polymers, metallurgy, and cryogenics.

During 1965, NBS research leading to publication of about 1000 scientific papers was conducted. Among the accomplishments was development of a thallium-beam clock, which may be more accurate by an order of magnitude than the cesium-beam clock. A second achievement was the use of a laser to make automatic length measurements. The accuracy obtained was 1.8 parts in 10^9. A third accomplishment was the discovery of superconductivity in the semiconductor strontium titanate. A new purification technique affords, for the first time, the possibility of obtaining absolutely pure and perfect crystals.

In addition to its responsibilities with respect to standards, NBS has long had other functions, such as conducting tests for other government agencies and advising them on scientific and technical problems. NBS is now to establish a central and major government resource in the automatic-data-processing field. It is also to serve as the focal point within the federal government for stimulating the application of science and technology to the economy.

A recently added responsibility of very great importance is the operation of a National Standard Reference Data System. What is involved is the massive effort required to produce the modern equivalent of the old International Critical Tables. The past achievements of NBS augur well for the able performance of the new tasks. Establishment of an effective National Standard Reference Data System would provide major benefits to science, technology, and industry throughout the world.

It is to be hoped that Congress will provide sufficient funds for effective implementation of this much-needed data system, and that the evident quality of the overall NBS effort will be as highly regarded in Congress as it is among knowledgeable scientists and engineers.

—PHILIP H. ABELSON

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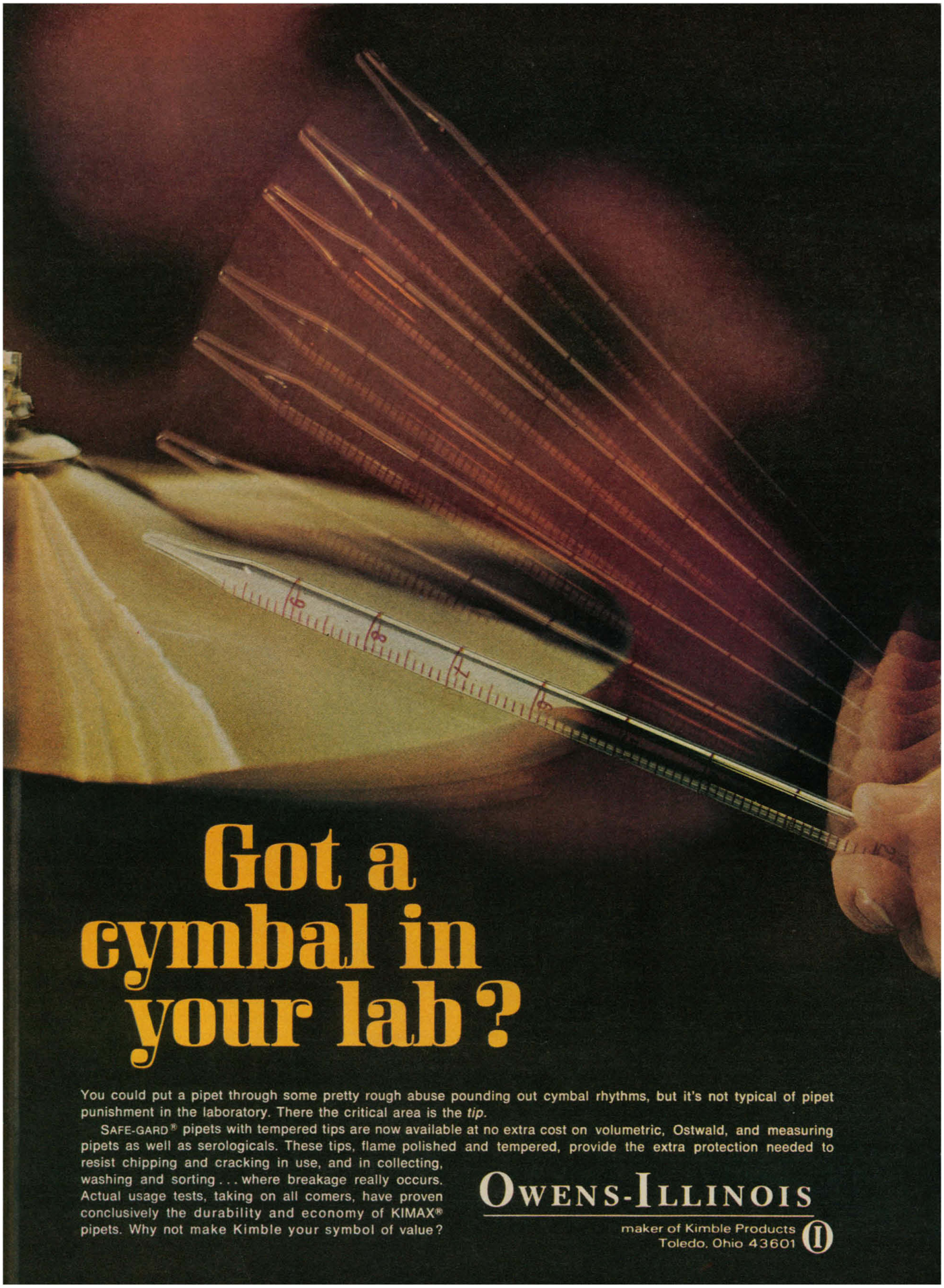

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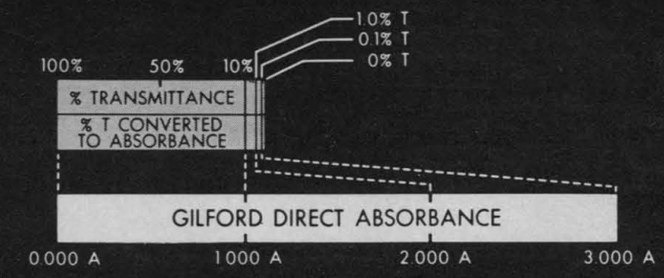

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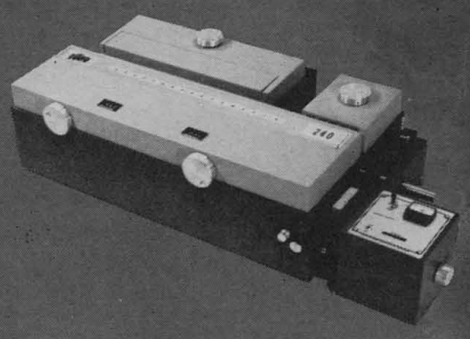

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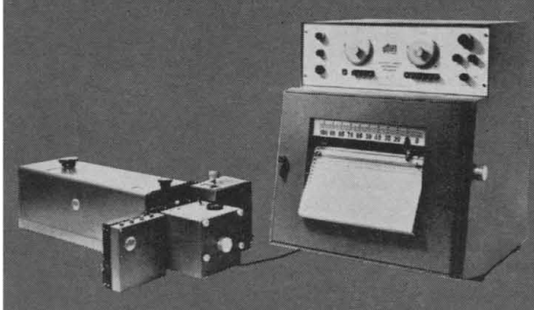

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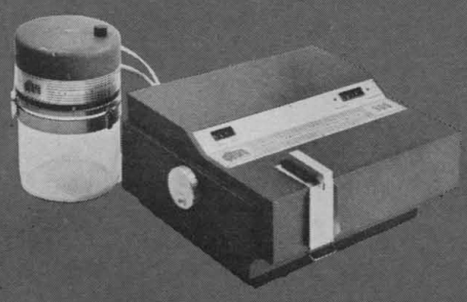

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Reeder. Lippincott, Philadelphia, ed. 11, 1966. 650 pp. Illus. $7.50.

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