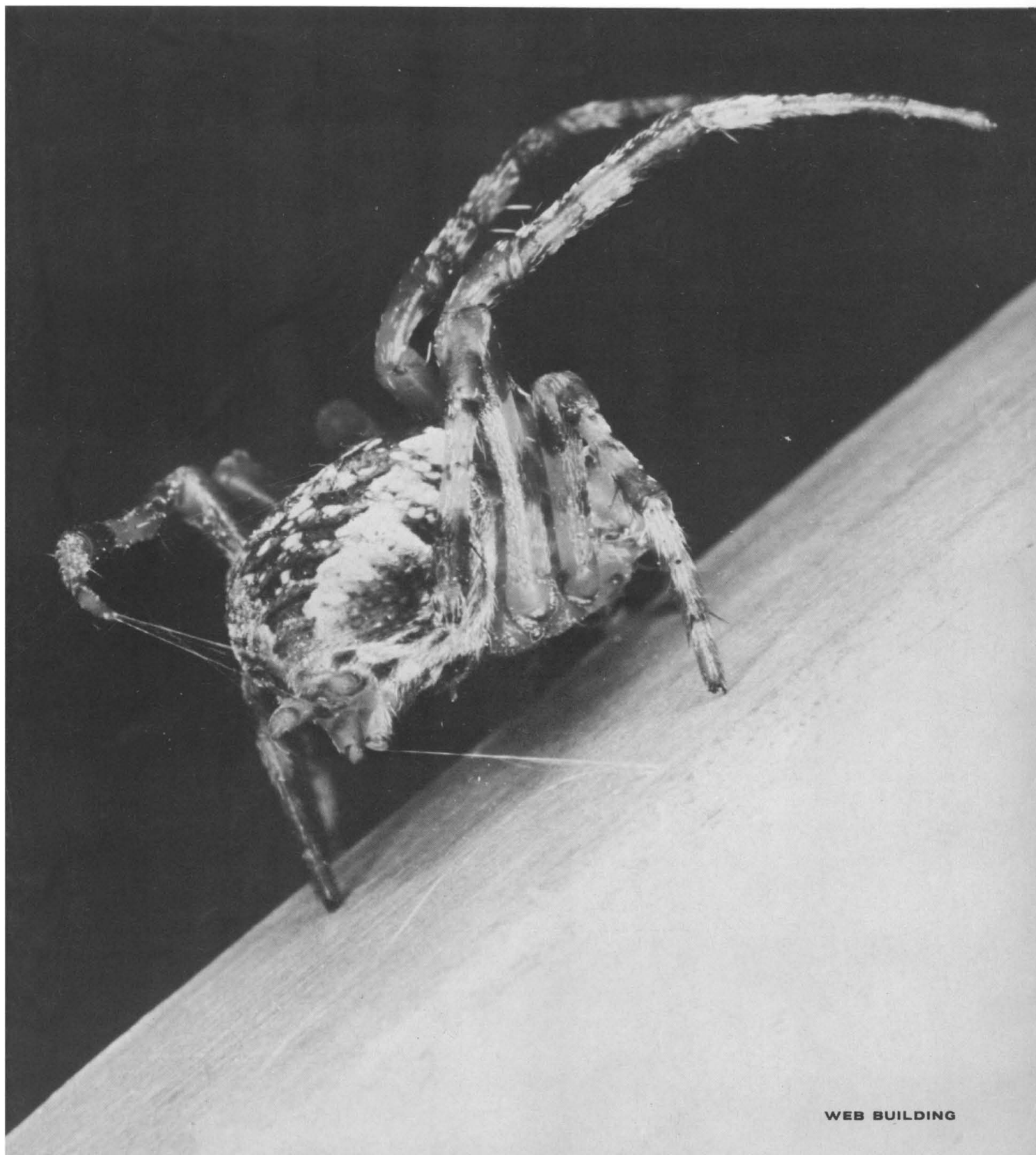


SCIENCE

1 December 1967

Vol. 158, No. 3805

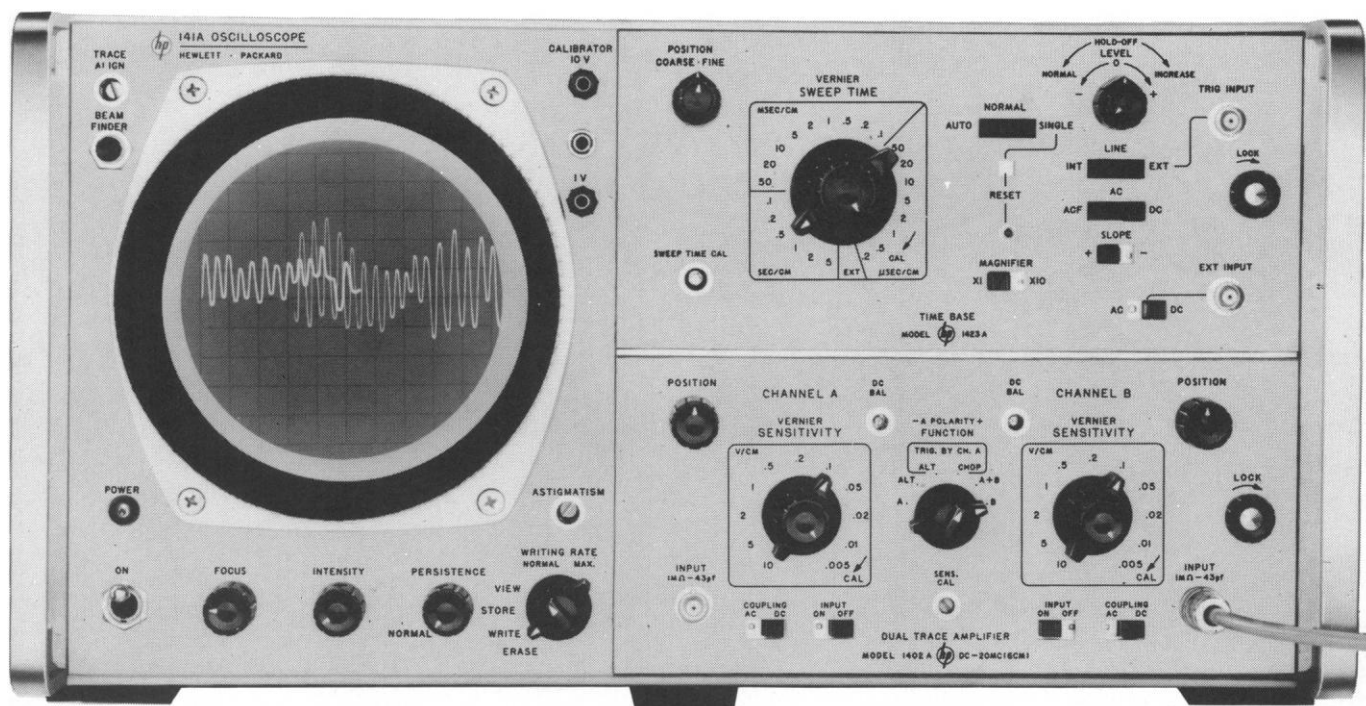
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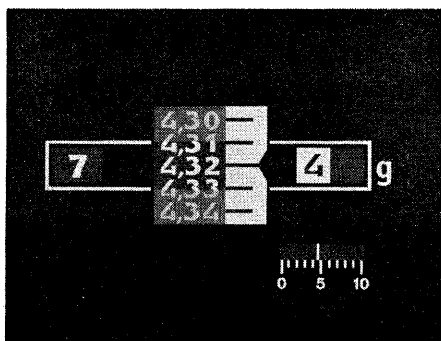
P160, P2000, P5 and P6 – these are the four new instruments we've added to our widely-accepted series of top-loading balances. They bring improved precision/capacity relationships while offering special advantages for particular applications.

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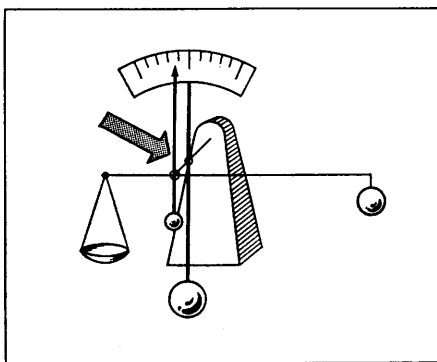
Digital or analog, up or down

volving weight loss studies such as drying and evaporation experiments and determination of residues. It makes possible, for the first time, gravimetric titration, in which titrant is dispensed directly by weight instead of indirectly by vol-

ume. We have done some homework on this subject.¹

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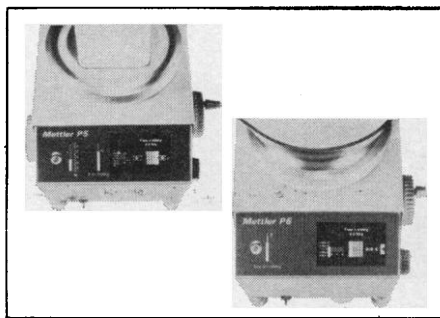
The model P2000 stands out by not really standing out. It is a remarkably compact unit that offers twice the capacity and 60% more

1) We've found 44 citations which suggest useful applications for, or advantages of, dispensing titrant by weight. If you'd like a copy, ask for Technical Information Bulletin 1014, "Gravimetric Titrimetry – a Review of the Literature."

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SCIENCE

LETTERS	Philanthropic Foundations and Grants to Universities: <i>W. Weaver</i> ; Does Science Neglect Society? <i>H. Wynberg et al.</i> ; Decline of the Lobster: <i>R. G. S. Bidwell</i> ; Openings for Negro Engineers: <i>E. D. Oliver</i>	1133
EDITORIAL	Student Anxiety	1139
ARTICLES	The Chemical Production of Mutations: <i>C. Auerbach</i>	1141
	Hydrazine-Air Fuel Cells: <i>G. E. Evans</i> and <i>K. V. Kordesch</i>	1148
	The Future of Scientific Journals: <i>W. S. Brown, J. R. Pierce, J. F. Traub</i>	1153
NEWS AND COMMENT	Health Crisis: LBJ Panel Calls for Reshaping American Medicine	1160
	Education Reform: Britain Tries It Top to Bottom	1162
	Aldabra: Reprieve for an Island	1164
	NIH: As the Time Approaches for Shannon's Retirement	1165
BOOK REVIEWS	<i>The Bering Land Bridge</i> , reviewed by <i>P. S. Martin</i> ; other reviews by <i>S. Engelsberg, T. B. Turner, R. N. Wilson, T. Regge, K. Laki, J. S. Boyer, E. W. Taylor, M. R. Rosenzweig</i> ; Books Received	1168
REPORTS	Chondritic Meteorites and the Lunar Surface: <i>J. A. O'Keefe</i> and <i>R. F. Scott</i>	1174
	Galaxies as Gravitational Lenses: <i>D. Sadeh</i>	1176
	Undersea Penetration by Ambient Light and Visibility: <i>R. F. Busby</i>	1178
	Deformation Lamellae Parallel to (1013) and (0001) in Quartz of the Coeur d'Alene District, Idaho: <i>W. R. Greenwood</i>	1180
	Radiocarbon Content of Marine Shells from the Pacific Coasts of Central and South America: <i>R. E. Taylor</i> and <i>R. Berger</i>	1180
	Landslide Noise: <i>J. D. Cadman</i> and <i>R. E. Goodman</i>	1182

BOARD OF DIRECTORS	ALFRED S. ROMER Retiring President, Chairman	DON K. PRICE President	WALTER ORR ROBERTS President-Elect	BARRY COMMONER DAVID R. GODDARD	HUDSON HOAGLAND GERALD HOLTON
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Splashing of Drops on Shallow Liquids: <i>P. V. Hobbs and T. Osheroff</i>	1184
Radioisotope Uptake as a Measure of Synthesis of Messenger RNA: <i>D. P. Nierlich</i> ..	1186
Sodium and Potassium: Effects on Skeletal Muscle Microsomal Adenosine Triphosphatase and Calcium Uptake: <i>B. B. Rubin and A. M. Katz</i>	1189
Allergic Adenohypophysitis: New Experimental Disease of the Pituitary Gland: <i>S. Levine</i>	1190
Cerumen in American Indians: Genetic Implications of Sticky and Dry Types: <i>N. L. Petrakis, K. T. Molohon, D. J. Tepper</i>	1192
Lymphocytic Choriomeningitis: Production of Antibody by "Tolerant" Infected Mice: <i>M. B. A. Oldstone and F. J. Dixon</i>	1193
Habitat Selection by Chemically Differentiated Races of Lichens: <i>W. L. Culberson and C. F. Culberson</i>	1195
Gekkonid Lizards Adapt Fat Storage to Desert Environments: <i>H. R. Bustard</i>	1197
Experimental Allergic Encephalomyelitis in Agammaglobulinemic Chickens: <i>M. E. Blaw, M. D. Cooper, R. A. Good</i>	1198
Immunological Time Scale for Hominid Evolution: <i>V. M. Sarich and A. C. Wilson</i> ...	1200
Visceral Tissue Vascularization: An Adaptive Response to High Temperature: <i>R. O. Rawson, J. D. Hardy, K. A. Vasko</i>	1203
New High-Temperature Chlorella: <i>C. Sorokin</i>	1204
A Direct Synaptic Connection Mediating Both Excitation and Inhibition: <i>H. Wachtel and E. R. Kandel</i>	1206
Mice: Individual Recognition by Olfactory Cues: <i>J. M. Bowers and B. K. Alexander</i> ..	1208
Technical Comments: Osmotic Mechanism and Negative Pressure: <i>S. L. Rawlins and</i> <i>J. D. Oster; J. Levitt; K. R. Knoerr; P. F. Scholander</i>	1210

ASSOCIATION AFFAIRS

Haskins Laboratories: Research on Human Communication, Marine Ecology, and the Biochemistry of Protozoa: <i>F. S. Cooper</i> ; Web-Building Spiders: <i>P. N. Witt</i> ; AAAS General and Sectional Symposia	1213
--	------

MEETINGS

Comparative Medicine: <i>W. I. Gay</i>	1220
--	------

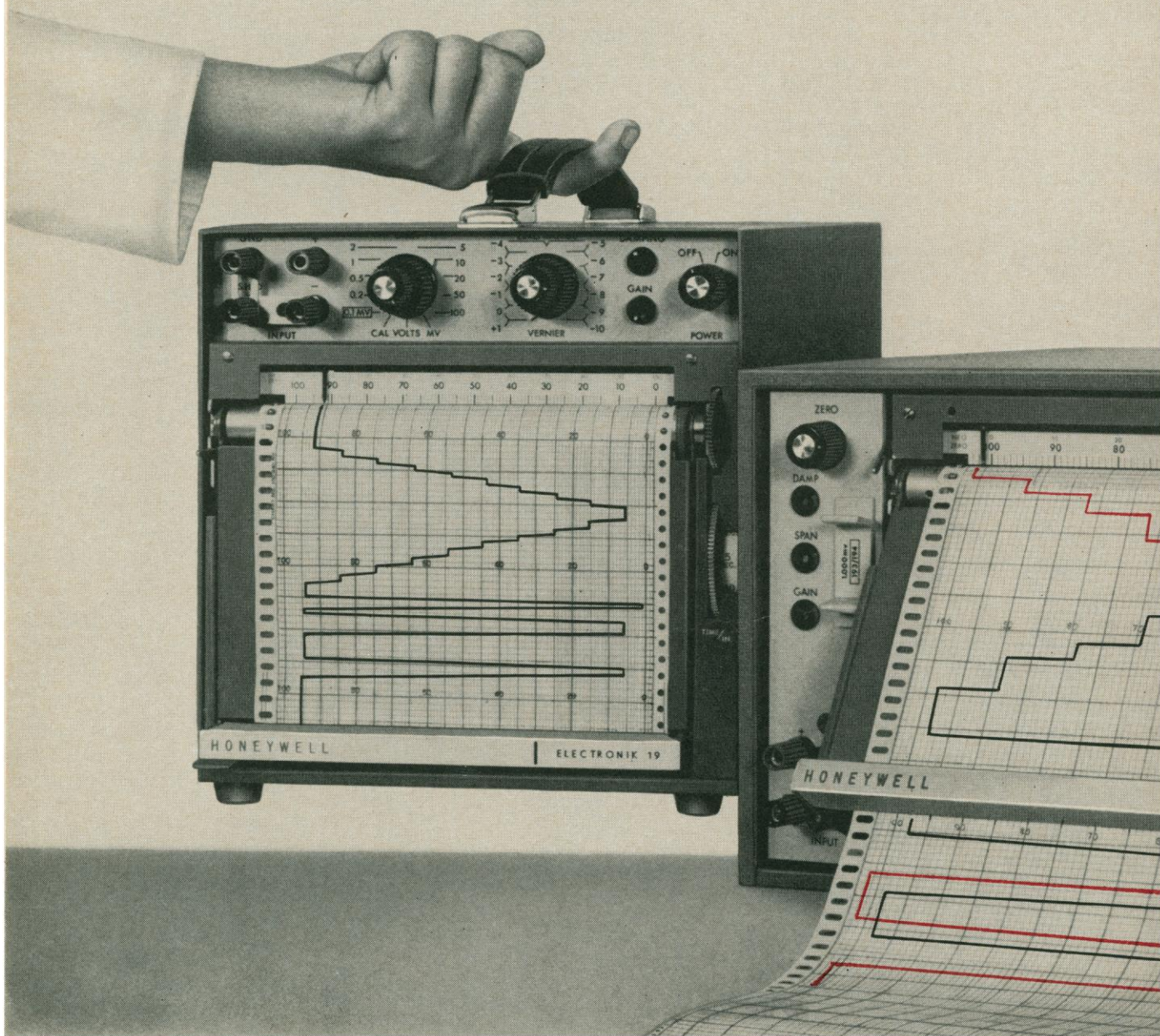
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COVER

Adult female spider, *Araneus diadematus* Cl. The eight legs perform different tasks. Here the left hind leg pulls out polypeptide silk from the spinnerets at the rear end of the body; the right hind leg probes in the air; the middle legs support the body; and the front legs "measure" distances and tension. (Actual size 20 millimeters, rear view). See page 1216. [Peter N. Witt, North Carolina Department of Mental Health]

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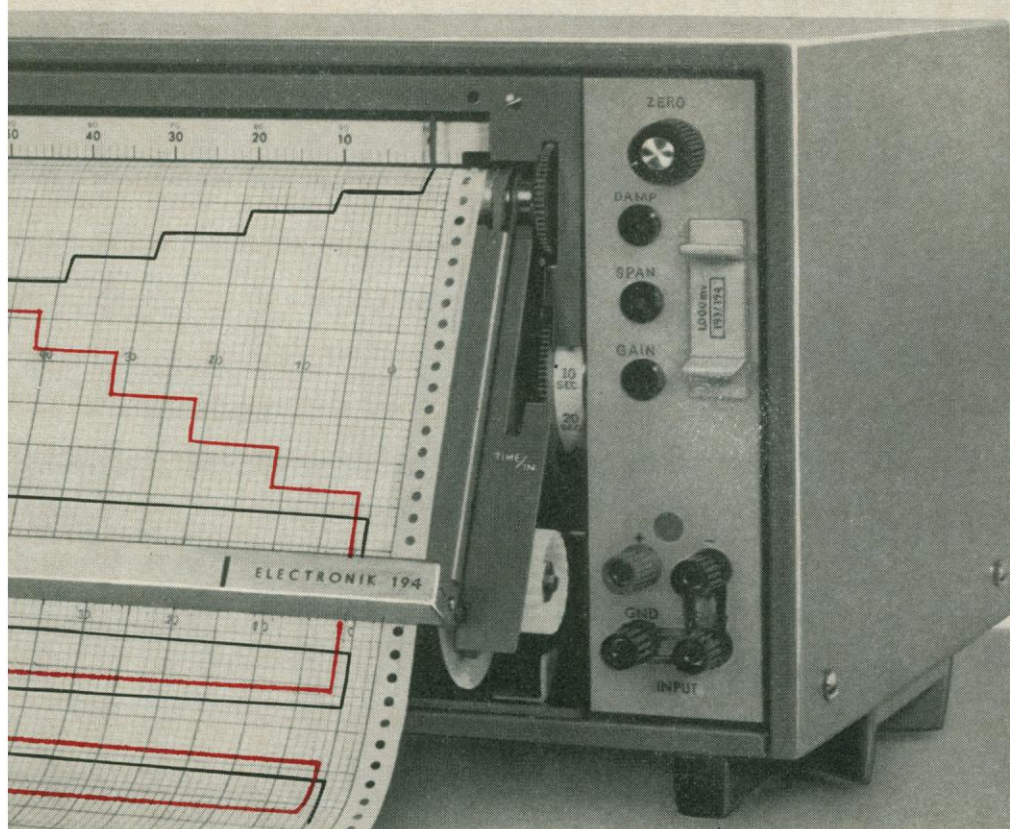
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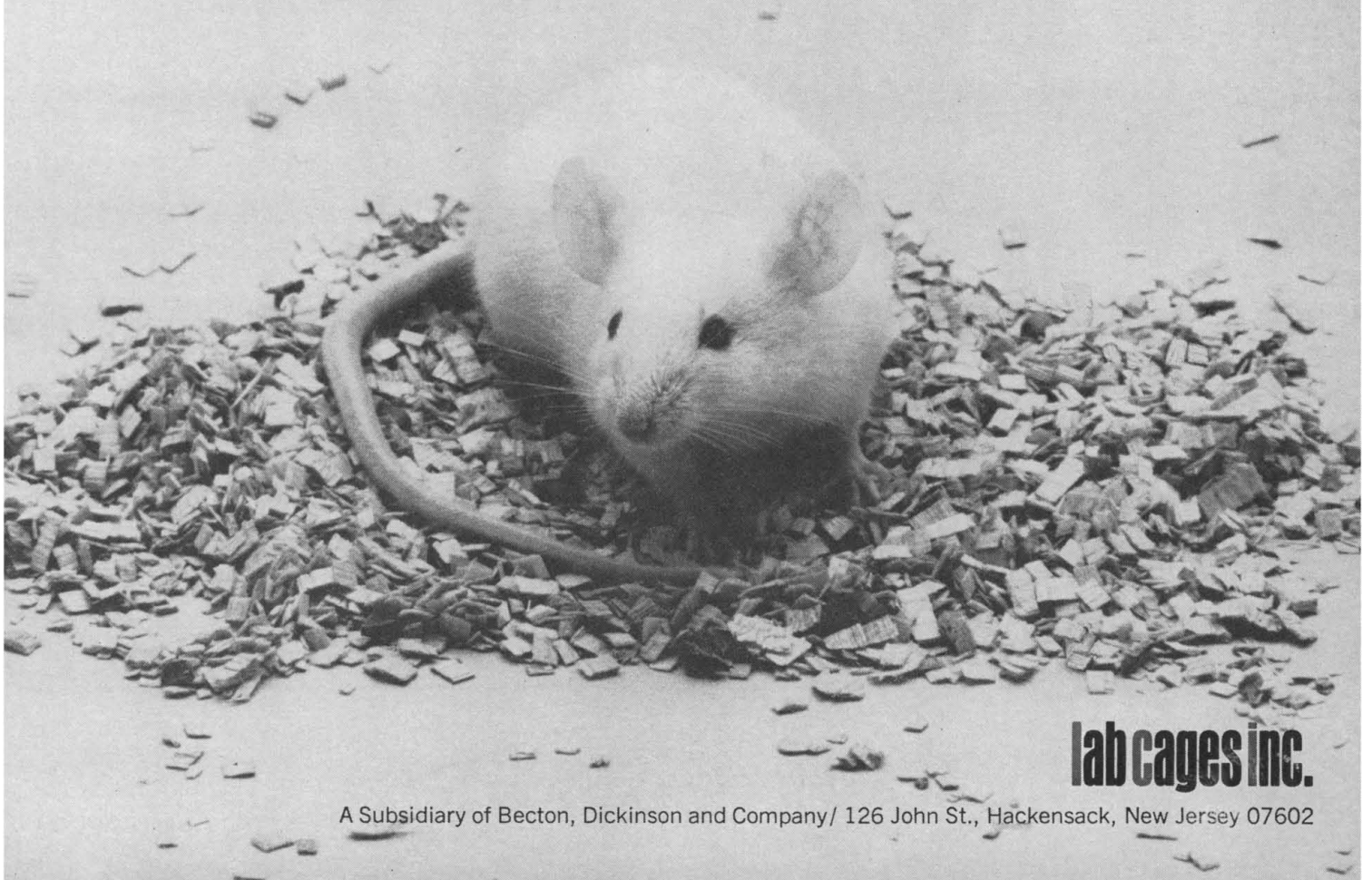
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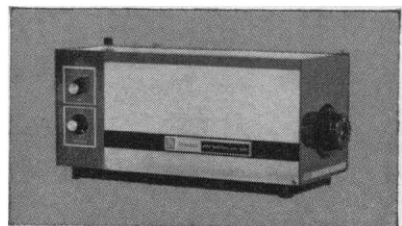


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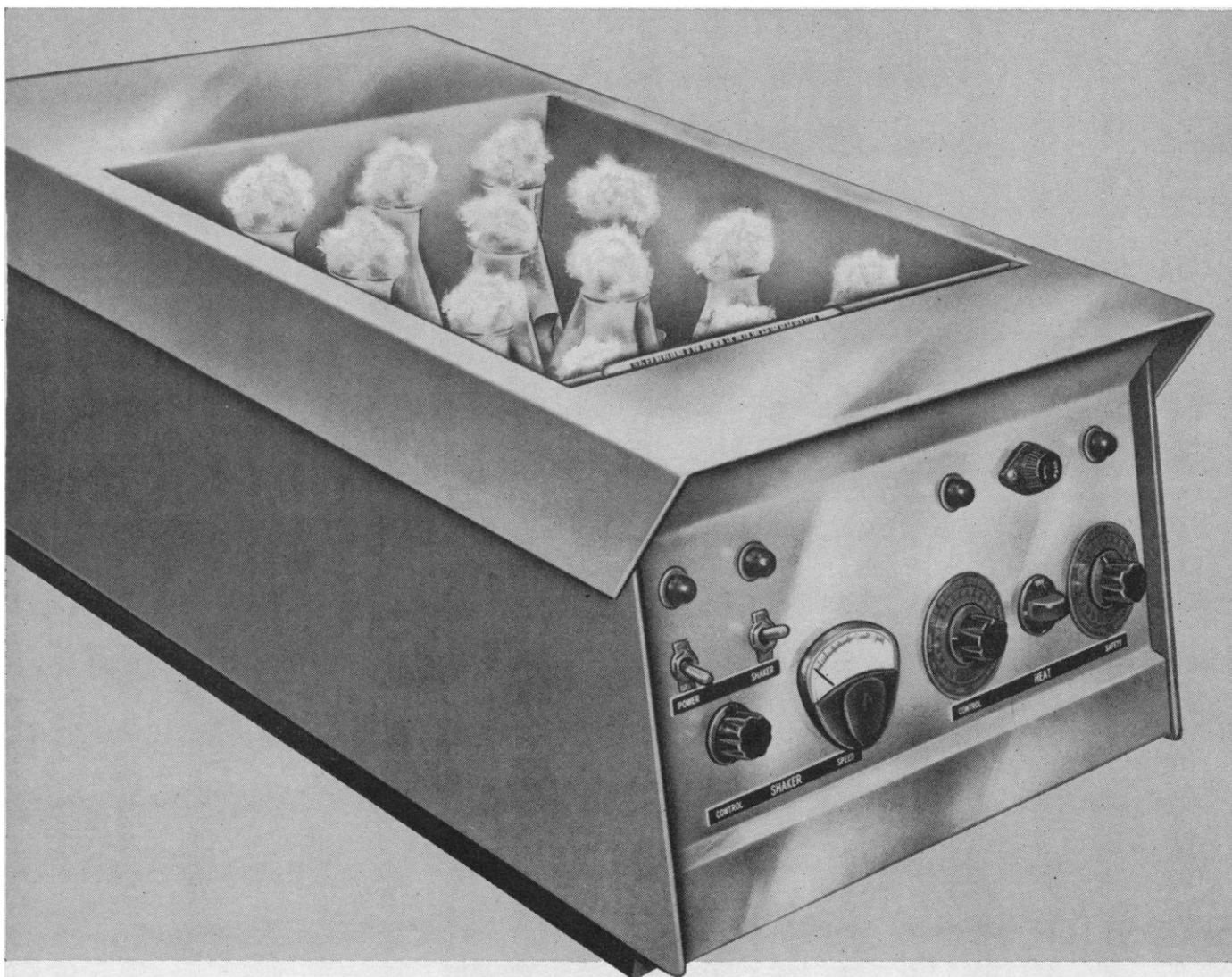
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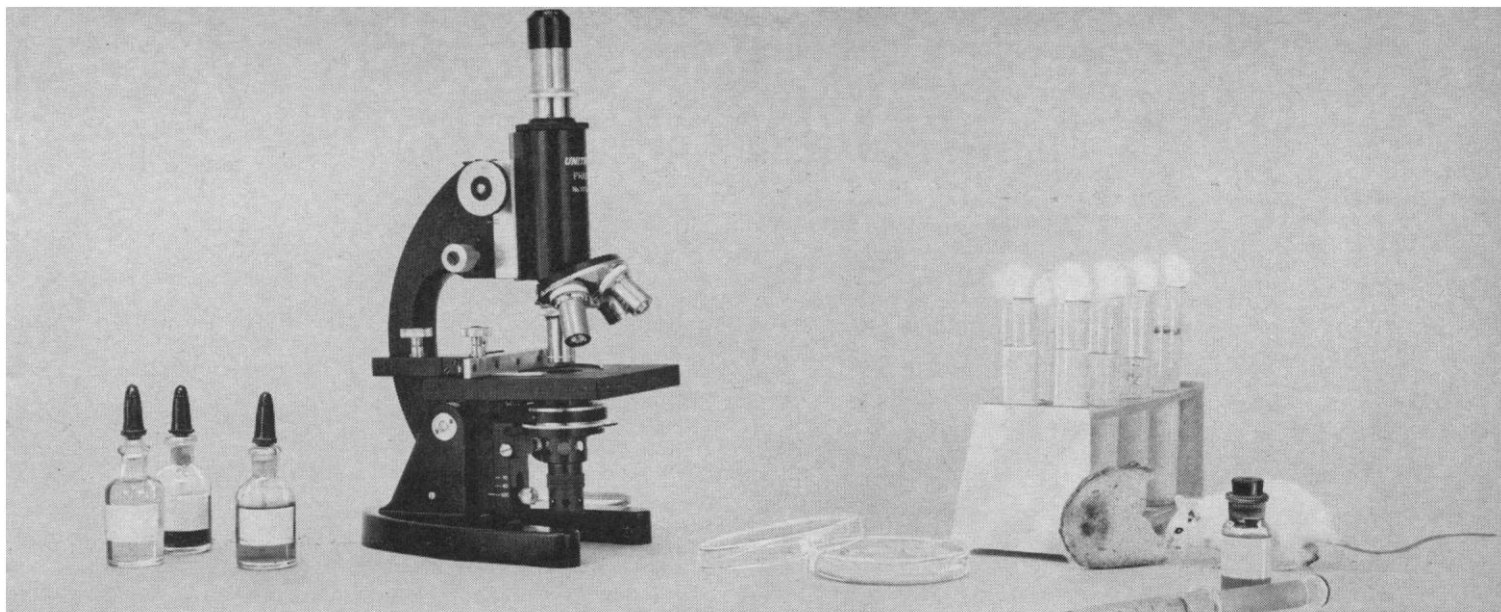
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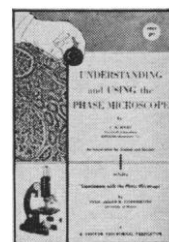
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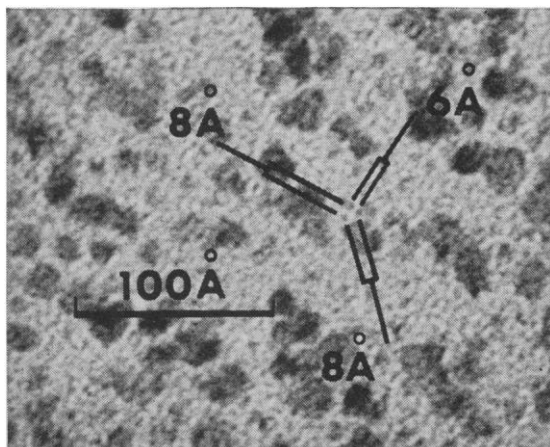


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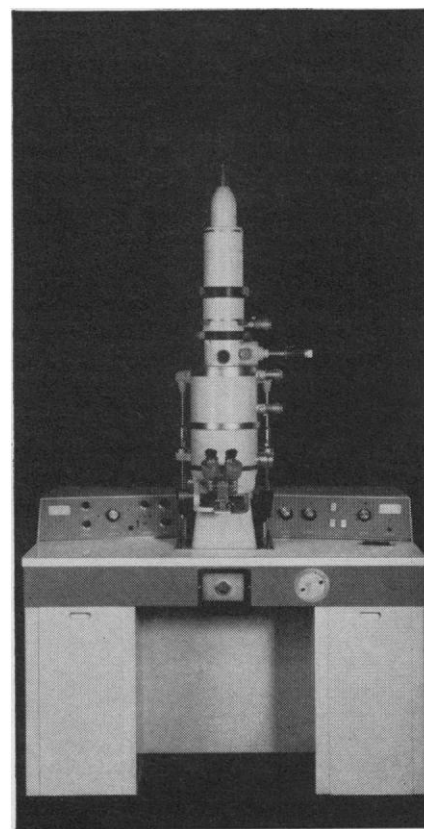
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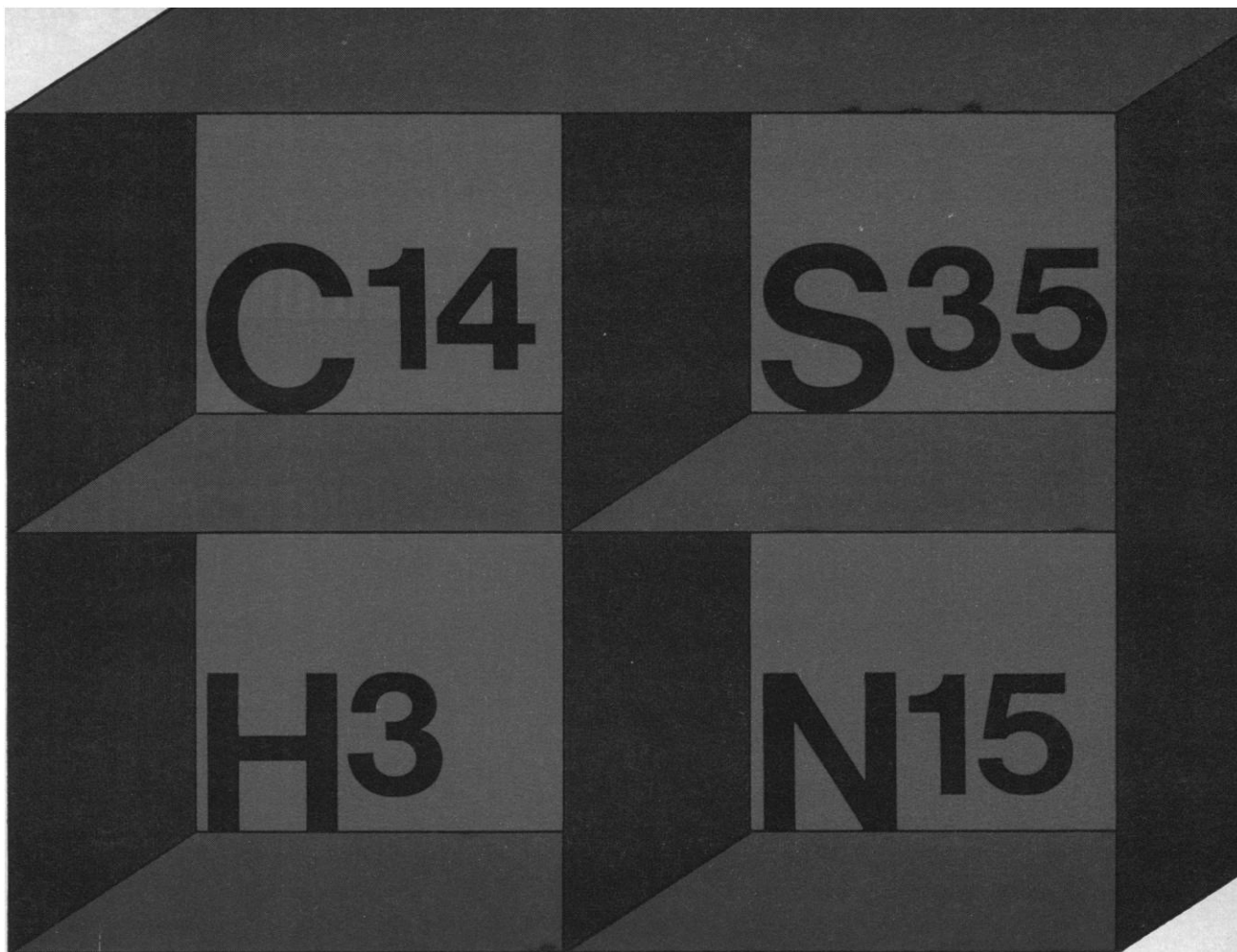
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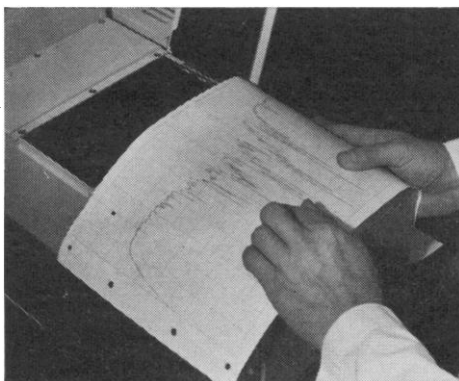


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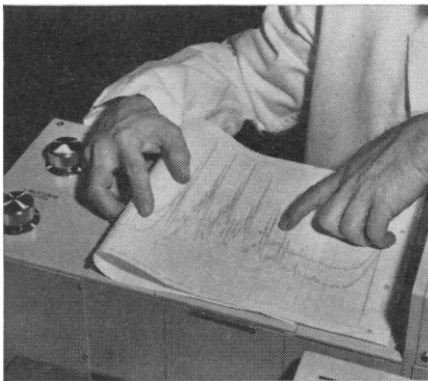
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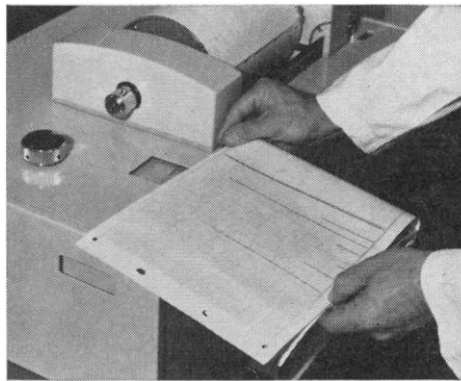
Here are some examples of its work:



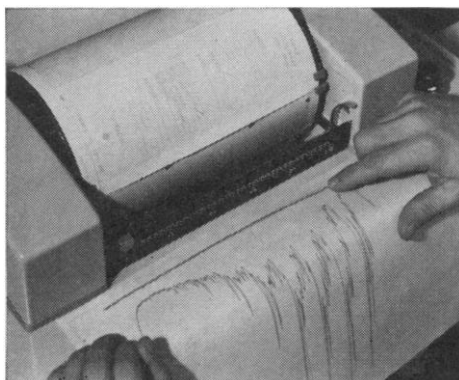
The chart above shows the remarkable resolution of Coleman Model EPS-3T. Critical adjacent peaks on the complex benzene vapor profile are clearly delineated.



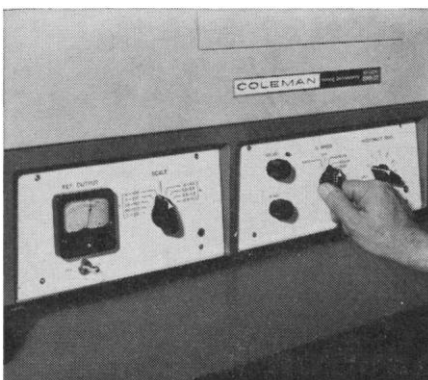
To demonstrate repeatability, the instrument overprints the same chart from the same sample. Note that chart presentations are all linear, not logarithmic.



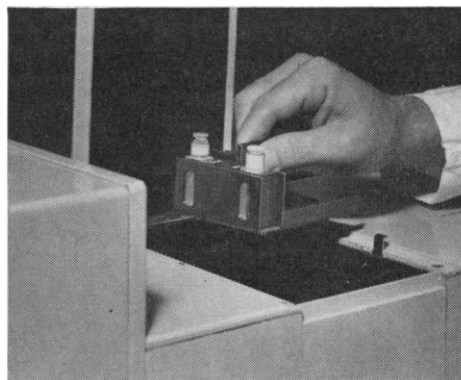
A significant mercury spike, perfectly centered at 253.7 $m\mu$. Wavelength accuracy is not affected by changes in ambient temperature. Photometric accuracy is 0.3%T.



Above, the 100% T line of the Coleman Model EPS-3T at maximum sensitivity. The line is demonstrably flatter than that of any similar spectrophotometer.



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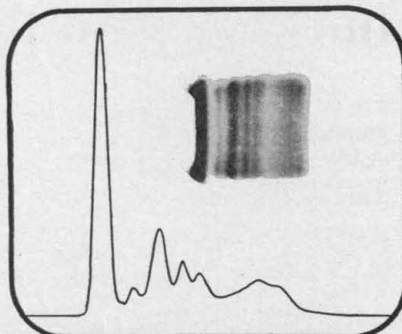
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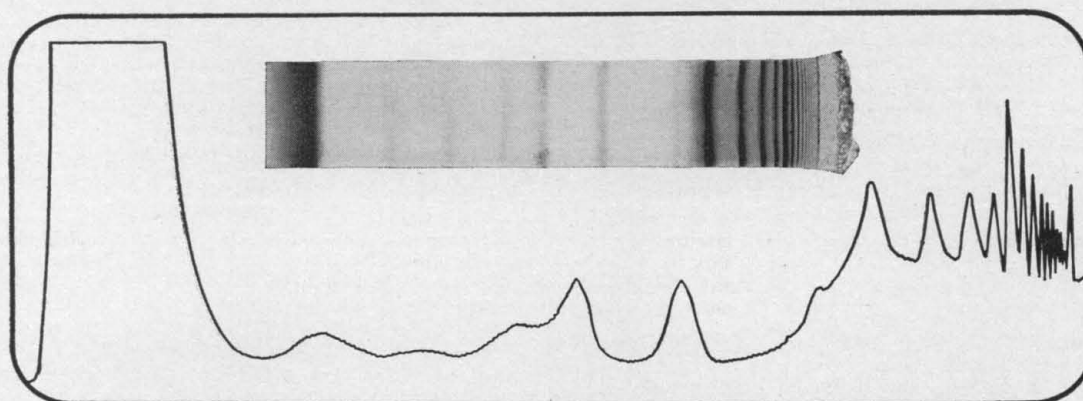


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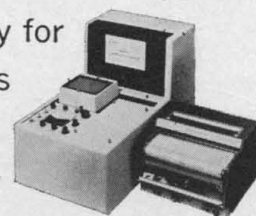
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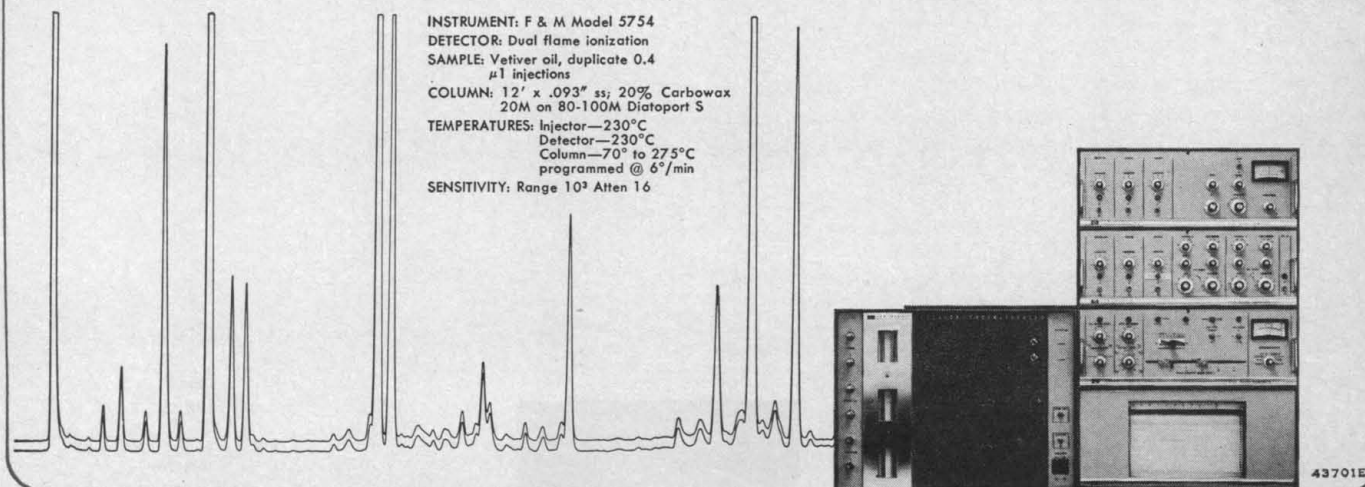
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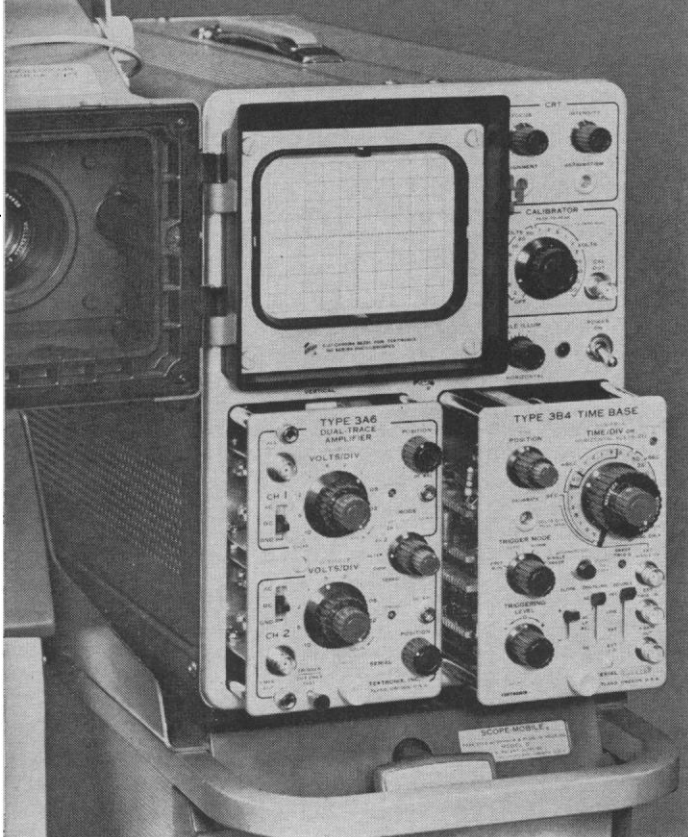
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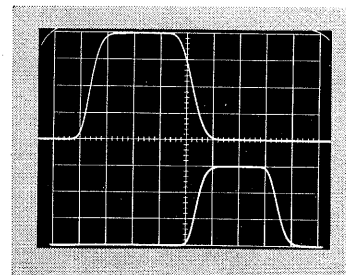
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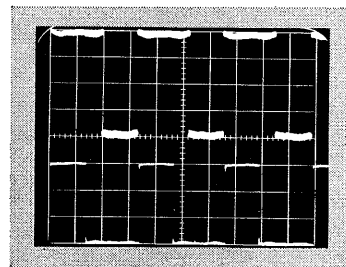
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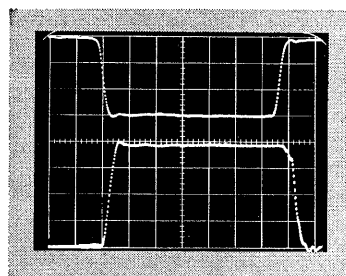


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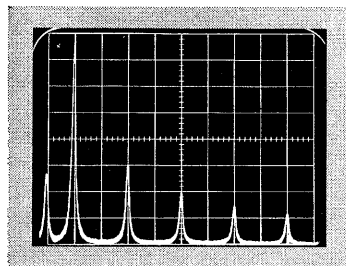
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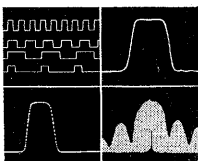
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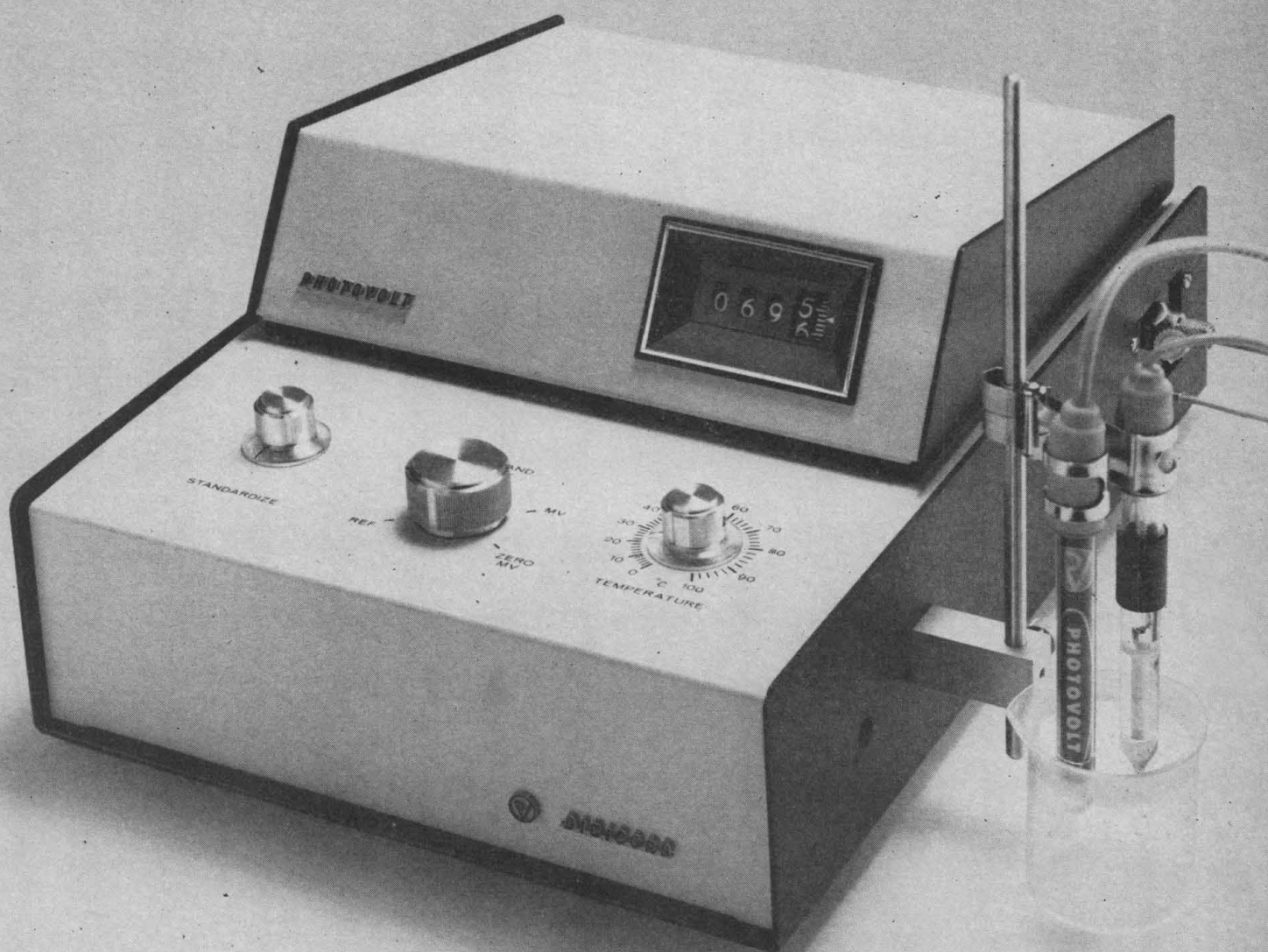
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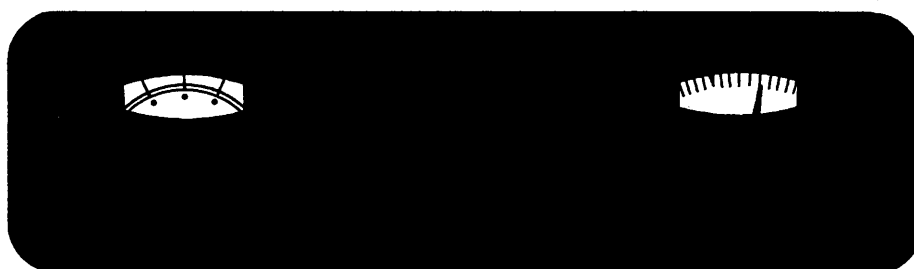
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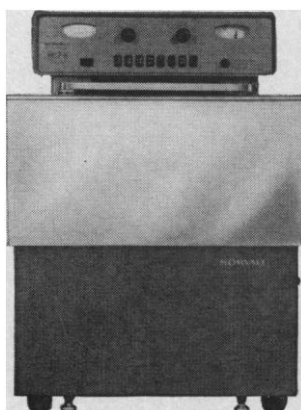
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Obviously, the single most important feature of photography is its ability to produce a permanent record of a visual happening. Something that may or may not be visible to the human eye. That may occur at a speed which would not make it visible to the human eye or that may occur in a place where it would not be convenient or even safe for a human observer to be.

It has long been acknowledged that the single most superior camera for most research purposes is the single lens reflex camera. Because all viewing and focusing is through the lens and is completely free from parallax error, then regardless of the combination of supplementary lenses, extension tubes and bellows extensions used, the image seen on the viewing screen is identical with the final picture.

Unfortunately, most of the single lens reflex cameras available to the researcher use the 35mm format and consequently suffer from lack of image quality when the negative is enlarged to any degree. This problem is overcome by the use of the 2 1/4 square format as in the Hasselblad system.

optics of Carl Zeiss lenses with built in Synchro Compur shutters allowing the use of both flash and strobe at all speeds, that the Hasselblad system does.

Here's what the Hasselblad System consists of. Firstly, the 500C, the standard camera in the system^A. It accepts all seven lenses available for the Hasselblad, and is a single lens reflex viewing camera. The 500C always shows you exactly how your final picture will turn out on the ground glass screen, in the same way a view camera does. This allows you to concentrate on the setting up and composition of your picture, no matter what lens or accessories you are using on the camera.

The lens, magazine, focusing hood and winding knob of the 500C are all instantly interchangeable.

Next is the Hasselblad Super Wide C. The camera that caused a breakthrough in 2 1/4 square photography. Equipped with a 38mm, 90° angle of view Zeiss

Biogon f/4.5 lens, this camera allows you to take pictures previously considered impossible. The superb optics of the lens assures perfect distortion-free horizontal and vertical delineation, with sharpness of image from corner to corner of the negative area, even at full aperture. Depth of field at an aperture of f/22 is from 26 inches to infinity.

The newest camera in the Hasselblad System is the electrically driven Hasselblad 500EL. This camera automatically advances the film and cocks the shutter, allowing a rapid series of exposures to be made, either by use of the camera release or long release cords, timer or remote radio control. The 500EL accepts all the lenses and most accessories available for the 500C. Obviously one of the advantages of this camera is that the photographer is freed from the actual mechanics of picture taking and can therefore, devote himself completely to the subject.

The use of the 500EL with the Hasselblad 70mm film magazine, (up to 70 exposures on cassette loaded 70mm film) allows the photographer, working on a job where a large number of exposures are required, to handle his work load much more quickly and efficiently.

There are seven Carl Zeiss lenses in the Hasselblad System, 40, 50^B, 80, 120, 150, 250^C and 500mm. Each lens has a built

Five different instantly interchangeable film magazines are available. These magazines allow the photographer to make 12 or 16 exposures on 120 film^D, 24 exposures on 220 film^E and 70 exposures on 70mm film. The magazines also allow the choice of 3 formats, (2 1/4 square, 2 1/4 X 1 1/8, 1 1/8 X 1 1/8). This allows not only for speed of operation, but the convenience of being able to change either film type or format in mid-roll.

Completing the system is a huge range of accessories that includes extension tubes and bellows extensions for close up work, filters, transparency copy holders, cut film backs, eye level prism finders^G, sports view finders, sun shades, rapid winding crank^I, quick focusing handles^J, grips^K, underwater housings, ring lights, tripod quick coupling^L, microscope attachments and carrying cases.

We have purposely avoided discussing specific applications to which the Hasselblad system might be applied. Not only because of the limitations of the space available, but because the number of applications is almost infinite.

Hasselblad systems are being used today in many branches of science and industry. And are even a part of the NASA space program. Shown below are just a few parts of the system that seem to have become particularly popular with many people engaged in some aspect of science or industry.



The simple fact is that there is not one camera system available today which offers the scientific or industrial photographer the choice of camera bodies, interchangeable film magazines, accessories and attachments, plus the superb

in Synchro Compur shutter, with automatic stopping down at the moment of exposure and manual preview for depth of field checks. Every lens has both M and X synchronization allowing the use of flash and strobe at all speeds up to 1/500th of a second.

This description of the Hasselblad system has been necessarily brief. If you would like a Hasselblad catalogue or further literature or if you have a specific technical inquiry write to Paillard Inc., 1900 Lower Rd. Linden, New Jersey 07036.

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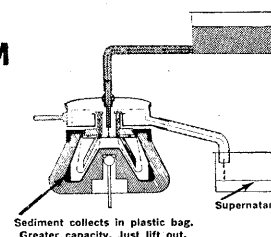
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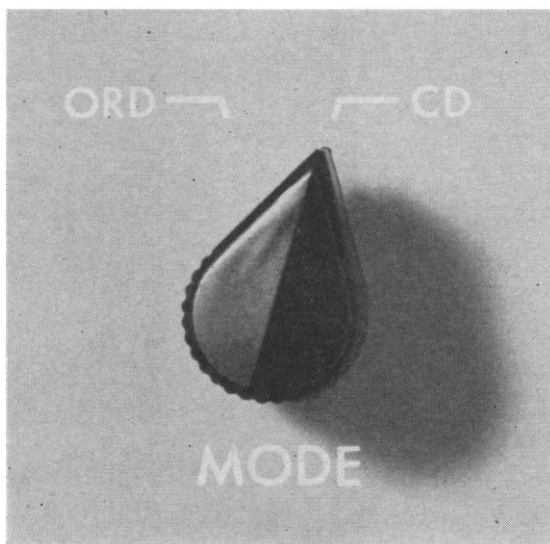
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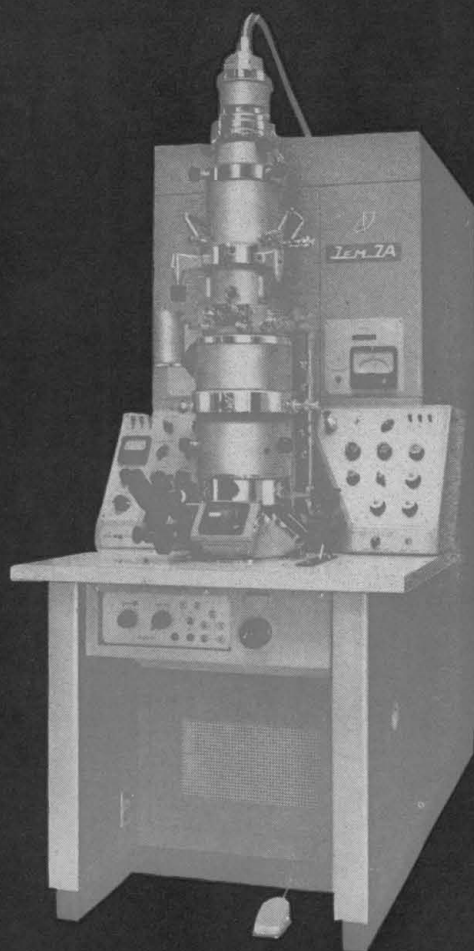
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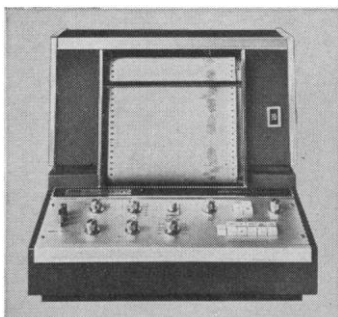
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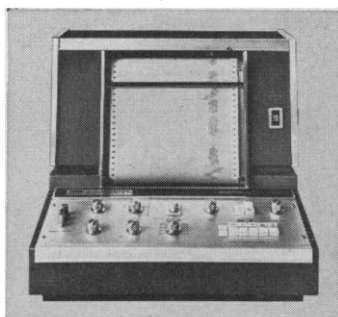
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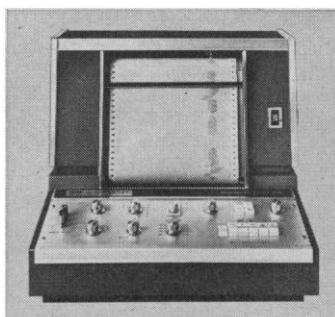
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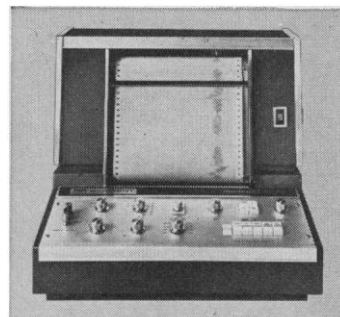
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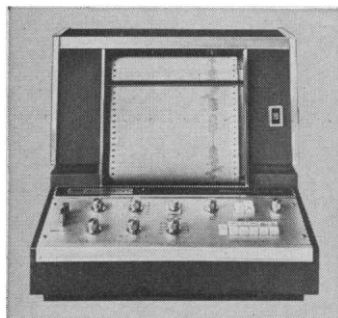
QUANTITY RECORDED: mV, V, μ a and ma—selected by panel switch.



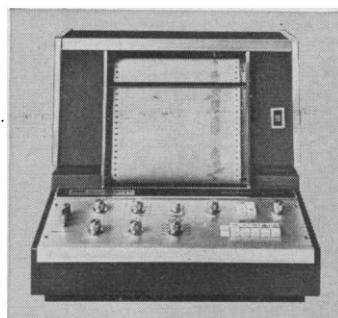
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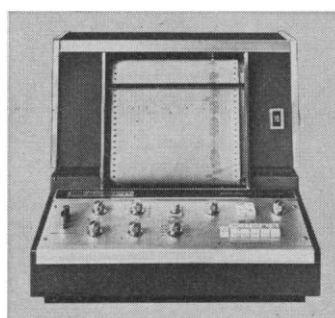
LIMIT OF ERROR: 0.1% or 5 μ v, whichever is greater.



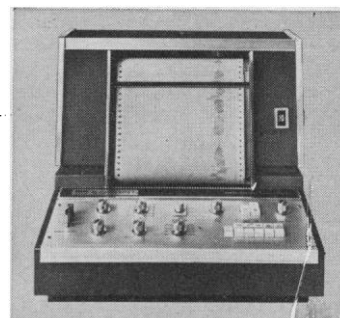
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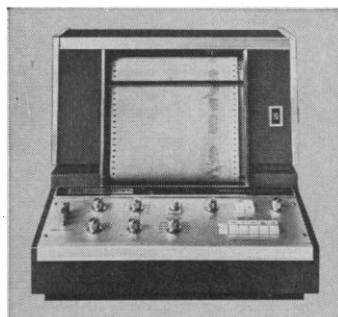
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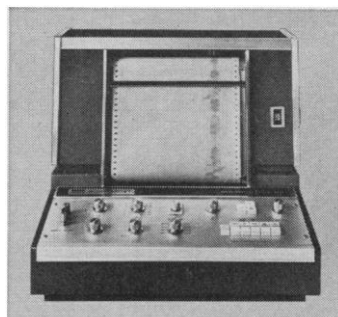


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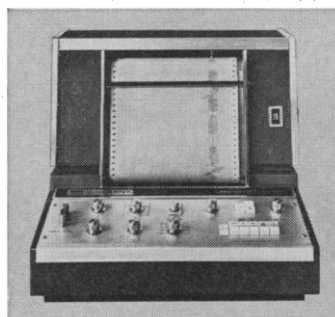
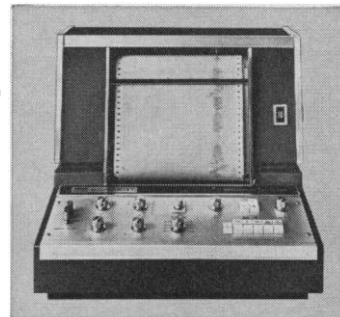


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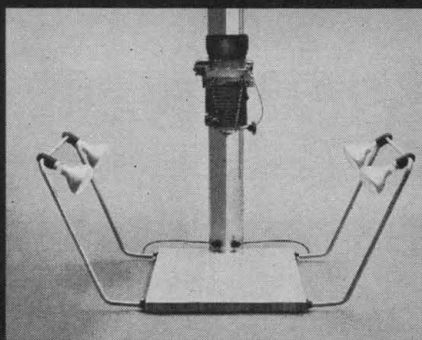
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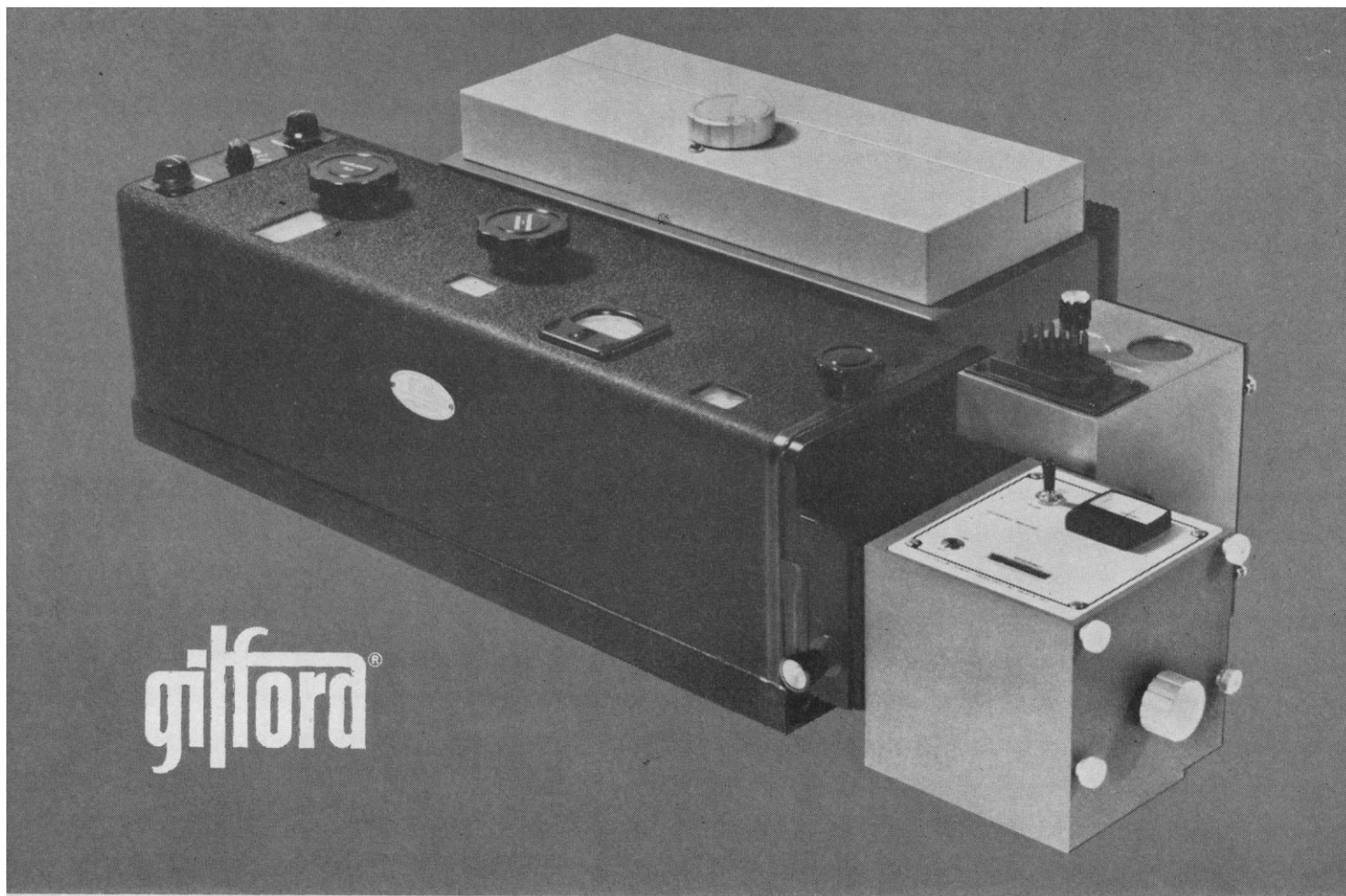
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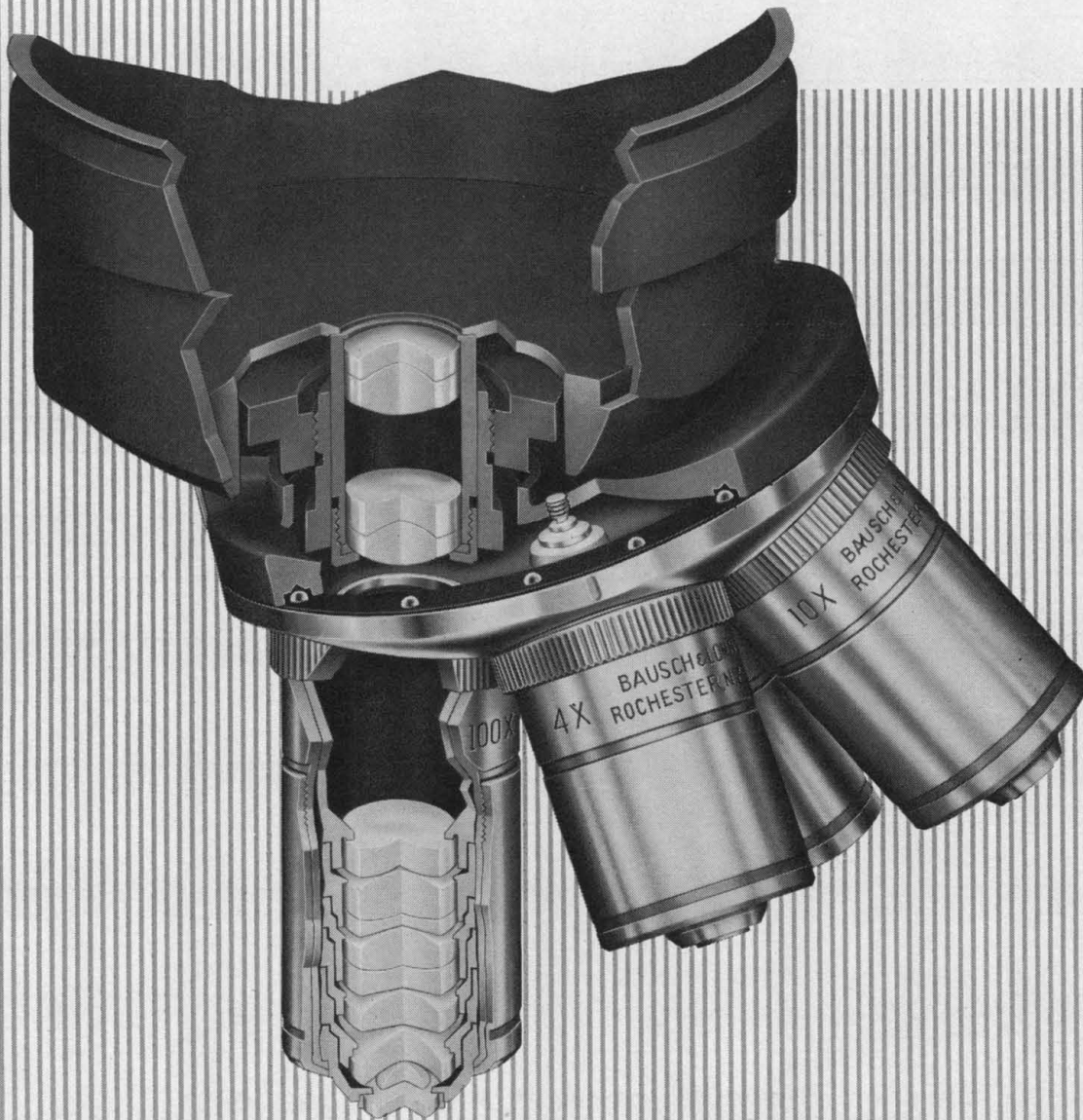
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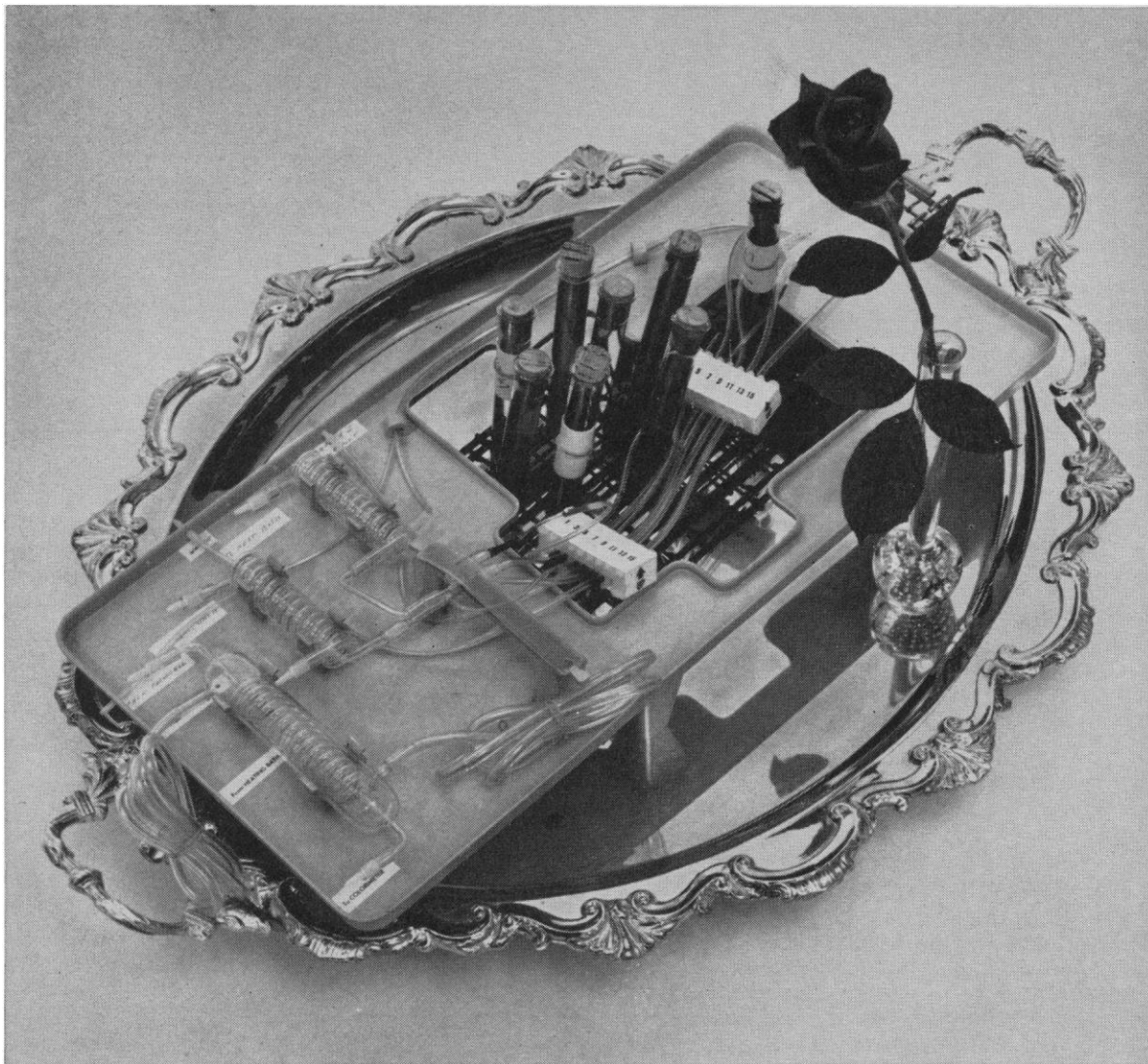
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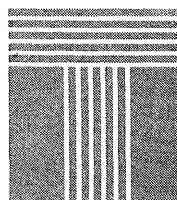
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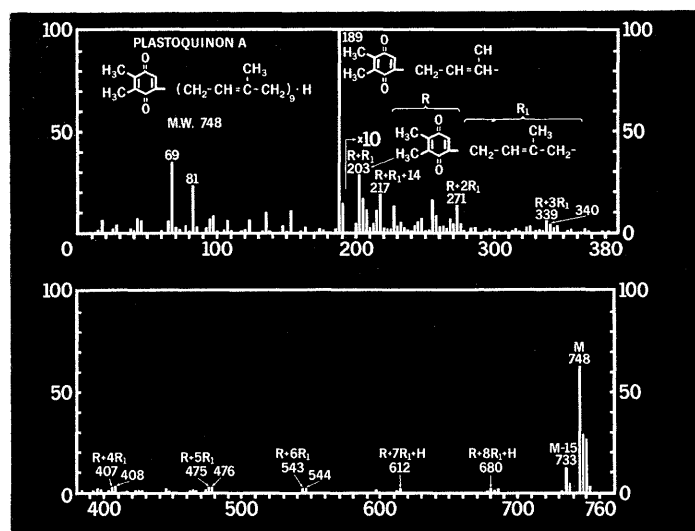


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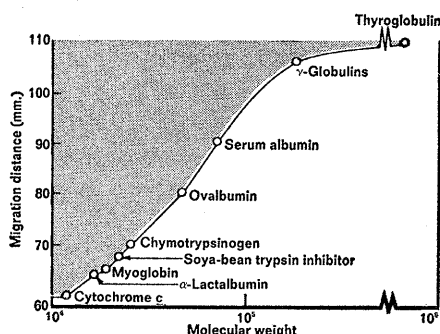
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try out new ideas. Foundations, in fact, are most frequently criticized for a lack of courage and imagination in supporting innovation, not for their failure to contribute to regular and ongoing budgets.

There is a good deal more that can and should be said on this topic (1).

WARREN WEAVER

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Reference

1. W. Weaver, *U.S. Philanthropic Foundations—Their History, Structure, Management, and Record* (Harper & Row, New York, 1967), chap. 12.

Does Science Neglect Society?

Although I am essentially in agreement with Weisskopf's letter (25 Aug.) that we should support all that is valuable in our civilization, it is time that percentages of our gross national product be used with caution and modesty. As Seymour Melman points out, only a frighteningly small percentage of our GNP is being used to add to the real value of our society (1). A huge remainder, for example, \$50 billion, is being used primarily to increase or maintain our "overkill" capacity. It is because of the woefully inadequate sums being spent in the human sector of our society that a \$200-million item (merely two Polaris submarines) can cause such a furor.

HANS WYNBERG

Department of Organic Chemistry,
University of Groningen, Holland

Reference

1. S. Melman, *Our Depleted Society* (Dell, New York, 1966).

One thing worries me more than the dollar drain connected with our present accent on basic science. There is a gigantic intellectual drain. No doubt the very top young minds today are attracted to basic science because that's the only place where there are clear, challenging, and solvable problems. This is wonderful to a certain extent. Our first-class minds are solving first-class problems. But I think they also use it as an escape. How many also turn their powerful intellects onto the many social and political problems facing the country? Some are willing to serve on summer studies but how many will take a year or two from research to attack our problems in urban affairs, pollution and con-

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servation, education, and our overseas politico-military questions? Admittedly, 2 years off in some of these fields means an irretrievable loss in rank, but perhaps these indefinable rankings are a hazard to the health of the country.

As the flowering of art seemed to strengthen past cultures, maybe the flowering of basic science in ours can cause an illusion of robustness that masks some fatal illnesses. Few great cultures have died from external attack while they were healthy. First they went through a period of blindness to their inner diseases.

Unfortunately, as J. R. Zacharias pointed out recently, there doesn't seem to be any sense of urgency among our great scientific minds (social and physical) as there was in 1940. However, the threat to our nation is even greater now than it was then. Furthermore, although fund granting has become a way of life within government, administrators in Washington are not taking a leadership role in finding good minds to work on these problems. Perhaps they could develop a sabbatical system to encourage the taking of leaves from the big science areas.

JOHN R. FRIEDMAN

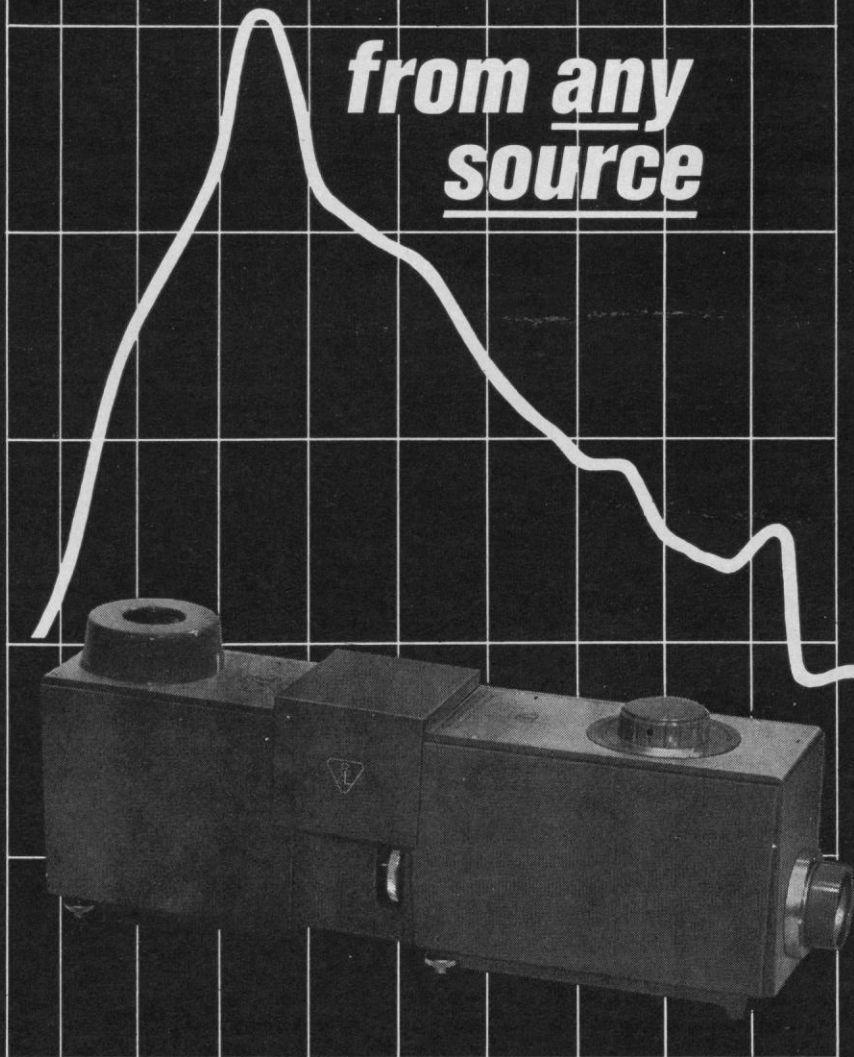
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As one who has a personal stake in the science industry, I wish that Weisskopf had been able to make a more convincing case for "the relevance of science during times of stress." Alas, it is not enough to respond to critics of the Age of Technology with *scientia gratia scientiae*, for some of these critics pose difficult questions. As they observe the electronic affronts to human dignity, the threat of nuclear extinction, the fouling of the environment, and the citizen revolt against the vastness of our technically based institutions, these critics wonder whether science is an unalloyed blessing. They might not wholly agree that scientific effort is "a part of our cultural heritage which makes our lives worth living." A few would remain unconvinced even when informed that "science is the basis . . . for industrial progress," and, though instructed "never to forget the aims of our civilization," they take these aims to be more concerned with the fulfillment of human ideals than with the gratification of artificially stimulated human acquisitiveness. They tend to resist the concept of an ever growing science establishment feeding a constantly increasing

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Nor can one pass off such critics as a collection of chronic malcontents since they include the likes of Louis B. Sohn, of Harvard, whose report *The United Nations and Human Rights* was recently submitted to the U.N. by a committee of distinguished Americans. The report, dealing with the threat to individual freedom by applied science, says, "There is cumulative danger in the merry march of technology and science without adequate considerations of the social effects" (New York Times, 5 Sept.).

Norbert Weiner once remarked that, as science becomes more and more able to achieve human purposes, it must become more and more accustomed to the task of formulating human purposes. Scientists have given a large amount of lip service to its social responsibilities, but the public view is that science is becoming more and more captive to an "establishment" that is committed to purposes that are something other than human. In fact, I wonder whether the 200-Bev accelerator, the supersonic transport, the space program, chemical and biological warfare, and genetic tinkering are really steps toward the better life.

DAVID W. KEAN

19687 Gary Avenue,
Sunnyvale, California

Decline of the Lobster

Emery and Iselin say that considerable controversy exists about whether the ocean can support much more efficient and intensive hunting ("Human food from ocean and land," 15 Sept., p. 1279). There are a number of areas where marine agriculture could effectively be practiced because of special geographic and physiographic peculiarities. One such location is the Northumberland Strait, which lies between Prince Edward Island and Nova Scotia, Canada. To date this ocean area is relatively unpolluted, and has in the past been very productive of certain kinds of marine animals, particularly lobsters and scallops. Current fishing practices are hopelessly inefficient (small lobster boats, lobster traps, and individual shellfish raking operations). However, perhaps because of the large number of "hunters," the catches have declined in recent years in a spectacular way. I have privately interviewed

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a number of fishermen in the area, and the average catch per lobster boat per season has declined from 16,000 pounds (7000 kilograms) in 1964, through 12,000 in 1965 and 6000 in 1966, to 1500 to 2000 pounds in 1967. Economically this is a marginal venture, and biologically the system is out of control.

To take advantage of the natural resources of this piece of ocean, it is obvious that individual free enterprise must immediately be replaced by an effective system which could be sponsored by either government or a large industrial concern. The basic conditions would have to be: (i) that this concern have the sole rights for hunting or fishing in the area; (ii) that it conduct biological surveys to determine the best agricultural practices consistent with optimum catches; and (iii) the clear recognition by all concerned (including the out-of-work lobster men!) that this is the only effective way in which the maritime resources of the country can be developed.

The same approach could be applied to such areas as the Grand Banks and the North Sea fisheries, but it would first be necessary to settle questions of sovereignty or international agreement. Areas lying wholly within territorial waters, like the Northumberland Strait, could well serve for experimental or pilot projects.

R. G. S. BIDWELL

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Openings for Negro Engineers

Father Fichter's report on opinions of Negroes (News and Comment, 6 Oct., p. 99) states that many of them believed that no opportunity existed for them in engineering. To me this view is clearly inaccurate. As an engineering professor, I had a conversation with a company interviewer who was actively looking for a Negro. He had not long before turned one down who was not very good, but government pressure had become so intense that he was looking for any warm body. Their opportunity will probably continue to be superior at least until there is one in every engineering department. . . .

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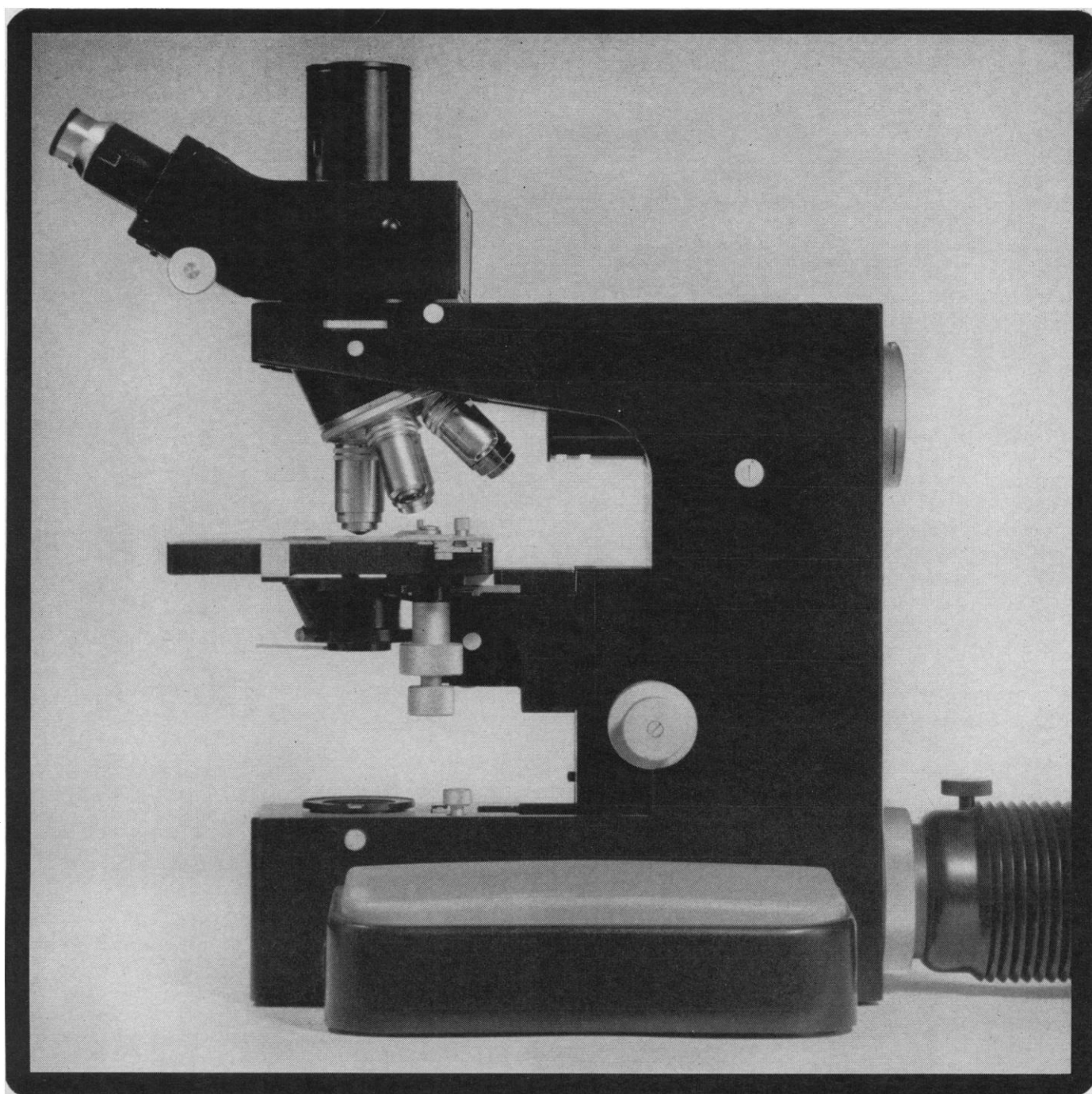
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Student Anxiety

Each generation of university undergraduates has questioned to some degree the value system of its elders. There has always been a small activist fringe advocating radical change. However, in the past, a very large majority of students neither probed very deeply nor were discontented with what they found. The mood on campus today is drastically different. Students are grappling with major questions with unprecedented intensity.

At Washington University, St. Louis, the fraternities on campus recently conducted a 3-day symposium entitled "Man Against Himself?" Some of the thoughts expressed by the fraternity men were as follows:

Society's institutions today fall far short of what serious college students expect. We look at the church and see an institution that is more a social gathering place than a source of spiritual inspiration. . . . We look to the business community and the professions . . . and we are troubled by the mass bureaucracy which seems everywhere to stifle individual growth . . . and which promotes a striving for acceptance which is often at the expense of justice.

We look to government and wonder whether our vote and our voice is really heard. . . . We see a war which we are asked to fight, but whose course we have little if anything to say in determining. We wonder whether the communications media are shaping our thoughts . . . through presentation of a managed view of the world.

In discussions at the symposium and in conversations at fraternity houses in which I participated, no student vigorously defended any aspect of our present way of life. Only a few advocated revolution, but many expressed deep unhappiness. What is worse, most seemed to be without hope, and religion had lost its role as a source of comfort.

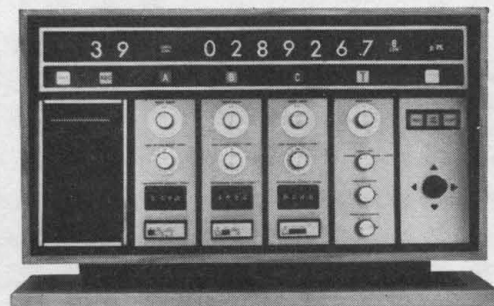
If this nation is to prosper, some of our brightest young men must enter the business world. However, few of the young men at the symposium were inclined toward a business career. Their attitude seemed to be even more negative than one recognized by a large company in a recent two-page advertisement in a national weekly: "Unfortunately, college kids don't even dislike American business. They just ignore it."

Discussion of the mass media elicited contempt, particularly contempt of material used in advertising. The offensive and phony appeals of some of the products of Madison Avenue contribute to the low esteem in which all industry is held.

Held in even lower esteem was government, an institution that students cannot ignore. When first queried, students cited Vietnam as a principal source of dissatisfaction. However, further questioning revealed that a majority of the fraternity men were not highly critical of our role in Vietnam. They did not defend our moral position, but they did not criticize our stance. The focal source of discontent is the draft. Students dislike the prospect of an interruption in their lives just as they are contemplating graduate school, a career, and marriage. Only part of the students will eventually be drafted. However, almost all live in tormenting uncertainty, unable to plan their lives. Few humans live comfortably for long periods under the stress of major uncertainty. The students are no exception. Almost all have responded by developing negative attitudes toward the major institutions of society. As yet, only a few have resorted to violence, and it is unlikely that many will. However, there is sickness at the universities, and society must respond sympathetically. As a first step of high priority, a mechanism must be developed and implemented to remove the uncertainties of the draft. Although use of a national lottery has been criticized, its liabilities would be small in comparison with the damage currently being inflicted.

—PHILIP H. ABELSON

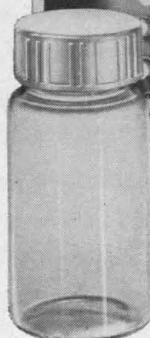
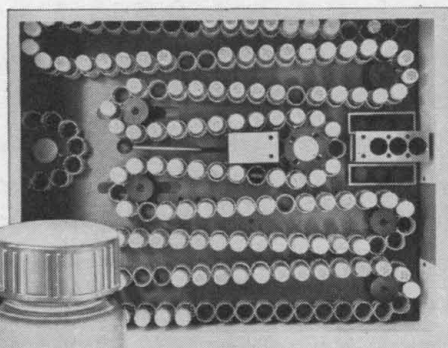
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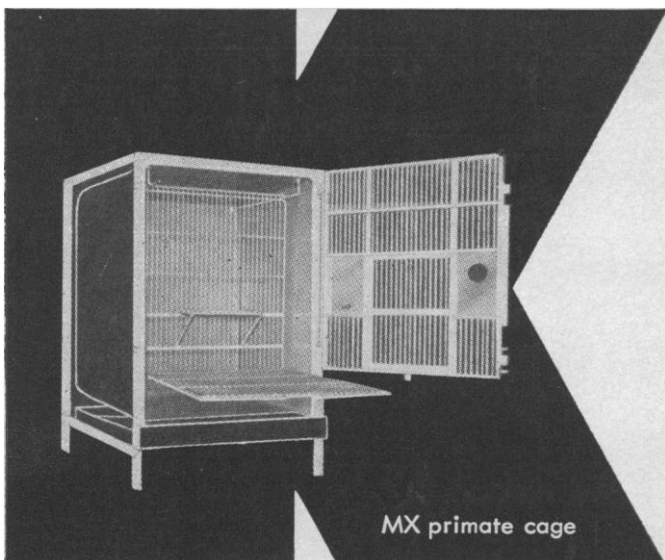
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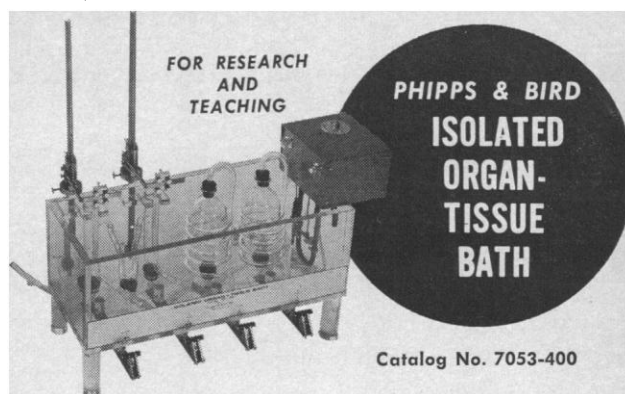
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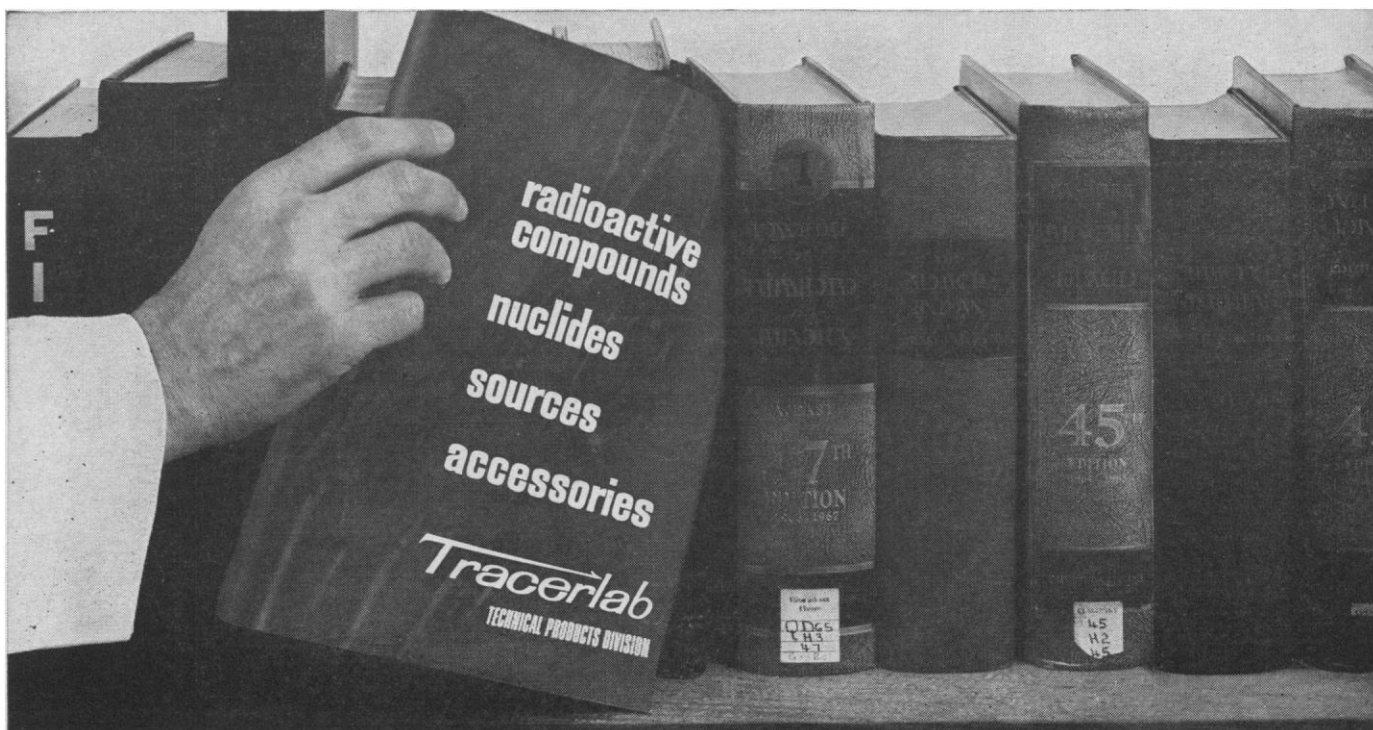
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of drugs varies from species to species. It has been clearly demonstrated, for example, that the baboon is superior to other primates except possibly the chimpanzee in the study of reproductive problems. However, it may not be superior to the dog for cardiovascular research. The baboon is an animal in which epilepsy-like seizures may be readily created. It may also prove to be a most valuable animal for dental research. A study of this animal in depth by scientists of many disciplines has revealed valuable information in comparative medicine which will aid scientists in many fields.

The study of anesthetic products on a comparative basis has just begun. There is a considerable variation of susceptibility among different species of animals to anesthetic products and methods of anesthetizing. These differences can be useful in detecting dangerous side effects of anesthetic agents earlier, as in pharmacology research.

As in man, degenerative diseases occur in all species of animals as they grow older. Large numbers of aging animals are available in the population of companion animals—dogs, cats, and horses—which are kept by modern society until they are aged. Those in the clinics of veterinary colleges or other animal centers associated with large medical research programs will provide naturally occurring disease research models that could not be duplicated in a research laboratory. Many of these clinics will be able to accomplish the detailed clinical diagnosis and study necessary to make this valuable research material available.

Zoo animals offer an important opportunity to study environmental health problems. Over a period of years, these animals develop physiological adaptations to their captive urban environment, and may develop health problems which are specifically initiated by the environment.

The effect of social or behavioral stress on health can be evaluated in companion animals. Although psychotherapy will not be possible for these animals, correction of the animals' problem by the administration of drugs, by hormonal changes, or by changes in the environment may be possible and in a comparative way demonstrate valuable new approaches to psychological problems.

Research on animal genetics is a well-established research field with an experimental basis. As more information becomes available on human ge-

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This book develops the theory of space vehicle dynamics expressly for the purpose of aerospace engineering, and is written for those actively engaged in this field. The numerous chapters cover performance and stability aspects of single and multistage vehicles; techniques of separation and ballistic flight; satellite orbit; angular motion in space; and satellite location. It is assumed that the reader will follow the mathematical formulae easily and thus understand the techniques evolved. 106 text figures. \$13.50

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netics, study of the large colonies of inbred laboratory animals and closely related animals such as dairy cattle produced by artificial insemination programs may provide valuable comparative leads as an important basis for human health research. Many of the inherited defects in the human such as cleft palate are already known to occur in animals. The coordinated approach to comparative medicine as suggested by the conference may reveal and make available many new models of genetic defects.

Trauma and injury are common among animals. Animals could contribute valuable information in the study of devices calculated to restore weight bearing and mobility in a very short time. The animals can be used to evaluate materials proposed for prosthetic replacement of tissue. They are valuable also in studies of tissue transplantation and other reparative efforts.

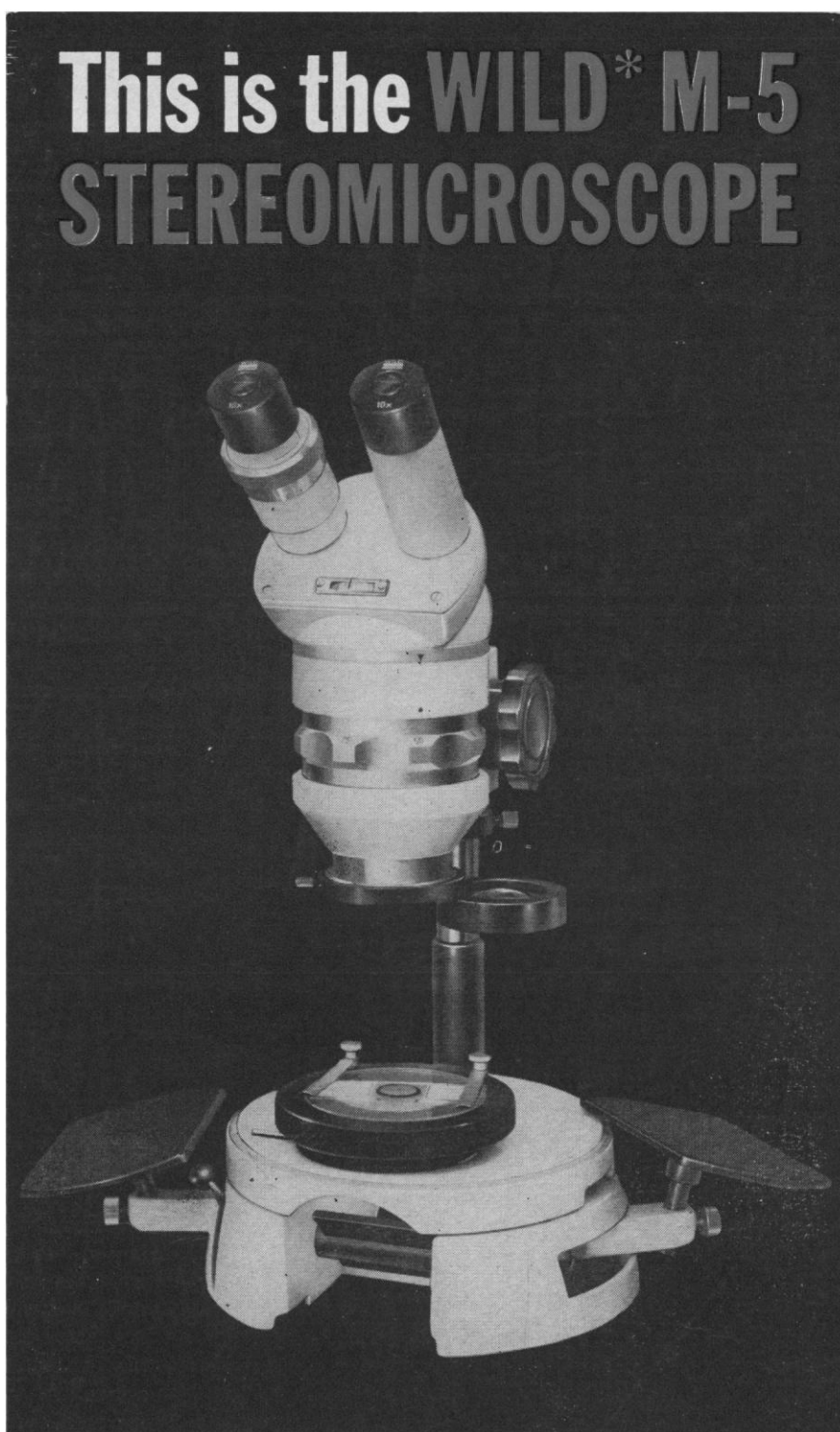
Plans for the Development of Comparative Medicine

The Workshop Conference concentrated on consideration of institutions or disciplines having the greatest potential to contribute to comparative medicine, and discussed the way in which they could more effectively advance medical research through comparative medicine.

Comparative Medicine in the Medical Center

A program in comparative medicine is needed at university medical centers and could contribute greatly to their immediate and long-range research goals. Medical centers have certain advantages as the major focus for attempts to develop such programs. First of all, they are already centers for ongoing research projects in human-oriented studies and at the same time employ animals of a wide variety in order to solve these problems. These medical centers contain groups of scientists with highly specialized abilities and knowledge, who could contribute to and profit by a comparative approach. Finally, their training programs would be of value to potential members of a comparative medicine group.

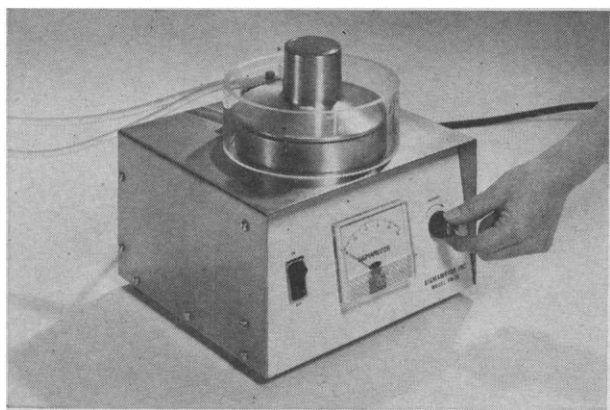
For the most part, the medical center can contribute to a comparative med-



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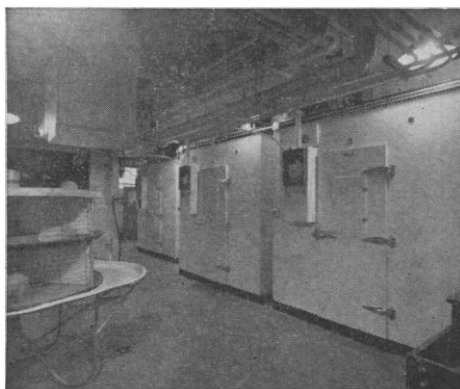


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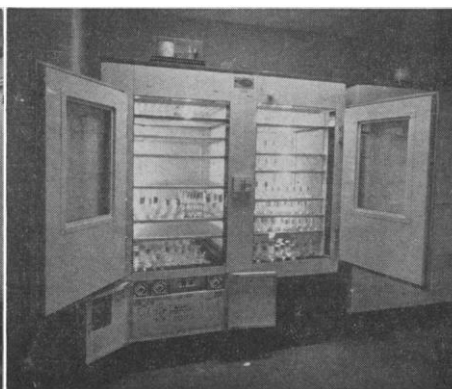
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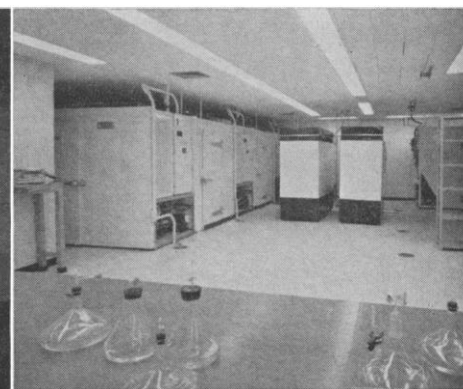
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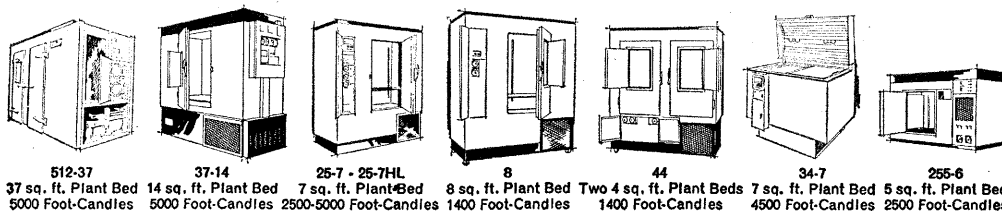
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icine program by providing training opportunities, by stimulating active research in disease, and by encouraging experienced scientists to participate in this work. Opportunities already are present for training in depth in various disciplines. What especially is lacking is the knowledge and the specific intent to see disease problems from a broad biological viewpoint. The goal of a comparative medicine program at a medical center thus would be to create an atmosphere that would stimulate interest in the study of a wide range of animals and plants. It would be a center of information in the field and would have the mission of extending knowledge both in breadth and depth.

There is a strong tendency for research scientists at most medical centers to penetrate more and more deeply toward molecular levels, with the result that they tend increasingly to neglect study of the entire organism and the overall disease process itself. On the other hand, a broad-based program in comparative medicine in such an environment could be a valuable complement to this trend, and could provide important new biological tools for the highly specialized scientists to use. Current in-depth studies by many medical scientists employ a wider range of comparative zoological material, but utilization of such material is often fortuitous rather than planned.

Such a loss of perspective results in overlooking opportunities that could come from full exploitation of the diverse possibilities provided in nature. Valuable insights can come from the entire biological spectrum. This does not exclude the molecular aspects of comparative medicine. The study of enzyme systems and fine structure should go hand in hand with the study of the whole animal. Specific recommendations include:

- 1) Bringing knowledge of disease processes to the zoologist. Medical specialists (pathologists, physiologists, microbiologists, biochemists) could participate in the presentation of courses in disease problems at the undergraduate level. Areas in the scope of a pathologist would be of great interest to a zoologist in dealing with basic processes such as inflammation, cell degeneration and necrosis, wound healing and regeneration, neoplasia and nutritional deficiency conditions.

- 2) Bringing zoologists and veterinarians into established training programs at university medical centers.

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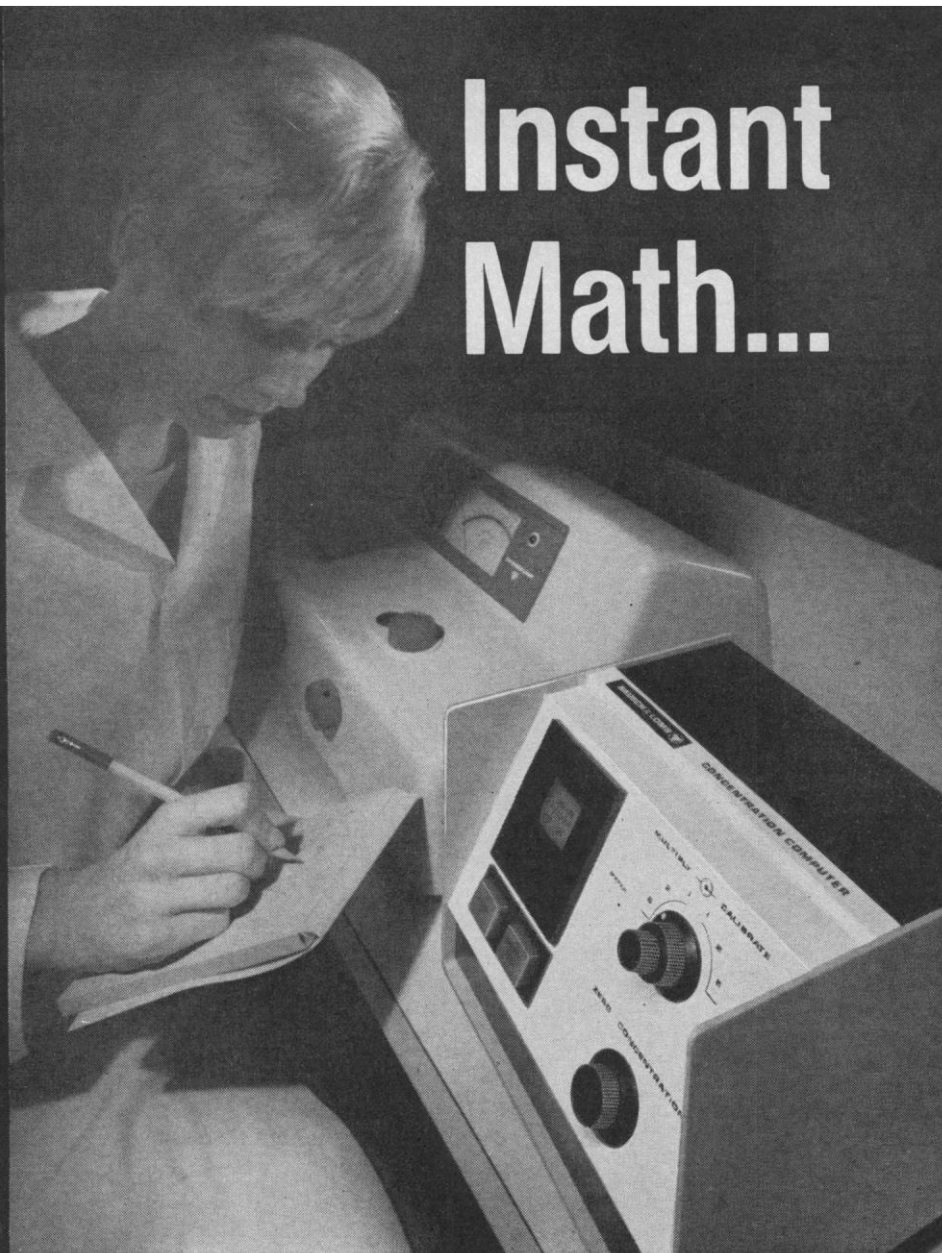
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Fellowships could be made available for zoologists or veterinarians who would desire to enroll in the Ph.D. programs in pathology, biochemistry, physiology, and other fields. Support might be provided for those with Ph.D. degrees in zoology who desire to obtain specialty research training in medical center programs.

3) Providing long-term support for comparative medicine programs to be developed within medical centers. Programs of this sort would of necessity be structured as appropriate to a particular university or medical center. For the most part, this support would probably require long-term commitment of salary support for a chair or professorship in comparative medicine, for the salaries of several additional faculty persons, and for the initial construction of laboratory and animal facilities.

One possibility is that such a program in comparative medicine could be placed administratively as a division within a department of pathology, and could be physically placed in the vivarium of the medical center. It is clear that the academic and research activities of the scientists in such a program would have to be distinguished from the service functions of the vivarium.

A conjoined title between disciplines such as pathology and zoology could be supported and might contribute to interaction between such groups.

Comparative Medicine in the Veterinary College

The vast wealth of clinical materials constantly presented to veterinary medical clinics may well represent one of the greatest sources of available comparative medical research material. These animal models would provide new avenues for sophisticated research not permitted on human beings. Animal diseases of comparative interest are frequently conditions which occur sporadically and are not the subject of great economic loss. Therefore, they have not been the subject of interest or research support by the agriculture or animal production community.

At the present time, little use is made of this rich source of information due to the lack of program support and physical facilities. There is obvious need to establish, at colleges of veterinary medicine, research hospitals staffed by disciplinary trained scientists

SCIENCE, VOL. 158



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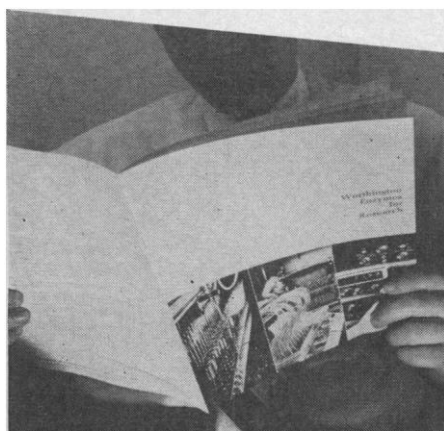


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who are sufficiently well supported that acquired and inherited animal diseases similar to those of man can be collected and studied. The nature of many of these studies will require long-term handling, observation, and treatment of subject animals. Special holding facilities will be necessary at certain centers to allow for the long-term maintenance of genetic lines and specific mutant stocks.

A potentially useful source of animals seen at veterinary colleges and certain animal research facilities are the animals that age as companion animals. They are especially valuable in chronic disease studies, in studies of the effect of environment, long-term medication, and social pressures. Specific examples of aged animals are the dog, the cat, and, more recently, the horse, which are ordinarily kept until they live out their days rather than until they live out their principal usefulness.

Artificial insemination rings which keep valuable bulls until they are in their advanced years provide another source of aged animals. If these animals can be studied in depth by research programs associated with large clinical programs, much significant and useful comparative medicine material will have been developed.

The preservation of such experimental models is of utmost importance so that veterinary medicine may make its maximum contribution to human health. It is expected that certain comparative studies would be conducted in-depth at colleges of veterinary medicine; however, it is recognized that more scientists with interests in specific diseases can be found in the many medical schools. An important role of the comparative medicine center at the veterinary college would be to make available to scientists throughout the country animals with specific model diseases.

It is of utmost importance that a coordinated effort be made within the National Institutes of Health to develop a system for disseminating information concerning the availability of existing animal models. In addition to the establishment of centers at certain veterinary colleges in close cooperation with medical institutions, a number of other programs should be initiated:

1) Symposia in comparative medicine to include investigators from medical and veterinary medical schools in order to exchange information on the potential material available in veteri-

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nary clinics and on the needs for comparative medicine material in medical schools.

2) Fellowships (multidisciplinary) in comparative medicine designed to integrate veterinary and human medical research programs and to apply comparative methods to biomedical research programs.

3) Publication of a compendium (by organ system) of existing animal models as to their nature, location, and present level of information pertaining to each topic.

Role of Zoological Parks in Comparative Medicine

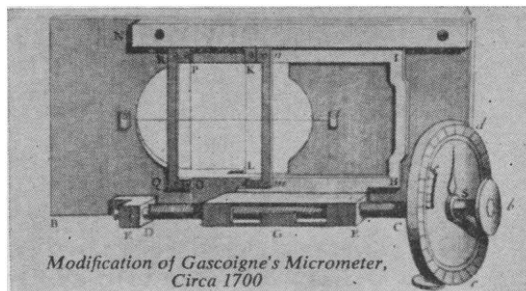
Zoological parks traditionally have been devoted primarily to exhibiting animals to the public; scientific and educational efforts have been built around this core objective. Research for the most part has been restricted to activities that would least disturb this fundamental direction. Taxonomy, anatomy, and to some extent physiology and pathology are amenable to these restrictions. Little effort, however, has been made to learn of the diseases which affect zoo animals and to extrapolate from this knowledge information this is of value to the science of medicine.

Notable exceptions can be found in the United States at the Penrose Laboratory in Philadelphia, the San Diego Zoological Gardens, and the Oregon Zoology Center in Portland. The Wellcome Institute for Comparative Physiology and the Nuffield Institute for Comparative Medicine at the London Zoological Garden have begun not only to make use of this source of comparative material but also to use it for research on an experimental basis.

The potential cannot be truly judged until much greater effort has been made to exploit the comparative medical aspects of zoo animals both in captivity and their natural habitat. The history of all biological research has taught us that the results of greatest significance are nearly always those which come as unexpected dividends. However, justification for funding agencies must be based on less ephemeral predictions. Fortunately, even limited efforts have yielded a considerable harvest from which we can point toward future possibilities. A few specific examples are:

1) Much valuable knowledge about the relationships of nutrition to ar-

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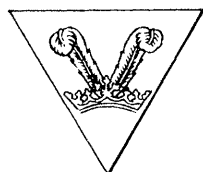
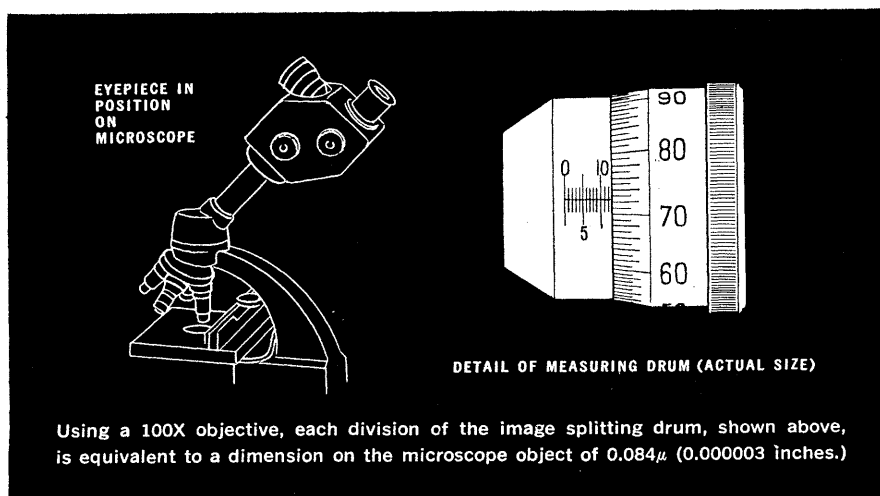


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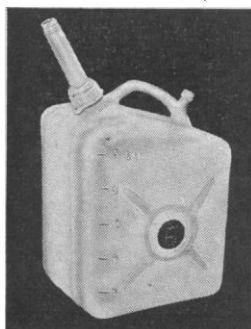
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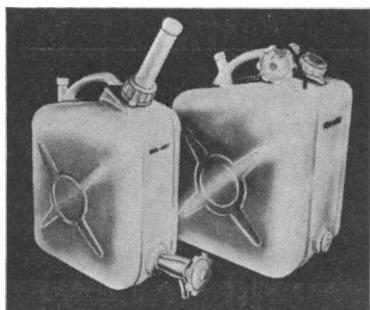


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teriosclerosis has been gained by studying specimens at Philadelphia and London zoos. Extension of these and related studies are contributing to our basic knowledge of arterial disease.

2) There has been a significant increase in the incidence of cancer in the animals of the Philadelphia Zoo during the past 30 years. This may have significance in relation to the pressure and pollution of urban environment. Indeed, zoo animals are usually located in urban areas and share with man the hazards of air pollution and crowding. Behavioral and pathological studies may help clarify the effects of urbanization upon the human population.

3) Metabolic bone diseases, especially of primates, have presented exciting and puzzling analogies with such human disease as osteitis fibrosa cystica.

4) Endothelial changes in parasitic infestation particularly by trypanosomes closely resemble those seen in man.

Those zoos which have a university affiliation are especially worthy of support because they are familiar with medical research methods and problems and can be expected to work profitably with medical research institutions.

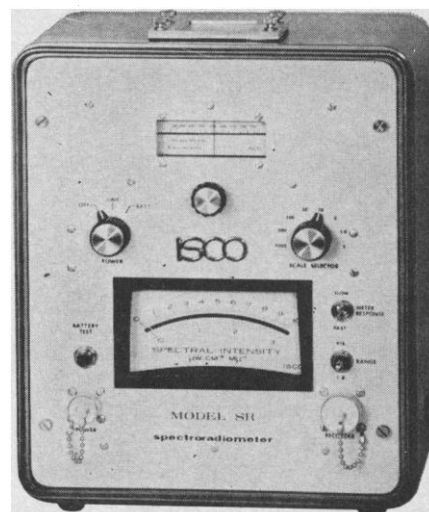
In order to encourage the development of research programs in zoos, the conference suggested the following activities:

1) Organization and support of a series of seminars in comparative medicine based upon studies of zoo animals. These should be held in outstanding zoos. They should utilize participants from such disciplines as physiology, biochemistry, and ethology but should emphasize pertinence of the work to human health and disease.

2) Establishment of a directory of zoo animals based upon identification of individual animals, up-to-date records of the environment, health, and age of each specimen. Careful postmortem study of each animal is essential.

3) Establishment of full-time research directors in zoos in close academic affiliation with universities, medical schools, or schools of veterinary medicine. Individuals of accomplishment in comparative medicine should be sought for such positions. These research directors should be encouraged to continue their own research programs, to develop training programs for young investigators and ancillary personnel, and to encourage visiting scientist programs.

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SCIENCE, VOL. 158

Role of Physiological Sciences in Comparative Medicine

Animals show physiological and behavioral adaptations or adjustments that make them uniquely suited to live in their particular environments. The comparative study of adaptations found within different species of animals with a continuum of varying degrees of stress makes it possible to define the physiological limits for such adaptations.

The goals of the suggested program are to measure and define such adaptation in both character and degree in a variety of environments such as cold, the desert, high altitude, tropics, salt water, and fresh water. To study animals in their natural environment is entirely different from a study of the animals under laboratory conditions. No understanding of the true adaptation of the animals can be gained unless one has observed first hand the extremes of the environment and the behavior and way of life of the animal. There is a peculiar lack of understanding of the value of field studies among most people in the health sciences. It is generally assumed that the same knowledge can be gained by bringing the animals to the laboratory. This is far from the truth. It is true that after the animals have been studied in the field, many problems can then be studied under more controlled conditions in the laboratory. In order to carry out these investigations the following are needed:

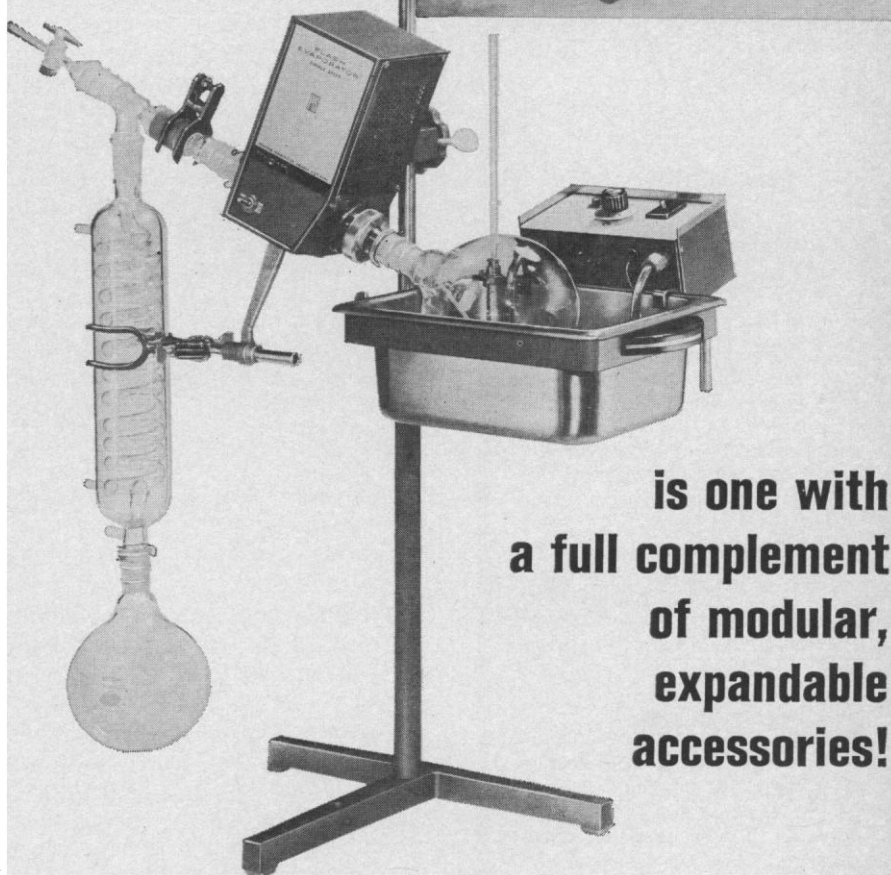
- 1) Well-established laboratories situated in extremes of environments, that is, an arctic laboratory, or desert laboratory, or tropical laboratory, or high-altitude laboratory, preferably associated with a university. These laboratories should have a permanent staff and should be well equipped. In addition, there should be facilities for collecting animals and maintaining them under almost natural conditions.

- 2) The second need is support of field stations and expeditionary efforts to conduct studies of animals found in particular environments where no well-established laboratory is present.

- 3) In order to make it possible to choose the right locations for field studies, it is recommended that a survey be made of available field stations throughout the world and a reliable list of the animals and services available at these field stations be prepared.

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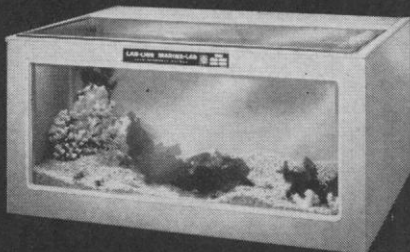


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tween established environmental centers or participation in field expeditions should be initiated. The expeditions and study at well-established field laboratories offer unique opportunities for training of younger participants. Trainees will be exposed to people who are used to working in the field and with first-hand knowledge of wild animals. It is assumed that the groups investigating animals in the field will include scientists representing various disciplines such as (comparative) physiology and biochemistry, pathology, veterinary medicine, and human medicine. This will offer opportunities for training of participants as well as for the trainees.

Behavioral Sciences in

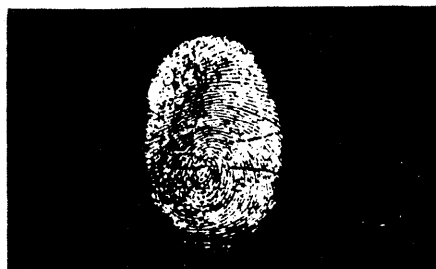
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Although much is known about behavior, in only a few species has the behavior of animals been studied in any detail. On the one hand, psychologists have tended to concentrate their efforts on working out principles of learning in such laboratory animals as the rat and the pigeon (although more recently their efforts have been extended to the primates). On the other hand, the zoologists (including ethologists) have tended to concentrate their efforts on the naturally occurring behavior of a variety of animals in normal environments. Another difference may be seen in the psychologist's predominant interest in the behavior of human beings—mostly in natural settings where controls are impossible or difficult to institute—while zoologists have limited their studies to infra-human organisms.

It is no longer necessary to keep these two avenues of approach apart. A science of behavior should be developed that does not restrict itself to any method or any organism but which would include both laboratory and naturalistic studies of a variety of animals, man not excepted.

In addition to the development of research projects between zoologists



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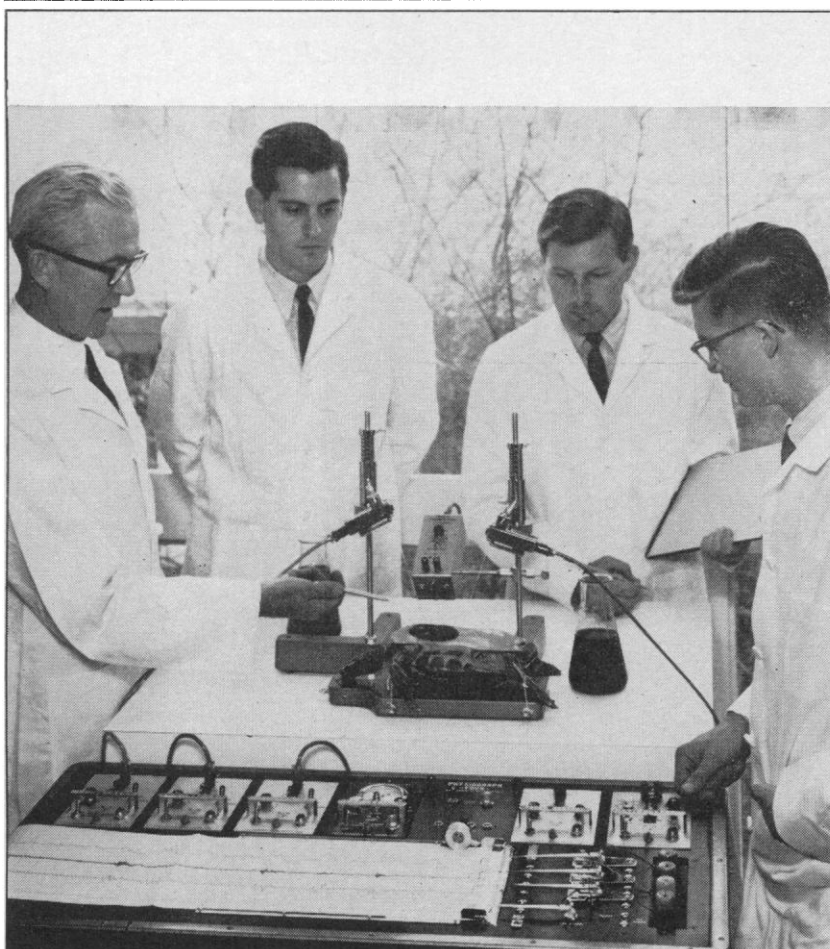
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and behavioral scientists, a research training program should also be developed. Study and training in behavior should be undertaken at centers where large numbers of animals are kept such as zoos, biological stations, veterinary colleges, and the vivariums of medical schools.

A number of research studies might profit by a comparative approach. Among them would be the study of social groups and the effects of crowding, the amount and kinds of stimulation required for normal or optimal development, and conversely the effects of deprivation. The role of parent-infant and peer-peer relationships upon social structure would relate closely to these more basic studies. In cooperation with the sciences basic to medicine, comparative studies of the biochemistry of memory and learning, and comparative studies of behavioral genetics are needed.

The knowledge gained by these comparative studies may have a direct application to man by revealing the basic mechanisms underlying antisocial behavior, crime, delinquency, and development of the individual's potential.

Summary

Many scientists are conducting research on human diseases which cannot be transmitted readily to laboratory animals or duplicated in the laboratory. Information offered by animal disease models should be compiled and made available to these scientists through the publication of extensive lists of animal disease models and annotated bibliographies for specific conditions.

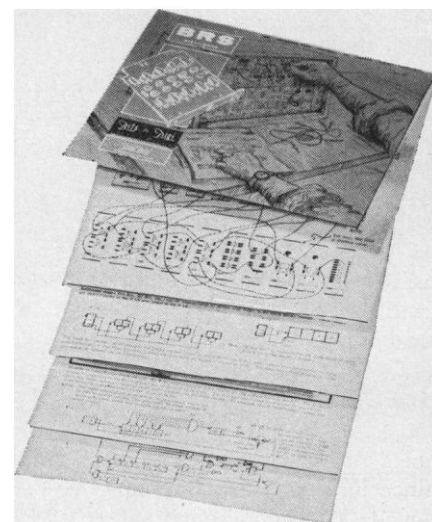
Reports should be obtainable for answering certain specific needs in fields such as the potential of animal disease models available in zoos, the potential of animal disease models available in veterinary clinics, the use of animal disease models in the evaluation of drugs and other new therapies, and animal disease models as they may be studied in the natural habitat.

Symposia should be held on the comparative material available in zoological parks, and how it might best be made accessible. Meetings should be held between medical researchers and the clinical staffs of veterinary schools to explore the potential of veterinary clinics for contributing more material to comparative medicine.

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trained to study specific animal disease problems using the comparative method and emphasizing comparison to the human.

Another need is training through fellowships to provide interim post-doctoral training at medical research institutions for veterinarians, psychologists, and zoologists, and to induce thorough study methods and laboratory procedures used in human medicine and duplicated in animal disease research. Such training would provide a better appreciation of animal diseases that are potentially important to human health research, and how they might be adapted to human health research methods.

Special fellowships should be made available for physicians to work in veterinary schools, zoological parks, or animal colonies to learn the clinical and pathological aspects of animal disease. Behavioral scientists working in medical research programs would then become familiar with the impact of various behavioral problems on diseased conditions developing in animals.

Integrated programs in which the joint research efforts between those trained in animal disease and those trained in human medicine must be developed. The appointment of full-time investigators using the comparative method to study animal disease models is strongly recommended. Such joint research could take place between medical schools and zoological parks, between veterinary schools and medical schools, or between any institutions conducting research in human health and having access to a large animal population, properly trained veterinary pathologists, and other animal health specialists. Many existing resources of animal disease material are not utilized to full capacity for contributing to comparative medicine.

Support for specific studies of the physiology of adaptation, the effects of environment on animal health, the interrelationship between diseases and the interrelationship between behavior and disease are also recommended.

WILLIAM I. GAY

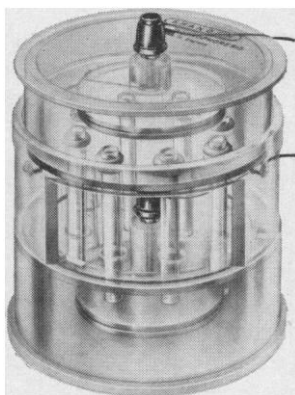
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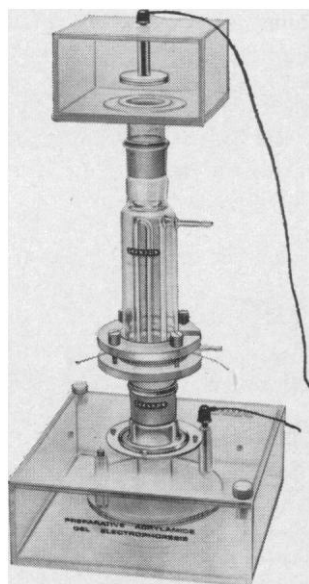
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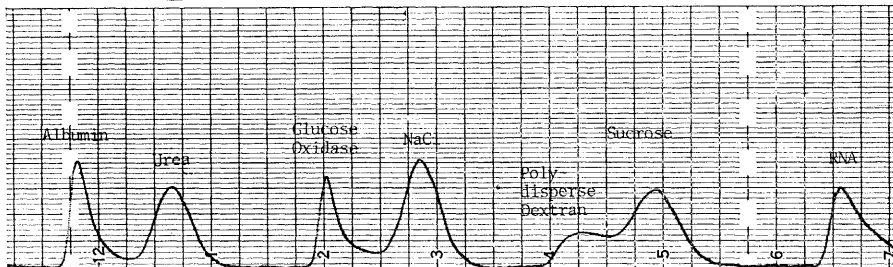


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Arithmetic for Science Students. Programmed Discussion. Jay A. Young. Prentice Hall, Englewood Cliffs, N.J., 1967. vi + 106 pp., illus. Paper, \$1.56.

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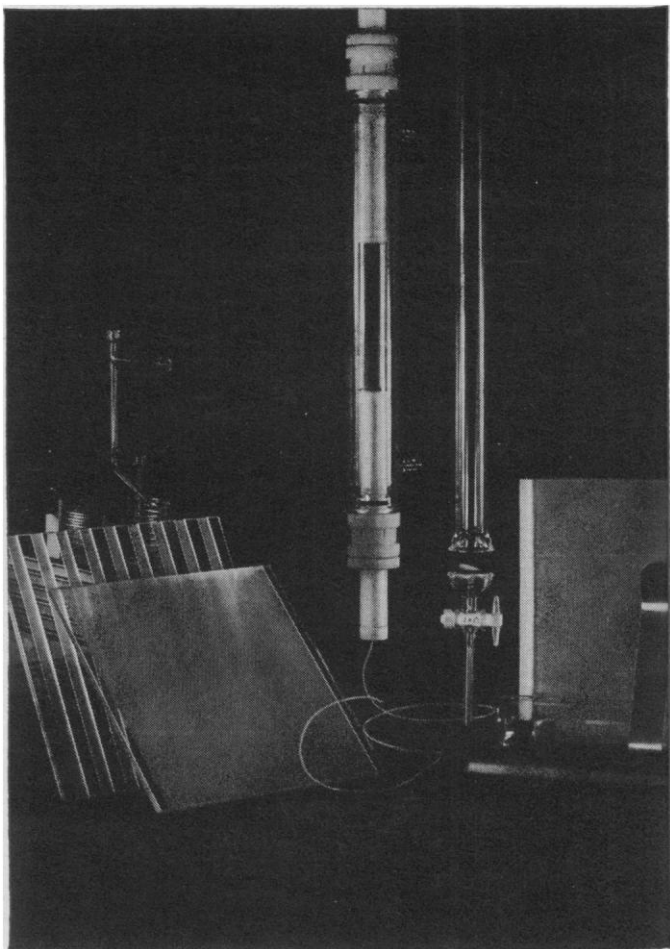
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Collection of Organic Chemistry Problems. John D. Roberts and Marjorie C.



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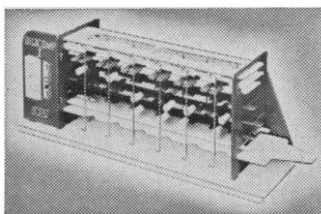
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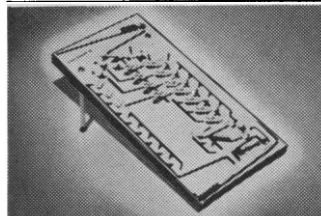
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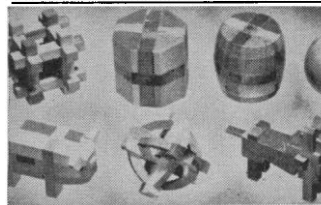
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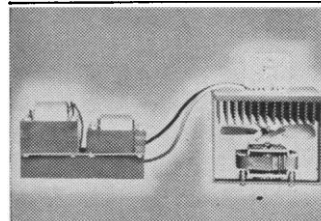
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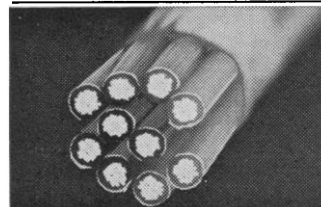
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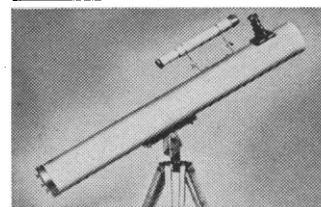
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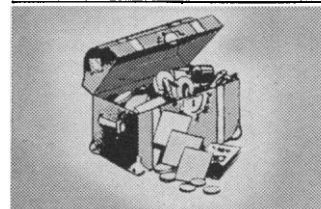
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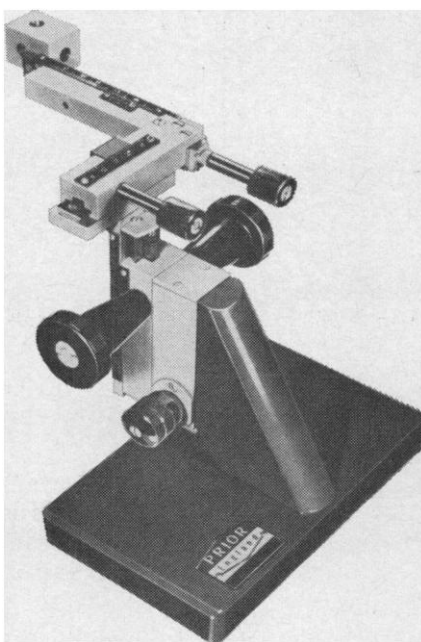
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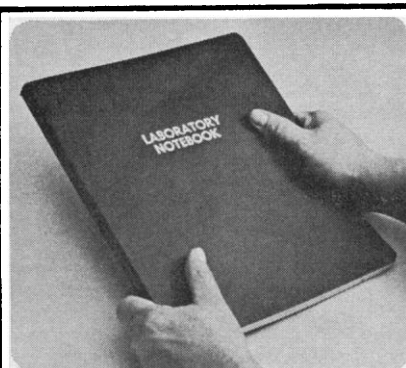
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