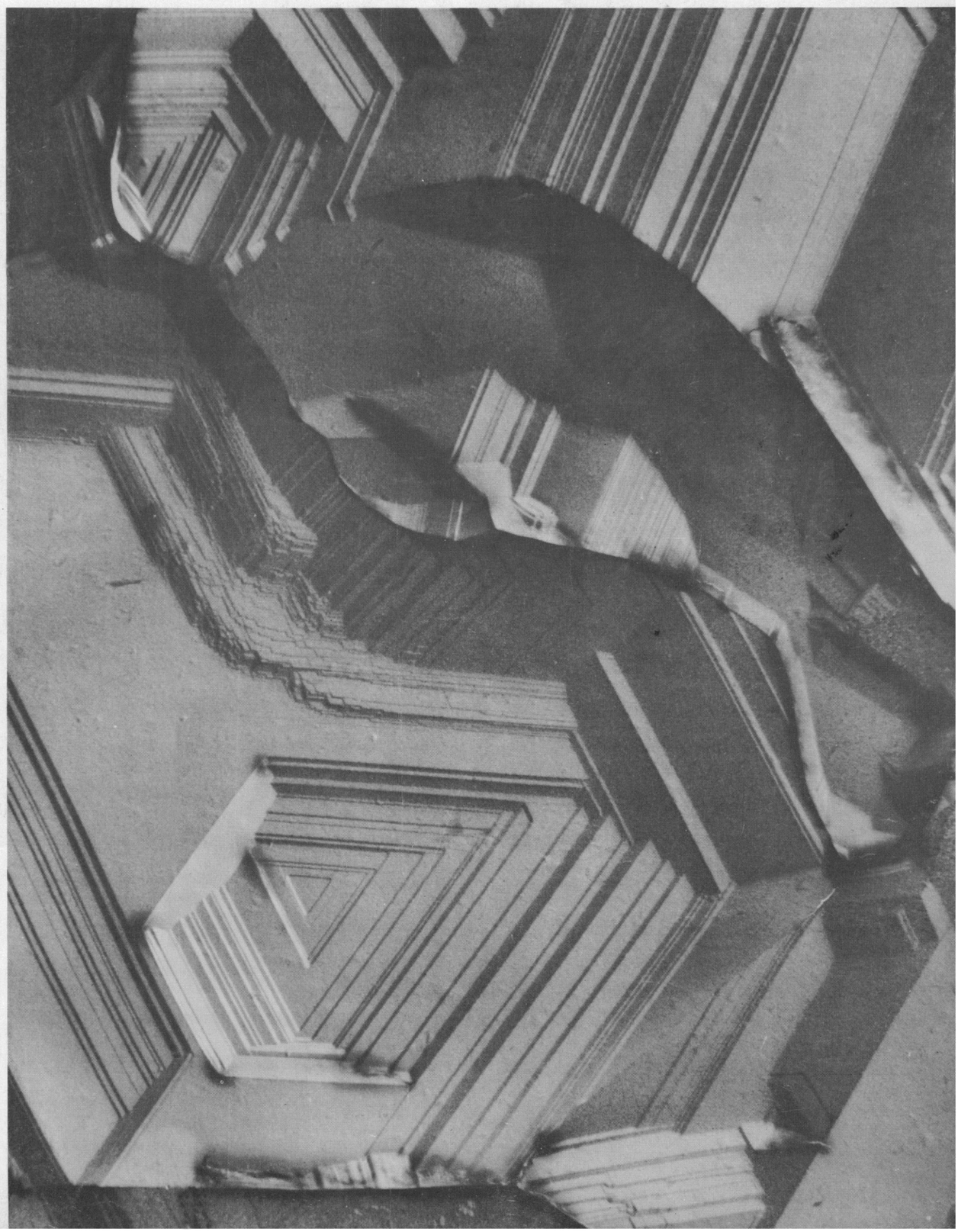
SCIENCE

8 September 1961

Vol. 134, No. 3480

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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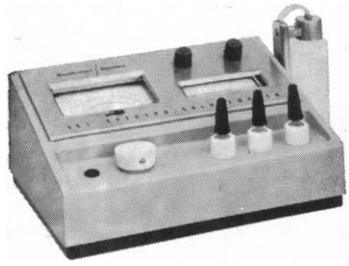

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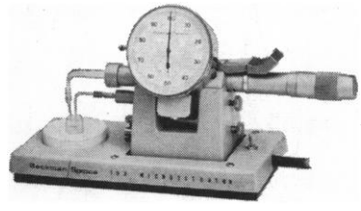

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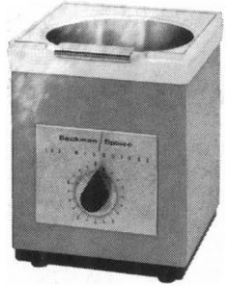

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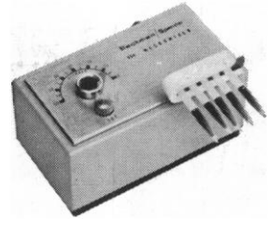

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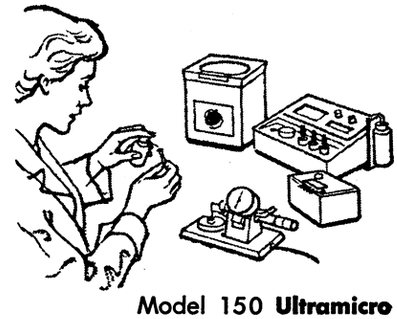

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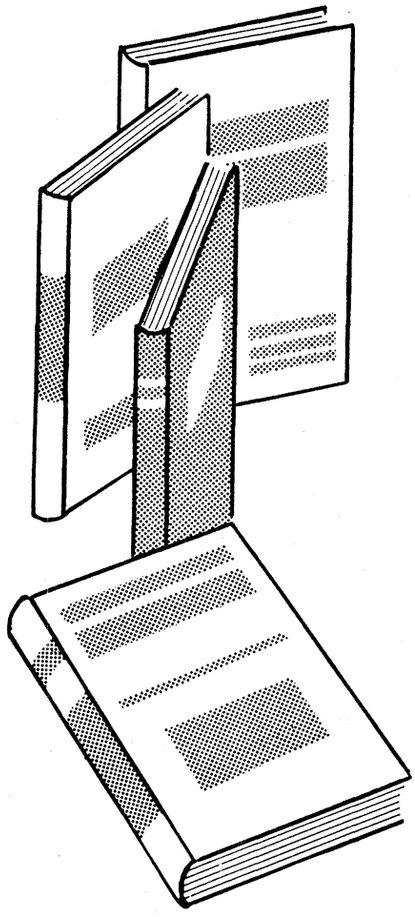

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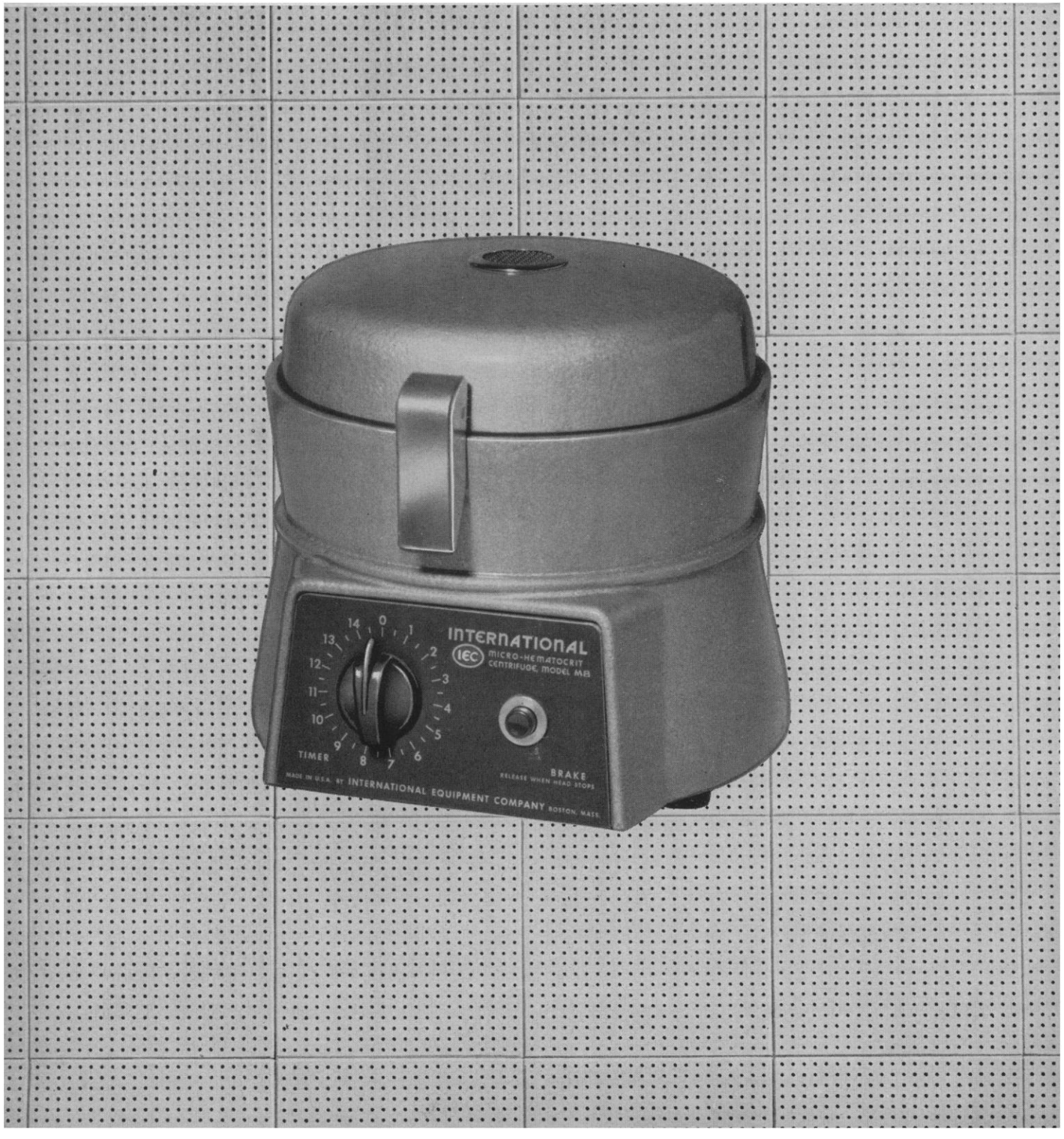

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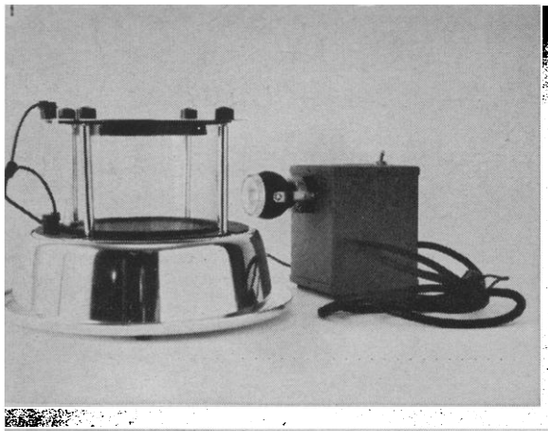
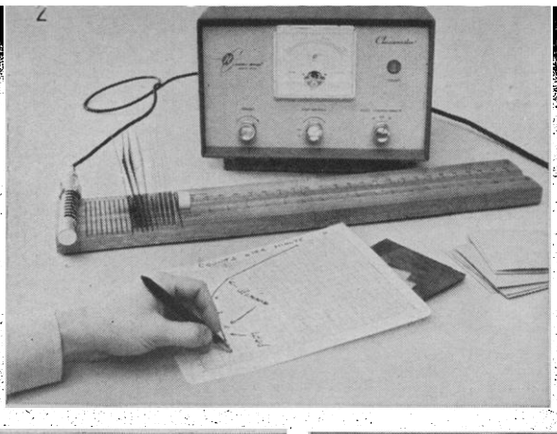
SCIENCE

Cover

Replicated surface of a stainless steel coupon or platelet oxidized for 32 hours at 1500°F and annealed for 500 hours at 1500°F in carbon dioxide. Electron microscope, × 25,000. [T. E. Willmarth, Analytical Chemistry Division, Oak Ridge National Laboratory]





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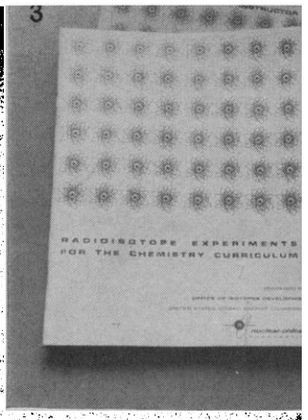

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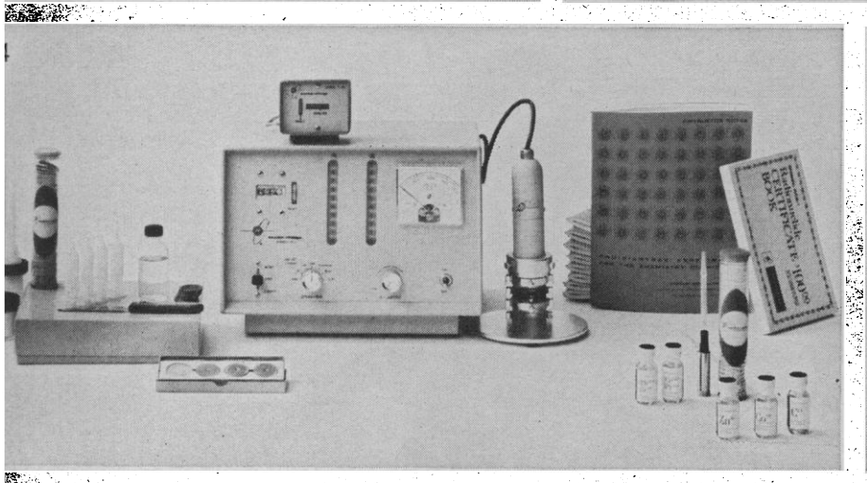

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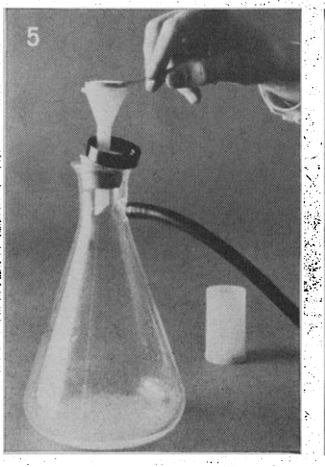

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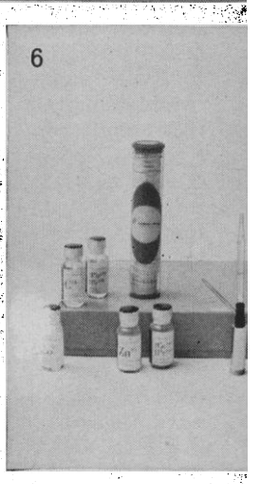

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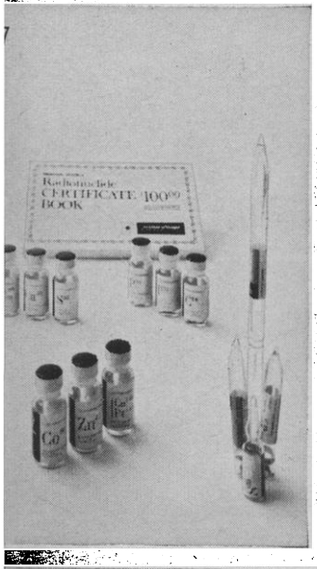

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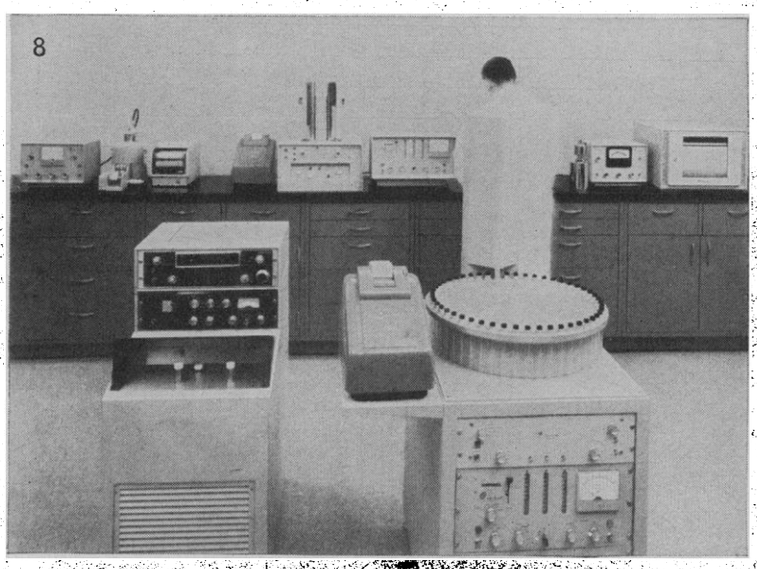

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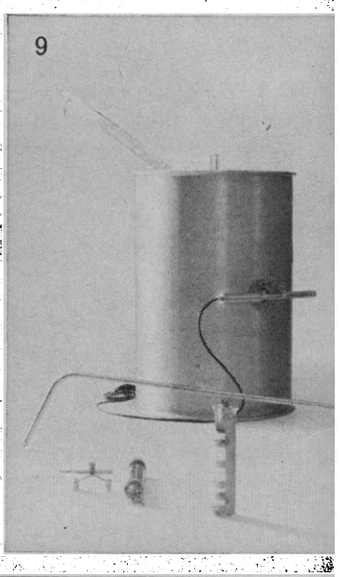

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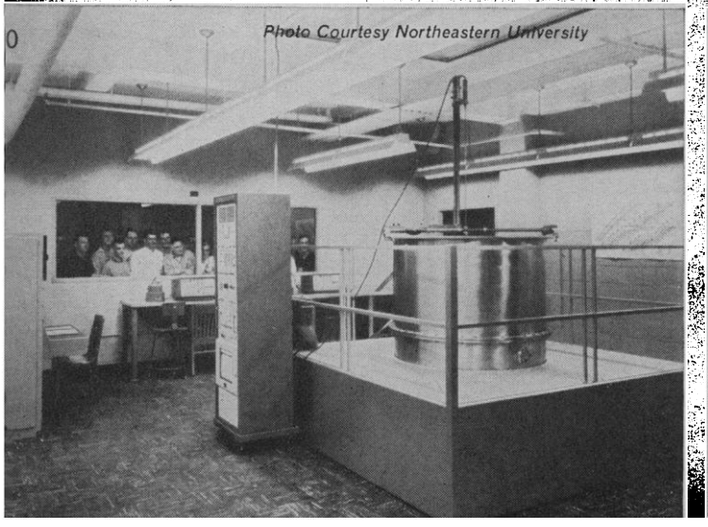

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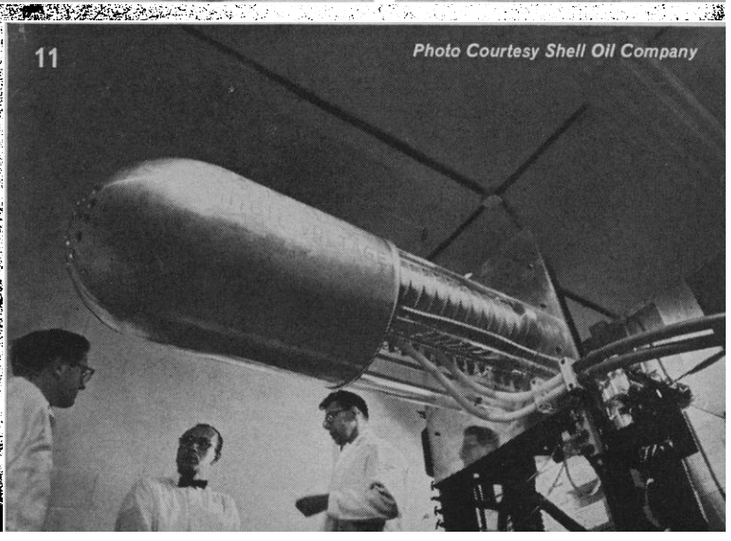

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How to bring radioisotopes into the science curriculum

Read how these Nuclear-Chicago products help to enlarge the scope of education in the physical and biological sciences

RADIOISOTOPE procedures offer students penetrating insights into the laws of nature. Forward-looking educators are using the equipment illustrated at the left in lectures, for student experiments, and in research. These eleven photographs suggest the scope and completeness of Nuclear-Chicago's instrument line for teaching and research. Systems range from low-cost equipment for demonstration to sophisticated instrumentation for fundamental investigation. All are characterized by reliability, precision, versatility, and inherent safety.

Schools now employing radioisotope techniques will want to consider program expansion to take advantage of the newer products illustrated. Others may well regard the apparatus presented here as a planning guide.

* * *

Low-cost demonstration equipment for the nuclear age became a reality with the introduction of Nuclear-Chicago's Cloudmaster® and Classmaster®. The Cloudmaster (figure 1) is a continuously sensitive cloud chamber that provides a spectacular display of ionization tracks caused by alpha, beta, gamma, and meson radiation. The Classmaster (figure 2) is a complete system for demonstrating radiation absorption, scattering, geometry effects, coincidence loss, etc. In addition, it permits simple tracer experiments using license-exempt radioisotopes. Both instruments enjoy wide acceptance because of their simplicity of operation and the vivid, easily-understood presentations they make possible.

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Model 4001 is supplied with the long-lived radionuclide set RNS-110 (figure 6) and the radionuclide certificate book RCB-1 (figure 7) with which the instructor can order short- or long-lived isotopes as they are needed. Neither requires an AEC license to purchase or use, and both are available individually.

As student mastery of radioisotope procedures advances, department heads will next want to consider establishing a complete nuclear laboratory for precision handling, detection, and counting of beta- and gamma-emitting isotopes. Such a facility has valuable application to studies in biology, chemistry, physics, and biochemistry at both the graduate and undergraduate levels. A typical installation is pictured in figure 8. In the left foreground is the Model 701 liquid scintillation detector with Logic scaler, and at the right is the Model C120 automatic sample changer for gamma-emitting liquids or solids in test tubes. In the background, from the left, are the Actigraph II® system for scanning radiochromatograms, a low-background automatic sample changer for solid beta samples, and the Dynacon® electrometer for high-efficiency measurement of beta samples in the gaseous phase.

At this stage, the ideally equipped university will lack only the means to create its own radioactive isotopes and to study reactor techniques and fundamental nuclear properties. For these basic needs, Nuclear-Chicago offers a three-step program.

First, undergraduate departments will choose the NH3 neutron howitzer (figure 9) for experiments with low-level neutron sources, production of short-lived, low-intensity radioisotopic tracers, and low-flux activation analysis.

Second, the science and engineering faculties will often cooperate in establishing an advanced training facility centered on the inherently safe Model 9000 subcritical assembly (figure 10). Characteristics of this water-moderated, natural uranium assembly are nearly identical in nature to those of a full-scale power or research reactor, and the student readily masters the fundamentals of reactor theory and design.

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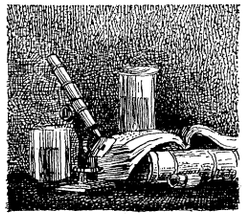
IT HAPPENED THIS MONTH...

a glance at yesterday in relation to today

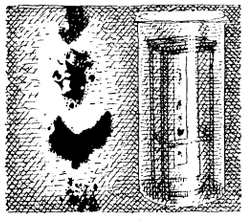
IN SEPTEMBER — (1923) — two biochemists at Toronto challenge current ideas about the amino acid composition of hemoglobin. Three years ago, Furth and Lieben — using the Voisinet reaction — had concluded that hemoglobin is free of tryptophane. Now, Hunter and Borsook[1], using the method of Folin and Looney, present data which suggests that the globin component contains 2 tryptophane residues. Further analysis indicates also the presence of 4 residues each of tyrosine and arginine, 8 of histidine, 10 of lysine, and 100 of other amino acids, including dicarboxylic acids.

Since 1923, dramatic contributions to precise determination of amino acid sequences in proteins have created new approaches to understanding the dynamics of protein biosynthesis. Now one may go beyond the analytical concern with the structure of completed proteins to the study of the biological mechanisms which control the sequence. For both sets of problems Schwarz BioResearch offers a variety of tools: optically standardized natural amino acids — many of them labeled with C^{14} and H^3 with high specific activity; peptides and polyamino acids; ribonucleoside 5'-triphosphates for RNA synthesis. (Labeled forms of these compounds will soon be ready). Have you written for our catalog and price list?



IN SEPTEMBER—(1908)—there is abstracted[2] a report by Büchner and Klatte on some attempts to determine the nature of the coenzyme of yeast press juice. Upon standing, press juice gradually loses its activity, and this is attributed to disappearance of the coenzyme. Activity can be restored by addition of boiled press juice. Lipase emulsions cause the boiled juice to lose its restorative powers, but proteolytic enzymes have no effect. Apparently the coenzyme contains an organic phosphoric ester which is split by the lipase.

Today the yeast press juice coenzyme is well known to the scientific world under such names as Coenzyme I, diphosphopyridine nucleotide, cozymase, and DPN. Schwarz BioResearch is also well known to the scientific world as a source of DPN and other metabolic cofactors such as ATP, ADP, adenylic acid, flavin adenine dinucleotide, guanosine diphosphate and guanosine triphosphate.



IN SEPTEMBER — (1954) — a note from Oak Ridge describes an ion-exchange method for separating 5′ ribo- and deoxyribonucleotides. Since the deoxy-compounds are not separated from their ribose analogs by chromatography with simple acids or salts, the authors employed a borate complex method previously used to separate isomeric ribose phosphates. This technique is of special interest in view of recent evidence suggesting that both types of nucleotides may exist in the free state in body tissues.[3]

Building on the many valuable contributions on separation of nucleotides by these and other authors, new and more economical techniques for the isolation of the 5′ nucleotides have enabled Schwarz to offer them to you at lower and lower cost. Our catalog is the first place to look for all types of nucleic acid compounds: RNA, DNA, nucleate salts, nucleosides, purines and pyrimidines. Send for your copy.

1. Hunter, A., and Borsook, H.: Nitrogen distribution in globin. J. Biol. Chem. *57*:507 (Sept.) 1923.
2. Buchner, E., and Klatte, F.: The coenzyme of yeast press juice. Chem. Abstracts *2*:2568 (Sept. 19) 1908.
3. Khyn, J. X., and Cohn, W. E.: The ion-exchange separation of the 5′ ribonucleotides and deoxyribonucleotides. Biochem. et Biophys. Acta *15*:139 (Sept.) 1954.

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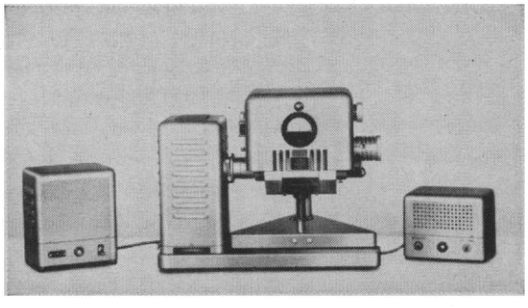

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SCIENCE

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Two Cheers for West Ford

At its recent assembly in Berkeley, California, attended by some 1000 astronomers from all over the world, the International Astronomical Union passed a resolution urging openness of procedure and great caution in the conduct of experiments that might affect the observations of optical and radio astronomers. This was quite right, but there was a second resolution opposing immediate carrying out by the United States of its project West Ford, a plan to place temporarily in orbit about 75 pounds of fine copper filaments to serve as a reflector of radio signals. The second resolution offers, in passing, one cheer for this country's behavior in the matter, but, so it seems to us, the United States deserves two cheers at least.

The International Astronomical Union was at pains to make clear just how any government should proceed when conducting an experiment that, in effect, uses the earth as a laboratory. It states that the government should make public its plans and the calculations justifying those plans, so that all interested scientists will be in a position to evaluate the program. The government should also invite interested scientists throughout the world to participate in making observations. But this is very much what the United States has done. Articles by American scientists published in the April issue of *The Astronomical Journal* describe the project and invite the cooperation of interested scientists.

The union is also concerned that no further launchings of reflecting belts be undertaken until the effects of the first experiment have been analyzed by project scientists in cooperation with other scientists. But again the United States had announced plans along the lines subsequently recommended by the union. In stating these requirements, the union acknowledges the actions of the United States, and this constitutes the one cheer offered.

There seem to be no difficulties about the effects of West Ford on the kinds of astronomical observations now possible. Opposition by the union arises out of fear that the belt might remain indefinitely in orbit, and so interfere, at some future date, with methods of astronomical observation yet to be developed. West Ford scientists intend, however, to orbit the belt in such a way that in a year or two solar radiation pressure will bring it into the atmosphere where it will be destroyed. The union wants more public discussion of this matter, and it is here that the United States could be in a better position. The calculations on which the contention of short life is based, although involving nothing particularly abstruse or secret, have not been published.

Failure to publish this material is an oversight that can easily be corrected, and there is reason to believe that this is soon to be done. In evaluating American conduct, however, the basic point to remember is that if our policy had been to run the entire experiment secretly, detection of the belt, according to informed sources, would have been unlikely in the extreme. Lacking advance notice of the project, no one would have been the wiser. The present American approach contrasts favorably with our handling of project Argus, in which, in 1958, without public notice, several atom bombs were exploded at low altitudes to create temporary radiation belts. It also contrasts favorably with the general Soviet practice of announcing launchings as accomplished facts.

For comments on another kind of experimentation that has worldwide effects, it will be interesting to see, at the forthcoming Pugwash-type conference in Colorado on nuclear weapons control, what Russian scientists have to say to their American colleagues.—J.T.

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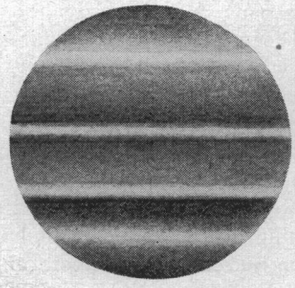

BAUSCH & LOMB
SINCE B&L 1853

Made in America,
to the world's highest standards

BAUSCH & LOMB INCORPORATED
64221 Bausch Street, Rochester 2, N. Y.

Please send me:
- ☐ Interference Filter Catalog D-248
- ☐ Grating Catalog D-261
- ☐ Monochromator Catalog D-259

NAME .....

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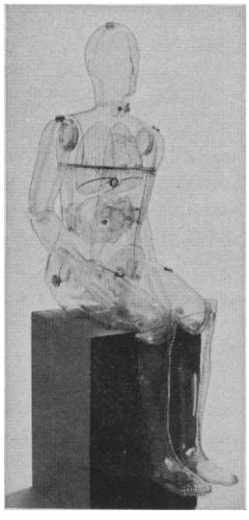
Kodak reports on:

Tenite Butyrate men . . . a job for the halogen-changer . . . when to remember our name and when to forget it . . . time-lapse at the professional level

A phantom



Dozens of these phantoms have been manufactured out of our *Tenite Butyrate* for government, industry, universities, and hospitals by Alderson Research Laboratories, Inc., 48-14 33rd Street, Long Island City 1, N. Y. We know an interesting phantom when we see one and will forgive you for not knowing that the word means a dummy which simulates the human body in studies with ionizing radiation. (In perfecting the new medical x-ray films mentioned below to make them give the kind of rendition that a radiologist best understands, our phantoms were radiographed so frequently they almost spit fire.) The *Tenite* phantom here shown acts as an emitter for calibrating whole-body counters and such, its Tenite thyroid, liver, lungs, spleen, kidneys, and other organs filled with radioactive solutions that simulate the radiative properties of a radioisotope-treated organ. Alternatively the Tenite shell can be equipped with a human skeleton inside and a system of dosimeter ports for studies of absorption of radioactivity.

How the mind wanders

Methanesulfonyl Fluoride (Eastman 8368) is the result of a day spent listening in on the ACS Division of Medicinal Chemistry and in particular a paper on "Preparation of Some Purinesulfonamides from the Corresponding Purinesulfonylfluorides." We don't recall its content with any precision. What the speaker succeeded in doing to us was to impress us with the strong role being played in biochemical thought today by the sulfonyl group. His mind was doubtless illuminating the big picture, but our mind was narrowing down to the little picture. Here was a trend, and we ought to make sure we were riding it well.

We offer *Methanesulfonic Acid, Methanesulfonic Anhydride, n-Butyl Methanesulfonate, Ethyl Methanesulfonate, Methyl Methanesulfonate,* and *Methanesulfonyl Chloride.* This fellow, we noted, was talking sulfonylfluoride. We have a man who is skilled in the art of exchanging any halogen for any other. We decided that as soon as we got home we would have him switch over some chloride to fluoride. That he has done. We are now ready to accept our small but rightful reward for thoughtfulness.

If you want some, or, what is more likely, a look at the list of some 3900 Eastman Organic Chemicals which we stock and which we properly reveal in our Catalog No. 42, get in touch with: Distillation Products Industries, Rochester 3, N. Y. (Division of Eastman Kodak Company).

A little x-ray news

More precious than rubies is confidence in the importance of what one does for a living. One thing we do for a living is to manufacture x-ray film. Unkind words are rarely spoken about society's need for x-ray film. Now we have news about x-ray film and need to make it seem important. Easy.

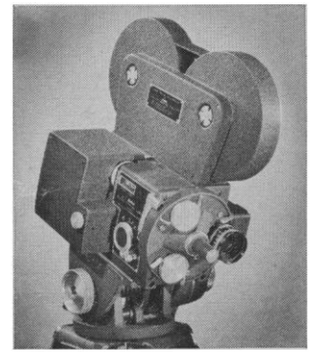
The first piece of news has it that *Kodak Industrial X-ray Film, Type M* is now obtainable with emulsion on one side only instead of both sides, the way x-ray film usually comes in order to double the strength of the image. Simple, yes; trivial, no. Ties in to the very large subject of mankind's current push for great structural strength in small mass. Load-bearing members are now getting so thin that putative flaws on their radiographs have to be checked out with a microscope. Since a microscope can focus on only one side of the film at a time, it's better to have the other side blank. Enough of this is being done now so that x-ray dealers are stocking the single-coated film of high contrast and fine grain.

Eastman Kodak Company, X-ray Division, Rochester 4, N. Y., will be glad to guide you to such a dealer.

The second piece of news much exceeds the first in importance. The nuclear testing debate has gone on for years. As an intelligent citizen, you have been given estimates by various authorities of how much radiation you and your children can expect to soak up, barring disaster. You have been told how much to figure for medical and dental radiological examination over a lifetime. Meanwhile we have been quietly goofing up the statistics! We have been upping the response of the films. With the latest step, the same amount of examination requires half or a third as much radiation as had been estimated.

No action is required on your part. Just privately rejoice a little at how the deal has been sweetened a bit for you, statistically.

Clear, steady movies



This is a professional motion picture camera. It is called the *Kodak Reflex Special Camera (16mm).* Its price is $1895. (Any amateur who buys it imperils his amateur status, but that's his lookout, not ours.) For a professional camera the price is remarkably low, particularly since it is the latest and most versatile of professional 16mm cameras and everybody knows that the cost of professional equipment in most fields rarely goes in any other direction than up. The base price includes a removable synchronous motor for 24 frames/sec, both 400- and 100-foot film chambers, and a Kodak Cine Ekton Lens, 25mm *f*/1.4. An accessory is available for any kind of time-lapse photography. Another accessory records synchronized sound. Etc., etc.

However long this recital were spun out, we doubt that the person for whom we spent 10 years making this camera is the kind who would commit himself on the strength of this ad. If he will signify his interest to Eastman Kodak Campany, Motion Picture Film Department, Rochester 4, N. Y., we shall work out some arrangement to bring him, the camera, and its accessories together.

Price subject to change without notice.

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

Kodak
TRADE MARK

Laboratory) served as program chairman for the 1961 meeting. The local chairman was P. L. Walker, Jr. (Pennsylvania State University), who with S. Mrozowski and M. L. Studebaker (Phillips Chemical Company) is a member of the executive committee of the American Carbon Committee. David S. Coleman (Pennsylvania State University) served as conference coordinator.

M. E. BELL

Pennsylvania State University, University Park

Forthcoming Events

October

1–3. Council for Intern. Organizations of Medical Sciences, Paris, France. (CIOMS, 6 rue Franklin, Paris 16)

1–4. Process Engineers, annual, Vienna, Austria. (Osterreichischer Intenieur- und Architektenverein, Eschenbachgasse 9, Vienna 1)

1–5. Electrochemical Soc., Detroit, Mich. (Electrochemical Soc., 1860 Broadway, New York 23)

1–7. International Special Committee on Radio Interference, plenary session, Philadelphia, Pa. (S. D. Hoffman, American Standards Assoc., 10 E. 40 St., New York 16)

1–8. International Congr. of Industrial Chemistry, 33rd, Bordeaux, France. (Société de Chimie Industrielle, 28 rue Saint-Dominique, Paris 7, France)

2–4. Communications Symp., 7th natl., Utica, N.Y. (R. K. Walker, 34 Bolton Rd., New Hartford, N.Y.)

2–7. Climatic Change, symp., Rome, Italy. (UNESCO, Place de Fontenoy, Paris 7, France)

2–7. International Astronautical Federation, 12th congr., Washington, D.C. (American Rocket Soc., 500 Fifth Ave., New York 36)

2–7. Inter-Regional Leprosy Conf., Istanbul, Turkey. (WHO, Regional Office for Europe and Regional Office for the Eastern Mediterranean, 8 Scherfigsvej, Copenhagen Ø, Denmark)

2–11. International Council for the Exploration of the Sea, 49th annual, Copenhagen, Denmark. (Charlottenlund Slot, Charlottenlund, Denmark)

3–5. Physics and Nondestructive Testing, symp., Argonne, Ill. (W. J. McGonnagle, Argonne Natl. Laboratory, 9700 S. Cass Ave., Argonne)

3–8. Aerosol Congr., 3rd intern., Lucerne, Switzerland. (Federation of European Aerosol Assocs., Waisenhaustrasse 2, Zurich, Switzerland)

4–10. Latin American Congr. of Electroencephalography, 5th, Mexico, D.F. (J. Hernandez Paniche, Instituto Mexicano de Seguro Social, Hospital La Raza, Mexico, D.F.)

4–10. Latin American Congr. of Neurosurgery, 9th, Mexico, D.F. (J. H. Mateos, Tonalá No. 15, Mexico 7, D.F.)

6–7. American Medical Writers' Assoc., New York, N.Y. (S. O. Waife, P.O. Box 1796, Indianapolis 6, Ind.)

6–8. Therapeutics, 7th intern. congr., Geneva, Switzerland. (P. Rentchnick, Case Postale 229, Geneva 2)

8–10. Zooplankton Production, symp., Copenhagan, Denmark. (J. H. Frazer, Marine Laboratory, P.O. Box 101, Victoria Rd., Aberdeen, Scotland)

8–11. Society of American Foresters, Minneapolis, Minn. (H. Clepper, SAF, 425 Mills Bldg., Washington 6)

8–13. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 15 Second St., SW, Rochester, Minn.)

9–11. National Electronics Conference and Exhibition, 17th annual, Chicago, Ill. (NEC, 228 North La Salle St., Chicago 1, Ill.)

9–12. Instrument Symp. and Research Equipment Exhibit, 11th annual, Bethesda, Md. (J. B. Davis, Natl. Institutes of Health, Bethesda 14)

9–12. Water Pollution Control Federation, 34th annual, Milwaukee, Wis. (R. E. Fuhrman, 4435 Wisconsin Ave., NW, Washington 16)

9–13. American Rocket Soc., space flight meeting, New York, N.Y. (ARS, 500 Fifth Ave., New York 36)

9–13. Luminescence of Inorganic and Organic Systems, intern. conf., New York, N.Y. (Miss G. M. Spruch, New York Univ., Washington Sq., New York 3)

10–12. Nuclear Reactor Chemistry, 2nd conf., and Analytical Chemistry in Nu-

clear Reactor Technology, 5th conf., Gatlinburg, Tenn. (Oak Ridge National Laboratory, Post Office Box X, Oak Ridge, Tenn.)

10–13. Administration of Research, 15th conf., San Juan, Puerto Rico. (G. F. Anton, Research Center, Univ. of Puerto Rico, Mayaguez, P.R.)

10–20. International Committee for Biological Control, Tunis. [P. Grison, Laboratoire de Biocenotique et de Lutte Biologique, La Miniere, par Versailles (S.-et.-O.), France]

11–13. Gaseous Electronics Conf., American Physical Soc., Schenectady, N.Y. (C. J. Gallagher, General Electric Research Laboratories, Schenectady, N.Y.)

11–14. Tau Beta Pi Assoc., Cincinnati, Ohio. (R. H. Nagel, Univ. of Tennessee, Knoxville)

11–14. Western Inst. on Epilepsy, 13th annual conf., San Antonio, Tex. (F. Risch, 3097 Manning Ave., Los Angeles, Calif.)

12–13. Congress of Neurological Surgeons, New York, N.Y. (E. Weiford, 4706 Broadway, Kansas City 12, Mo.)

12–29. Pacific Intern. Trade Fair, 2nd, technical meetings, Lima, Peru. (PITF, P.O. Box 4900, Lima)

14–20. International Congr. of Neurological Surgery, 2nd, Washington, D.C. (B. S. Ray, 525 E. 68 St., New York 21)

15. American College of Dentists, Philadelphia, Pa. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis, Mo.)

15–20. American Inst. of Electrical Engineers, fall general meeting, Detroit, Mich. (E. C. Day, AIEE, 33 W. 39 St., New York 18)

15–20. International Congr. of Allergolgy, 4th, New York, N.Y. (W. B. Sherman, 60 E. 58 St., New York 22)

15–21. Pan American Congr. of Endocrinology, 5th, Lima, Peru. (M. San Martin, Av. Central 325, San Isidoro, Lima)

16–17. Engineering Writing and Speech, natl. symp., East Lansing, Mich. (J. D. Chapline, Philco Corp., 3900 Welsh Rd., Willow Grove, Pa.)

16–17. Ionization of the Air, intern. conf., Philadelphia, Pa. (I. C. Kornblueh, American Inst. of Medical Climatology, 1618 Allengrove St., Philadelphia 24)

16–18. American Soc., of Safety Engineers, Chicago, Ill. (A. C. Blackman, 5 N. Wabash Ave., Chicago 2)

16–18. Entomological Soc. of Canada and Entomological Soc. of Quebec, Quebec, Canada. (L. L. Reed, ESC, Neatby Bldg., Carling Ave., Ottawa, Canada)

16–18. Metallurgy of Beryllium, intern. conf., London, England. (Secretary, Inst. of Metals, 17 Belgrave Sq., London, S.W.1)

16–19. American Dental Assoc., Philadelphia, Pa. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

16–19. Vacuum Science and Technology, 2nd intern. congr., Washington, D.C. (W. M. Welch, Intern. Organization for Vacuum Science and Technology, 1515 Sedgwick St., Chicago 10, Ill.)

16–20. American Ornithologists' Union, Washington, D.C. (H. G. Deignan, U.S. National Museum, Washington 25)

16–20. American Soc. of Civil Engineers, New York, N.Y. (W. H. Wisely, 33 W. 39 St., New York 18)

(See issue of 18 August for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

Time-code generator produces a serial readout of 20-bit, 24-hour code. Frequency stability is said to be 3 parts in 10^8 per day. The instrument also furnishes a 1-Mcy/sec differentiated square wave for synchronization with external standards and a 1-pulse-per-second output for comparison with time ticks from radio station WWV. The unit is designed for operation over an ambient temperature range of −20° to +55°C. An external signal may be substituted for the internal crystal oscillator. (Electronic Engineering Co., Dept. Sci295, 1601 E. Chestnut Ave., Santa Ana, Calif.)

Automatic monitor has a scanning rate of up to 5000 inputs per second and measures any variable reducible to a voltage signal as well as the rate of change of the variable. The monitor compares measured values with preset values and converts the result into digital form. Alarm conditions are displayed by a cathode-ray tube. Five types of alarm conditions are recognized: high alarm; excessive rate of change; approach to trip; irrational high; and irrational low. The system can be expanded to 3600 input channels. Systems with self-healing as well as self-checking features are available. (Monitor Systems, Inc., Dept. Sci296, Fort Washington Industrial Park, Fort Washington, Pa.)

Digital readout device decodes either binary inputs or pulse trains and displays information in digital form. Sixteen ¾- by 1¼-in. alphanumeric characters are displayed at rates up to 50 per second. Ten of the symbols are decimal digits; the other six can be specified by the customer. A built-in memory keeps the last character in position with no power requirement. Operation is on either 12 or 28 volts d-c with power requirement 0.57 watt sec per bit. Size is 1 by 3.1 by 2.5 in. (Datascope Corp., Dept. Sci330, Culver City, Calif.)

Cardiovascular measurement equipment offers two to four simultaneous intercardiac pressures for left and right heart catheterization. The equipment includes a four- to eight-channel oscil-