SCIENCE

23 September 1960

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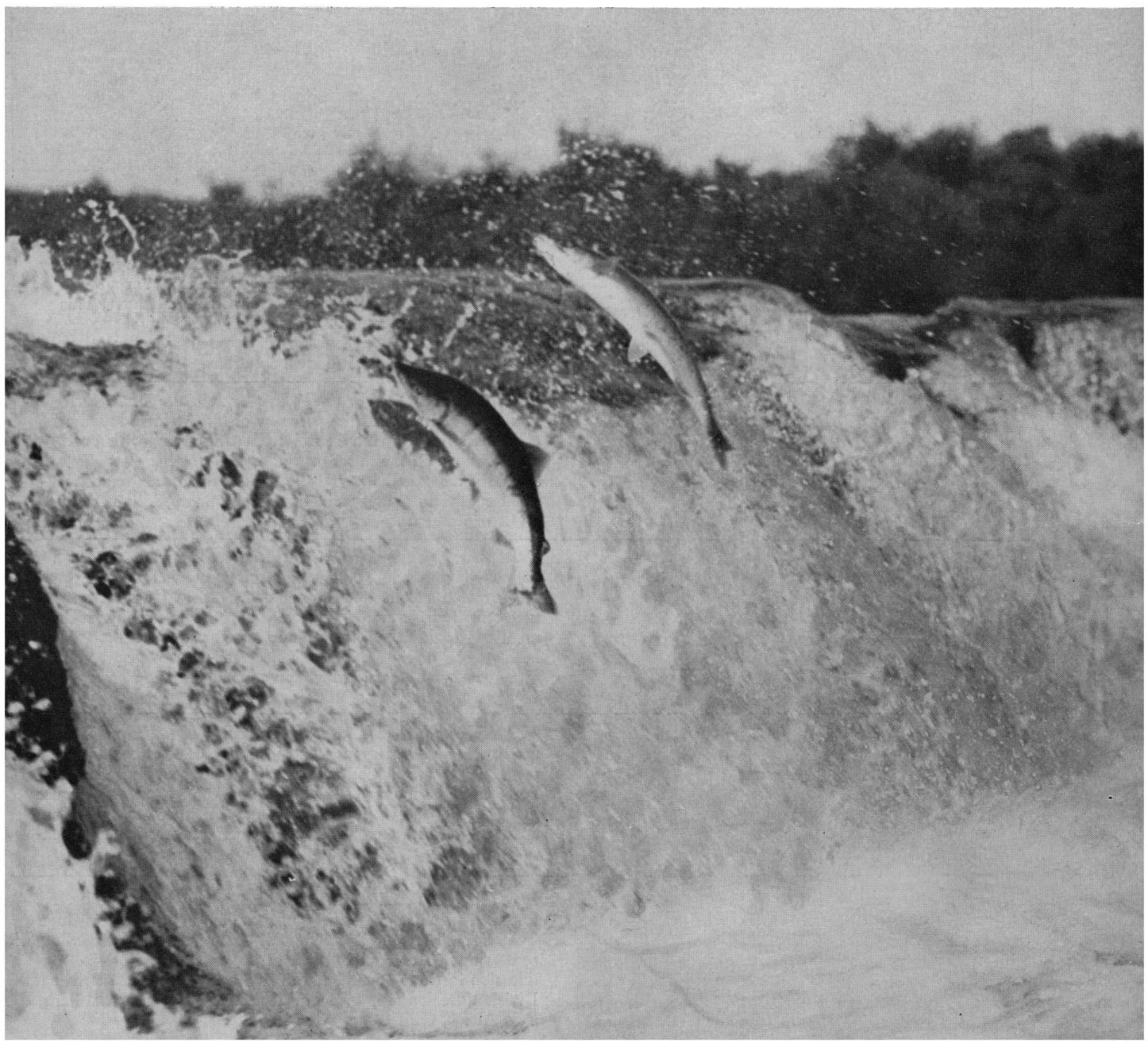
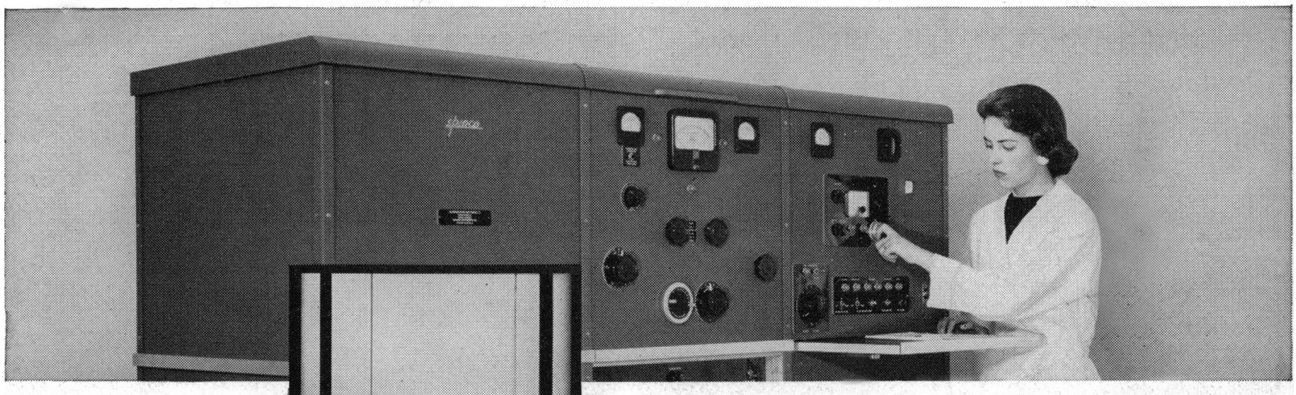
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



New Methods Extend the Usefulness of the Ultracentrifuge

Recent studies by research scientists have further increased the uses of the Analytical Ultracentrifuge for measuring molecular weights and purity of viruses, enzymes, proteins, polymers and a variety of organic and inorganic molecules. Here are four new developments as reported in the technical literature.



Interacting Systems

Kegeles and Rao at Clark University have measured the molecular weights of chemically reacting systems in the ultracentrifuge cell using the Archibald "approach-to-equilibrium" method. Studying the enzyme system alpha-chymotrypsin, they showed it to be present in the ultracentrifuge cell as an equilibrium mixture of monomers, dimers, and trimers. This is an extension of previous work which showed that the Archibald method applies to polydisperse non-ideal solutions, as well as to monodisperse ideal solutions.

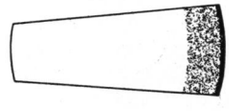
Improved Accuracy

Trautman, at New York's Rockefeller Institute for Medical Research, showed that the accuracy of the Archibald method can be improved by more precisely locating the position of the meniscus on the ultracentrifuge photographic plate. He made a detailed study of the optical fine structure at the meniscus, and used a special optical aligning procedure with a mirror in the ultracentrifuge cell.

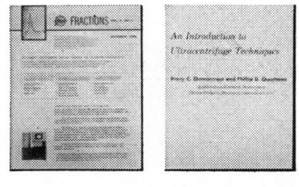
Simplified Measurements

At Stockholm's Nobel Medical Institute, Ehrenberg reports a simplified approach-to-equilibrium method which makes measurements from the schlieren curve easier. He runs the ultracentrifuge fast enough for a peak to begin forming at the meniscus so that the schlieren curve is parallel with the baseline and no extrapolation is necessary. His measurements of molecular weight and diffusion constants agree closely with those by other methods.

Rapid Equilibrium



Van Holde and Baldwin at the University of Wisconsin have used short liquid columns to achieve complete sedimentation equilibrium in a fraction of the time previously required. Using liquid columns of only 3 mm, they report equilibrium with sucrose in 3½ hours, and with a 1 mm column in only 30 minutes. In addition, the authors report that measurements during approach-to-equilibrium permit calculation of a diffusion coefficient.



If you are not familiar with the Ultracentrifuge, we will be happy to send you copies of "An Introduction to Ultracentrifuge Techniques" and the latest issue of "Fractions", a periodical sent to owners of Spinco ultracentrifuges, electrophoresis-diffusion instruments and amino acid analyzers. Write Spinco Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto 5, California.

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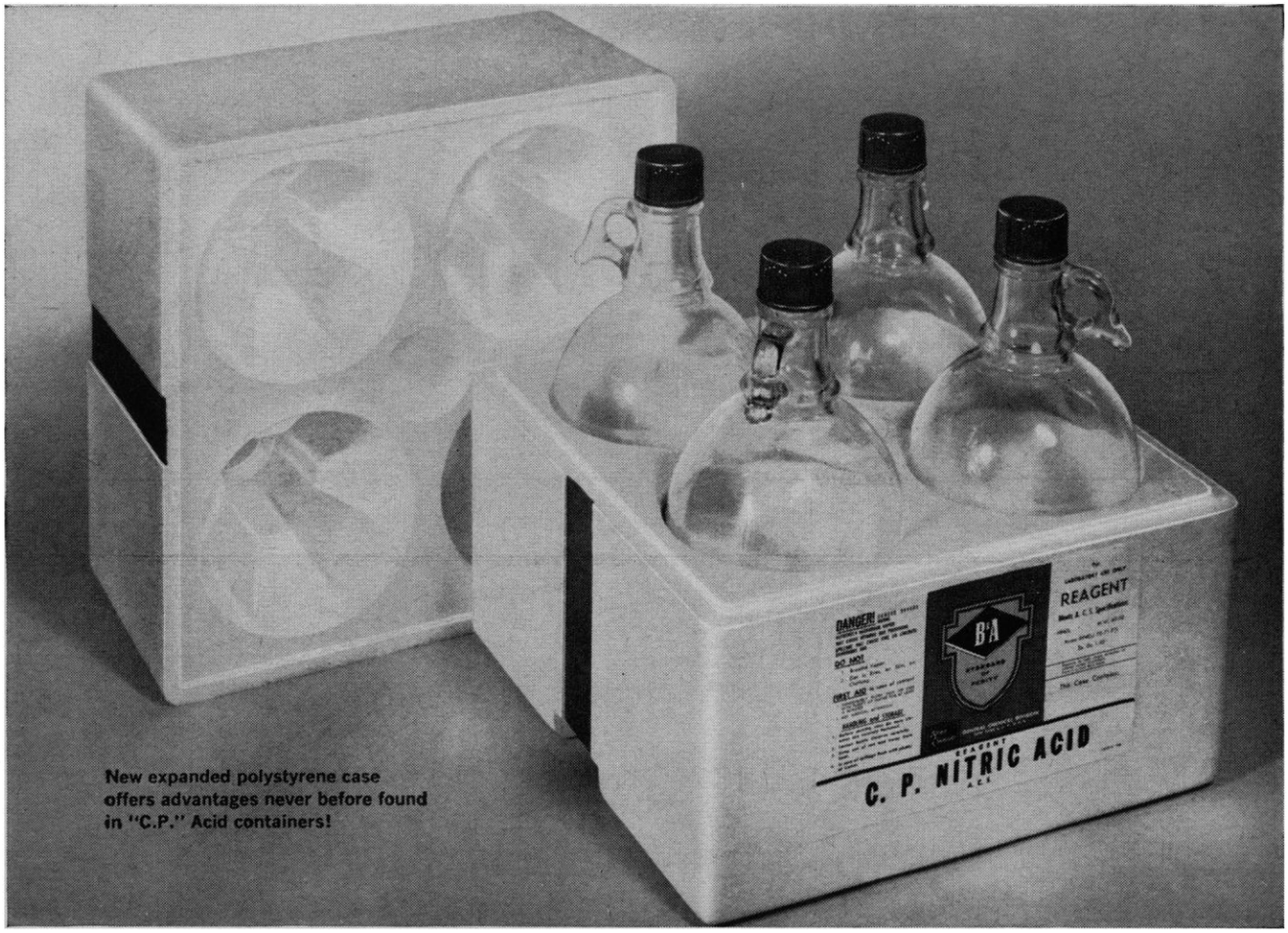

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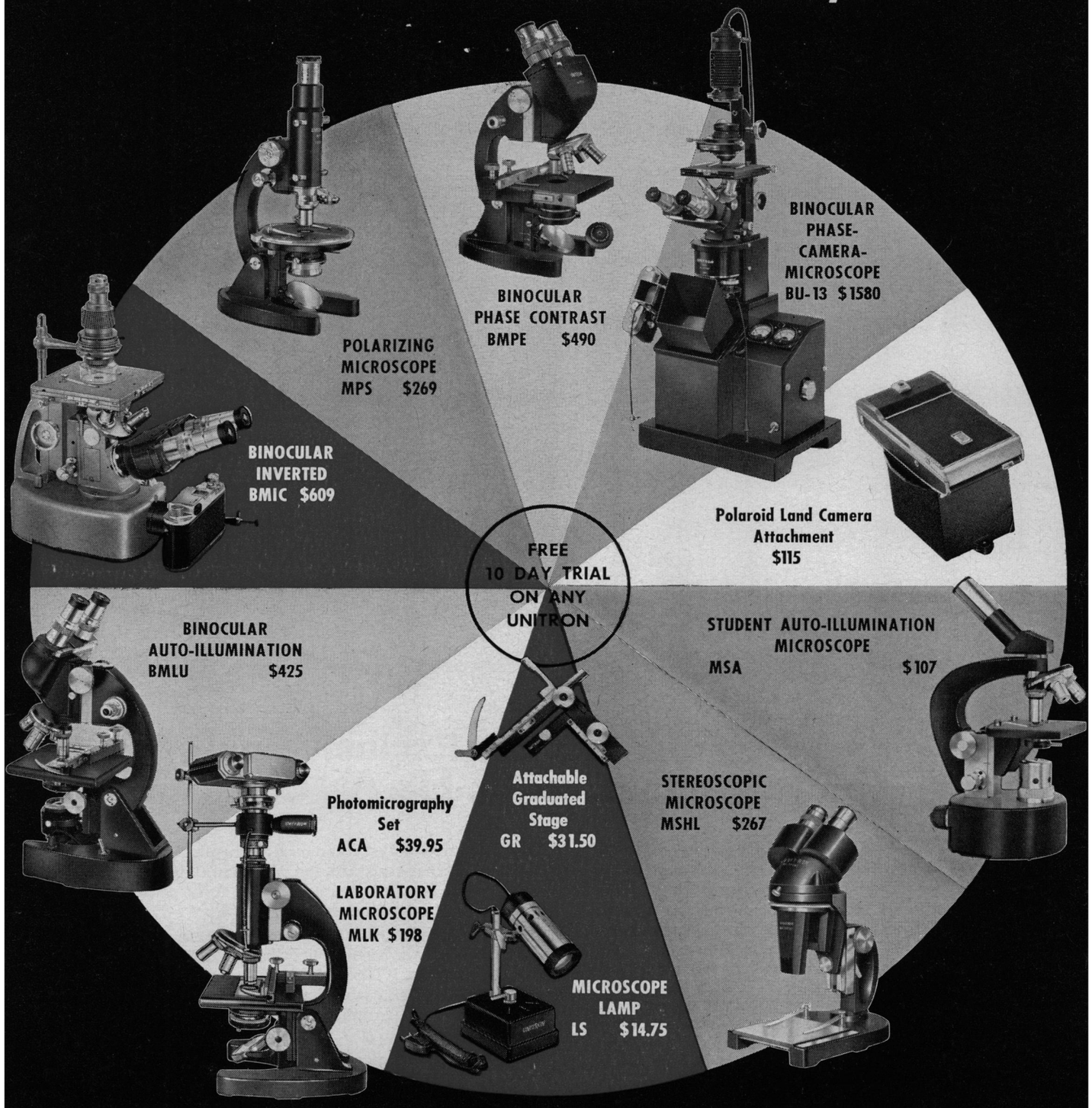

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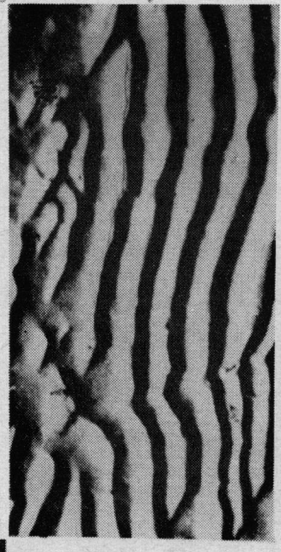

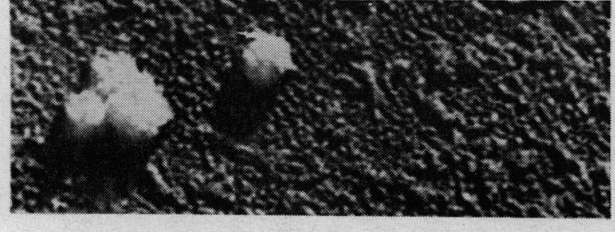

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by Wendell C. Peacock, Vice President and Technical Director, Tracerlab, Inc.

There is nothing complicated about selecting automatic sample counting equipment . . . It simply boils down to a careful analysis of your needs. When you reach the point where automatic equipment is desirable, consider all the equipment commercially available and obtain the following information:

1. Sample Capacity
2. Detection Method
3. Type of Data Printout Provided
4. Simplicity and Versatility
5. Efficiency and Reproducibility
6. Cost
7. The Experience and Reputation of the Manufacturer

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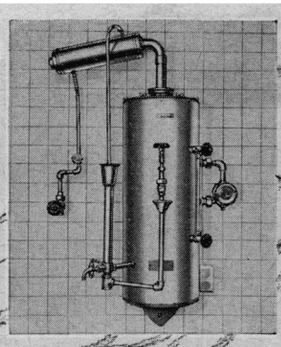

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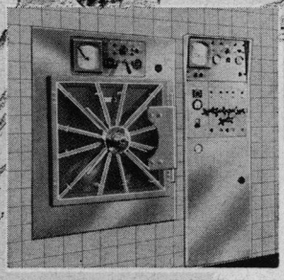

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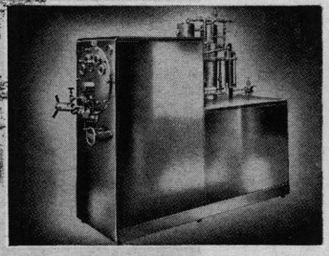

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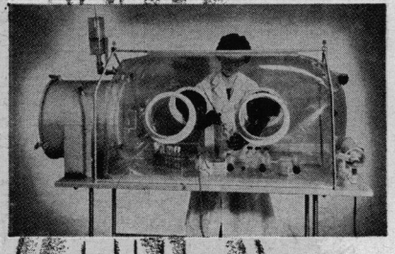

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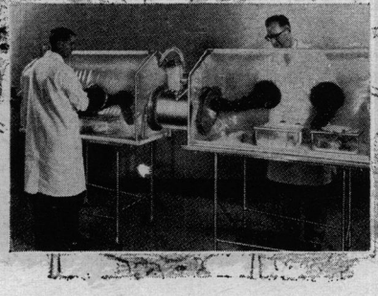

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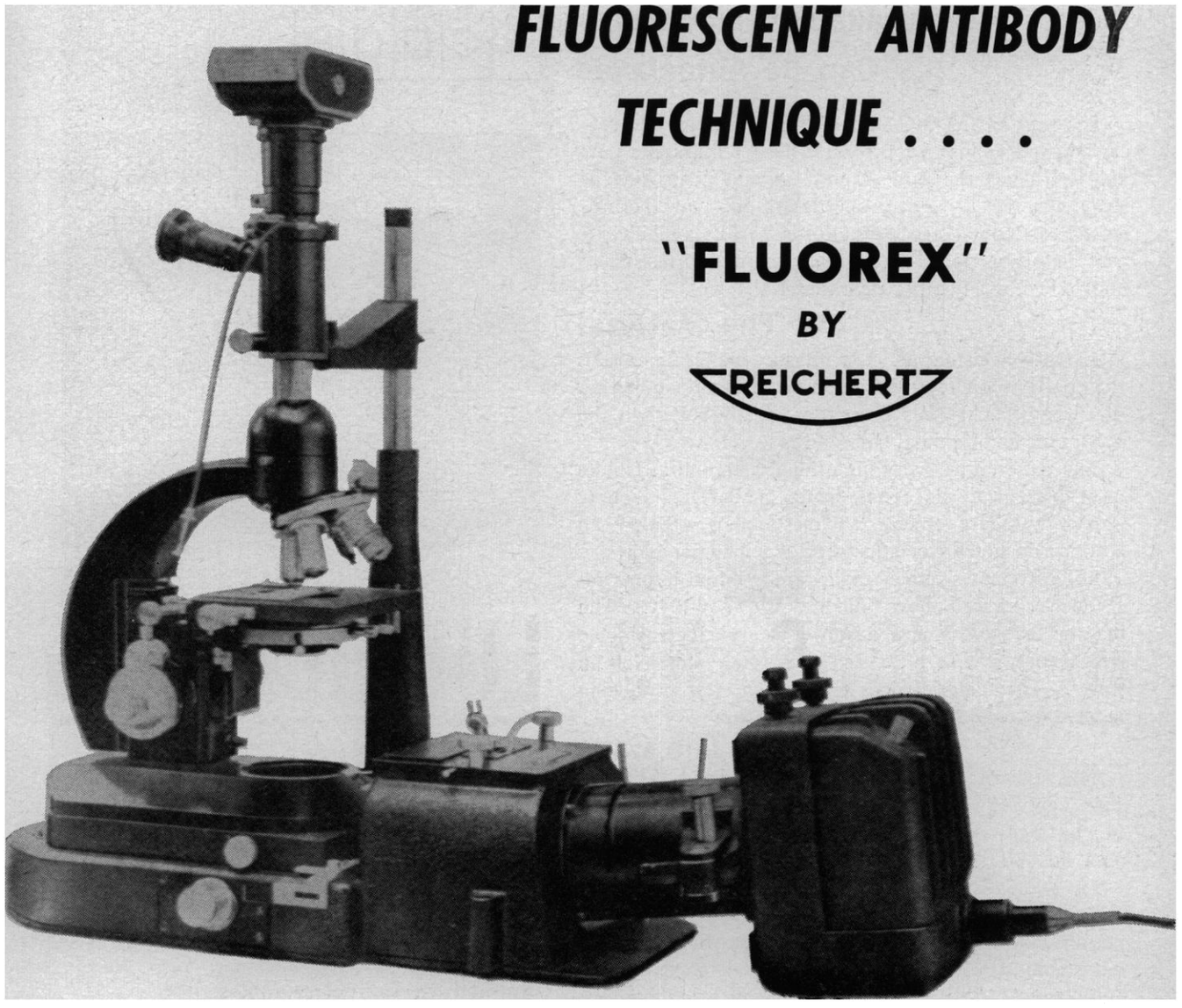

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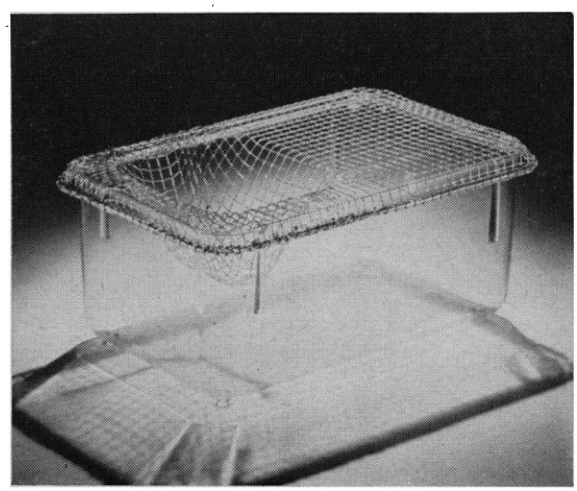

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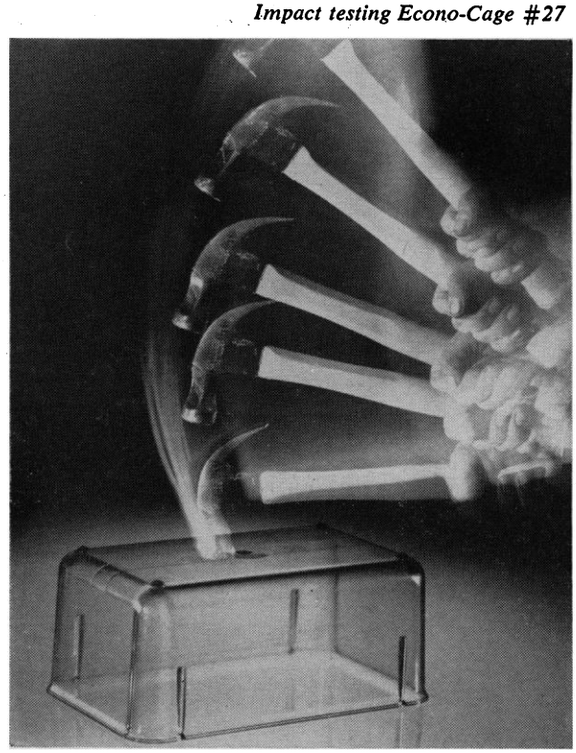

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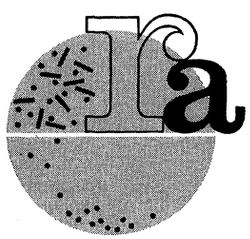

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Gas chromatographic analysis of methyl esters of saturated and unsaturated fatty acids to about C_{26} is well-known[2]. Analysis of these materials and higher molecular weight esters in a single run has been limited, however, by suitable instrumentation and the lack of high temperature liquid phases. Analysis of wide boiling esters from C_1 to C_{36} recently was found possible in our laboratory using a linear programmed high temperature gas chromatograph and a silicone gum rubber column.

The chromatogram at the left shows the analysis of a synthetic mixture of saturated C_6, C_8, C_{10}, C_{12}, C_{14}, C_{19} and C_{27} esters, the unsaturated C_{18} oleic acid ester, and the dimethyl ester of C_{36} dimer acid. The run was made on a 2 ft. Chromosorb P—20% silicone gum rubber column using a linear heating rate of 5.6°C./min. over the range of 75° to 400°C. The detector was maintained at 350°C. and the injection port at 400°C. Observe the sharp peaks of nearly the same shape. These are typical of programmed temperature chromatograms as is the even spacing between the members of the homologous series C_6 through C_{14}.

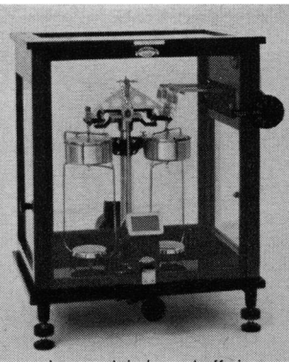
The apparatus used in this work is F & M's Model 500 Linear Programmed High Temperature Gas Chromatograph. In brief, it offers independent operation to 500°C. of the column, hot-wire detector, and injection port. The temperatures of each can be read on a temperature indicator. The unit offers fast-heating, fast-cooling by means of a circulating air oven. The air oven takes column lengths to 50 ft. With column changes, baselines re-establish within six minutes. Additional details were recently described[1,2].

LITERATURE CITED

(1.) Anon, *"Gas Chromatograph Hits High °C"*, *Chem. and Eng. News, 38*, 42-43 (1960).

(2.) *Martin, A. J., Bennett, C. E., and Martinez, F. W., Jr., *"Linear Programmed Temperature Gas Chromatography to 500°C"*, presented at the Cleveland ACS Meeting, April 1960.

(3.) Orr, C. H., and Callen, J., *Annals N. Y. Acad. Sci., 72*, Art. 13. 559-785 (1959).



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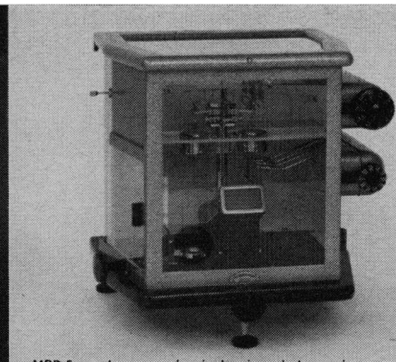

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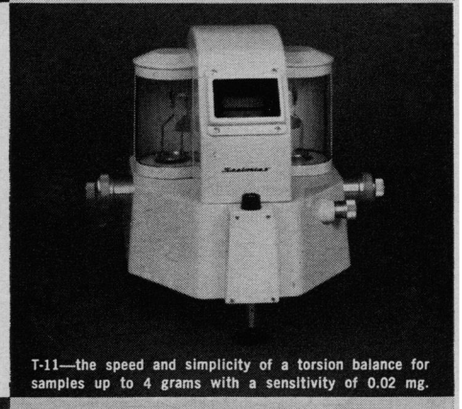

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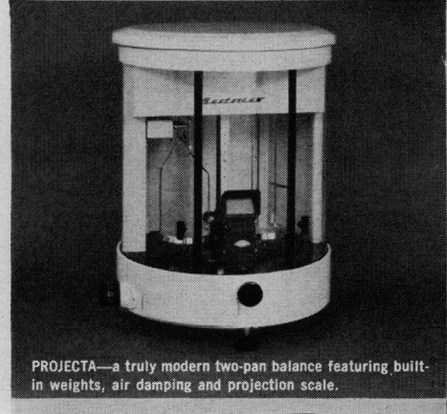

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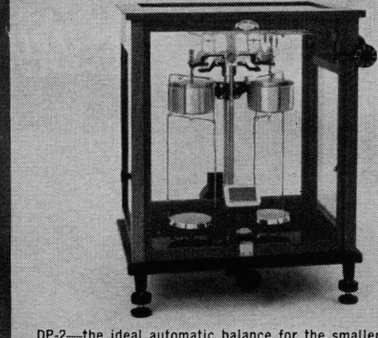

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The SERVALL SS-1 Superspeed, SS-3 Automatic Superspeed, SS-4 Enclosed Superspeed and RC-2 Automatic Refrigerated Superspeed Centrifuges, all designed to accept the unique SERVALL 8 to 2 Tube Direct Sedimentation Continuous Flow System, lead the field in a *functional versatility* that is determined by one thing: the modern researcher's requirements—*your* requirements.

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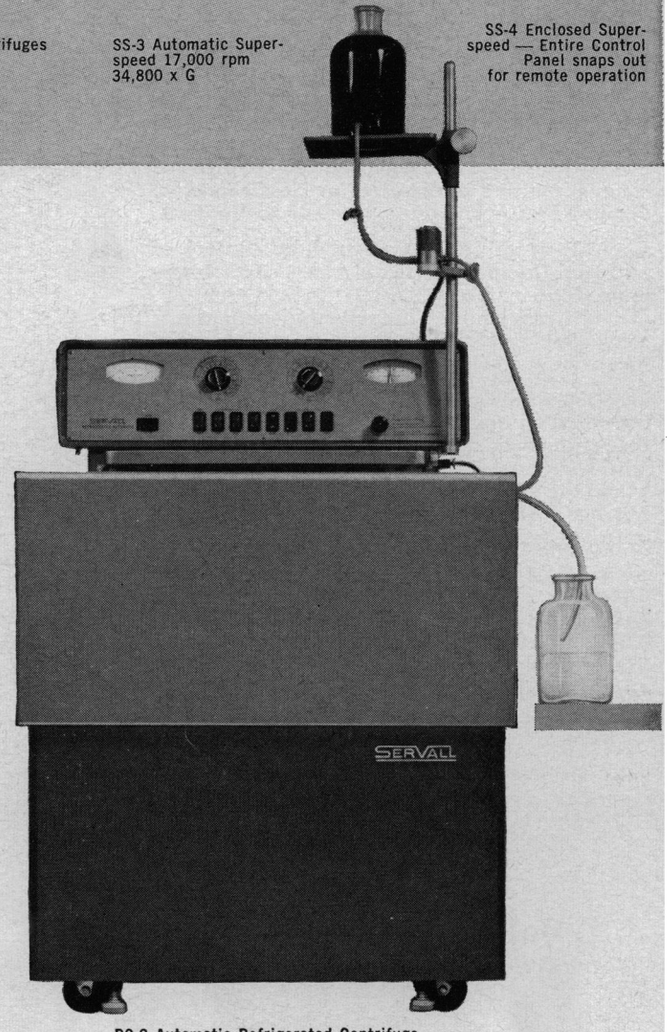
And remember, in the U.S. you get direct, personal service on all your needs from SERVALL-*trained representatives. In Canada and elsewhere* SERVALL *Centrifuges and Instruments are available from specially appointed distributors.*

For that additional centrifuge, or replacement of out-moded or inadequate equipment, do what thousands of others do, select a SERVALL, the centrifuge that has been *proved in operation.*



RC-2 Automatic Refrigerated Centrifuge — basic unit includes standard 8 x 50 ml Superspeed Rotor — up to 37,000 x G

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The determination of total Nitrogen...Ammonia Nitrogen . . . Protein Bound Nitrogen . . . Nitrate Nitrogen . . . is important in clinical tests and in the analysis and control of plant foods, agricultural products, explosives and munitions.

J. T. Baker offers you a choice of reagents particularly suitable to the needs of your nitrogen determination. Whatever your sample, or the method you elect, one of the 'Baker Analyzed' Reagents described below will help you work rapidly, with greater precision and accuracy.

CHOOSE 'BAKER ANALYZED' SODIUM HYDROXIDE 50% SOLUTION . . . for the neutralization of the acid digestion in the Kjeldahl nitrogen determination. This reagent affords an assay in the range of 50.0-52.0% NaOH . . . the proper concentration for direct addition to the digested sample. No fuss to dissolve, and less chance to "bump" than when adding pellets to the flask.

Low blank values are assured by control of Nitrogen Compounds (as N) to 0.0005% maximum. Carbonate (as Na_2CO_3) is held to a level of 0.10% maximum. The polyethylene bottle is convenient and easy to use . . . no chance for breakage. Available in both 1 pt. and 8 pt. sizes.

CHOOSE 'BAKER ANALYZED' POTASSIUM IODIDE . . . for the preparation of Nessler Solution for the colorimetric determination of ammonia. The label shows *actual lot assay* . . . 99.5% or higher ...and the *actual lot analysis* of trace impurities. Nitrogen Compounds (as N) controlled to 0.001% maximum assure low blank values.

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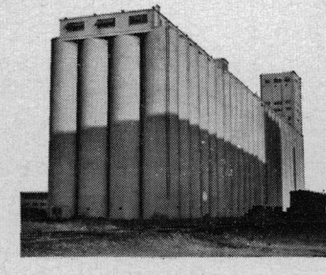
Nitrogen is routinely determined for diagnostic purposes. 'Baker Analyzed' Reagents are commended for their suitability in nitrogen determinations in blood, urine, gastric contents and other biological fluids.



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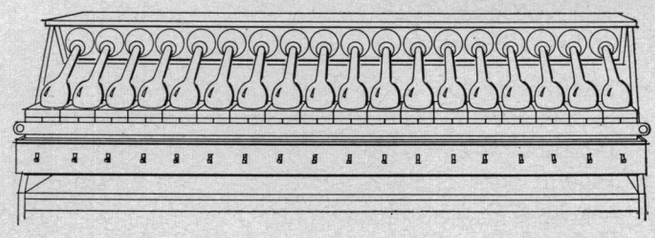
Control of nitrogen content is important to the manufacturer of fertilizers. 'Baker Analyzed' Reagents are particularly suitable for nitrogen determinations necessary for the control of plant foods and agricultural products.



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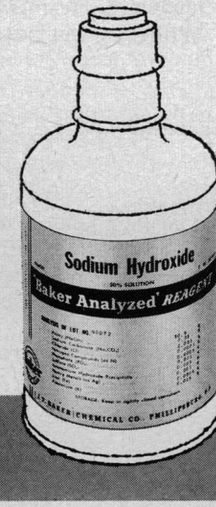

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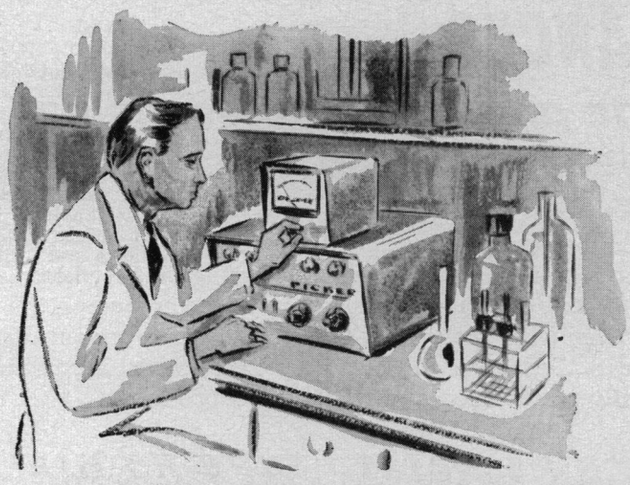

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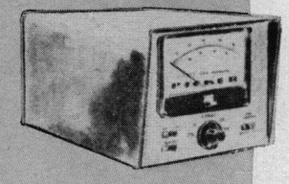

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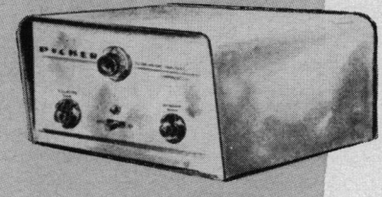

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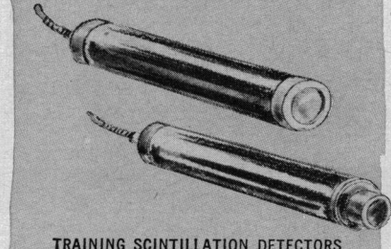

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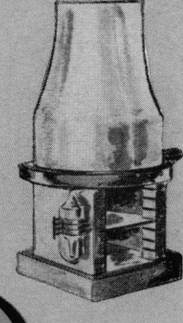

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Picker Nuclear announces a comprehensive line of basic instrumentation for training students in radioisotope technics. Uniquely versatile, these instruments permit the scheduling of full laboratory courses in radioisotope technics (including such important fields as pulse height analysis and rate function studies).

The cost of this new equipment falls well within the reach of modest equipment budgets. Instruments can be delivered before the start of the 1960-61 academic year. For details, please call any local Picker office (see 'phone book) or write Picker X-Ray Corporation, 25 South Broadway, White Plains, New York.

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Standing behind every Picker instrument is a local member of the Picker X-Ray national sales and service network.

He's there to protect your investment.

Because of him the user of a Picker instrument is never left stranded.

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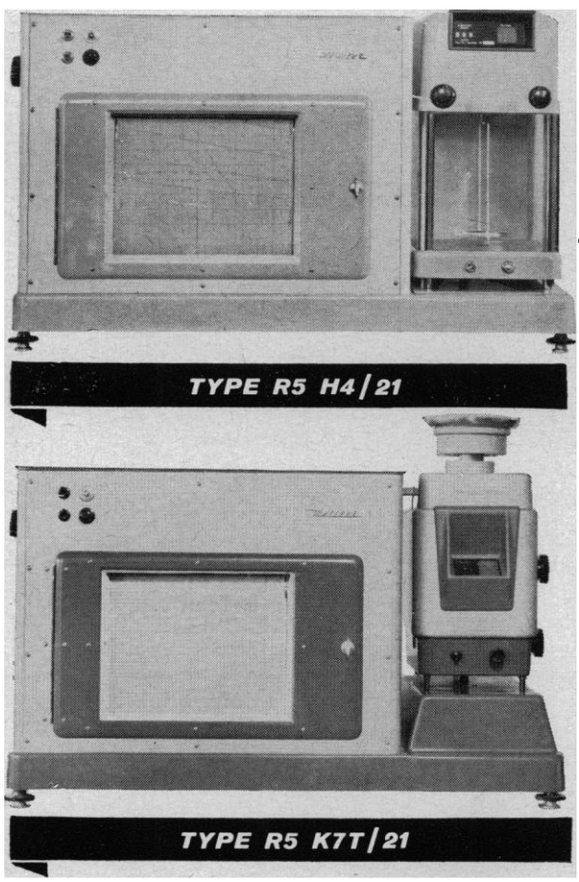
THREE NEW METTLER RECORDING BALANCES

based on photoelectric scanning of the beam position



Photoelectric scanning, with a beam of light representing the only link between the moving balance beam and the recording unit, avoids any interference of the recorder with the vitally essential free movement of the beam. Precision and accuracy of the weighing unit are fully maintained and faithfully reproduced.

TYPE R5 H4/21 TYPE R5 H15/21

Weighing range: 160 g 160 g

Recording range: 1.02 g 0.102 g
corresponding to the optical range of the balance.

Recording accuracy: ±1 mg ±0.1 mg

Balance: *analytical type, weighing by substitution, pan enclosed in balance housing.*

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Recording range: 102 g
corresponding to the optical range of the balance.

Recording accuracy: ±0.1 g

Balance: *precision type, weighing by substitution, pan unobstructed on top, built-in taring device with 100 g range.*

Both types can be equipped for weighings below the balance, such as in an oven.

Write to us today for our literature describing in detail the performance and construction of the METTLER recording balances.

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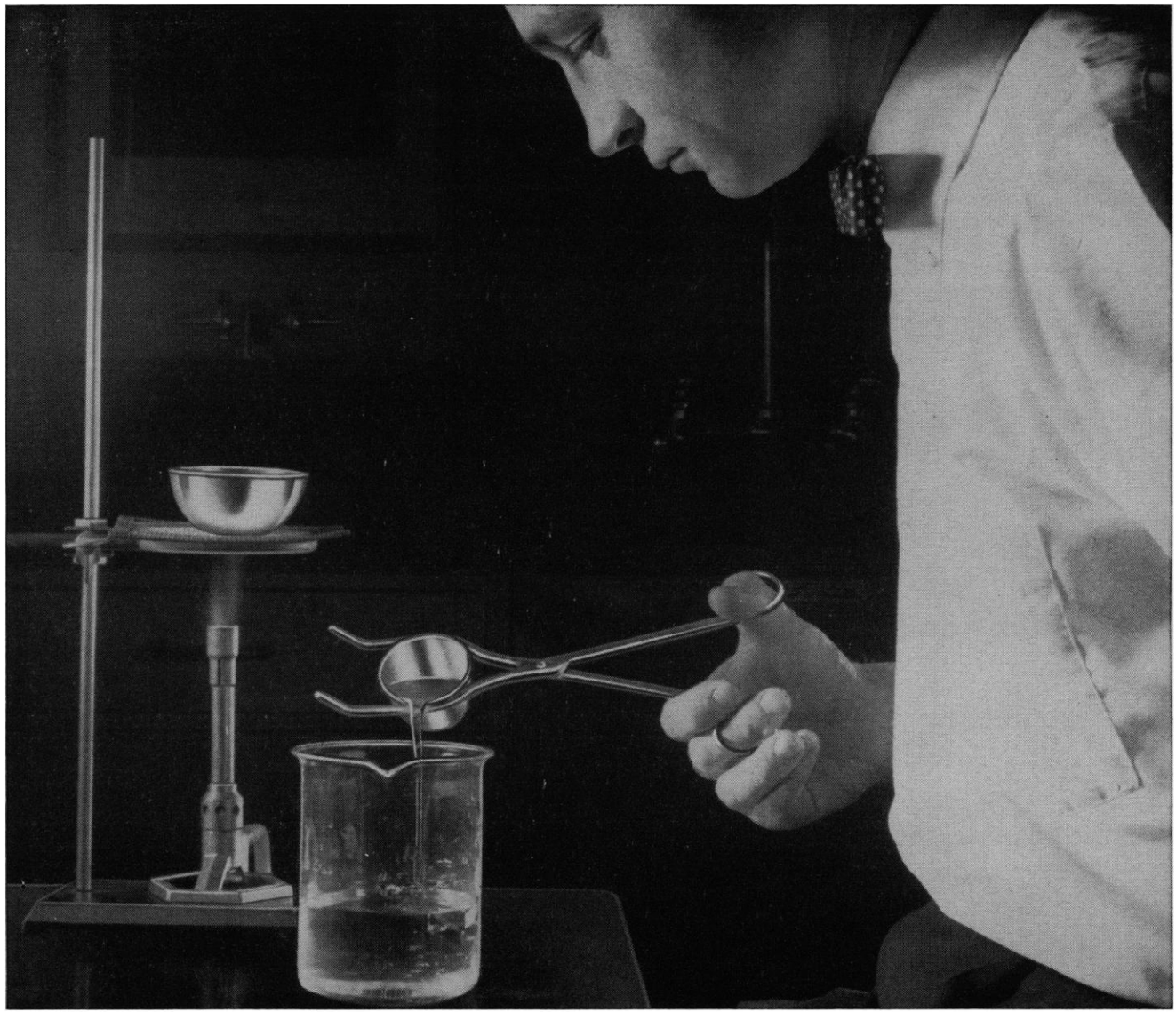

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—with Fisher PLATINUM/CLAD Labware!

Chemical, biological and testing labs can now handle corrosive chemicals at temperatures up to 1000°F—without tying up funds in expensive (and often pilfered) equipment. At only one-third the cost of solid platinum, Fisher PLATINUM/CLAD Labware is *four times stronger*, lasts years!

A platinum alloy lining, containing rhodium for improved hardness, is firmly bonded to the stainless steel vessel by a special patented process. The sturdy stainless exterior resists damage from tongs and other mechanical devices; the platinum-clad interior prevents chemical attack. Top edges and spouts are platinum clad and rolled over to prevent reaction with the exterior metal as chemicals are poured.

From stock, Fisher offers PLATINUM/CLAD Crucibles and Evaporation Dishes. You may return this labware when no longer usable for a high scrap refund. (And, since the platinum can be reclaimed only by a special technique, pilferage is reduced.)

Fisher PLATINUM/CLAD Crucibles are $50 each ($45.60 each in lots of 6 to 23; $42.70 each in lots of 24 or more). They are 42 mm in diameter, 42 mm deep, hold 40 cc.

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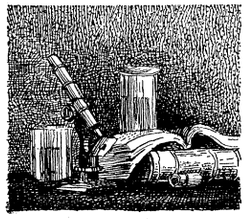
Chicago	New York	Washington	Toronto

IT HAPPENED THIS MONTH...

a glance at yesterday in relation to today

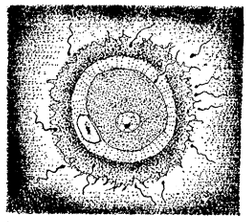


IN SEPTEMBER — (1831) — at the first annual meeting of the British Association for the Advancement of Science, John Dalton[1] reports a series of experiments concerning the relationship of his food consumption to his body secretions. He shows that the carbon content of his diet is 11½ oz. daily, of which there passes off sensibly 1 oz. The carbonic acid gas expelled from his lungs contains 10¼ oz. of carbon leaving ¼ oz. lost as insensible skin perspiration. Mr. Dalton's "regular habits of life and uniform good health" added validity to this self-experimentation.

Modern students of intermediary metabolism have much more sophisticated ways of studying the fate of carbon. Schwarz BioResearch supplies over sixty C^{14}-labeled intermediates, including amino acids, nucleic acids and their component parts, carbohydrates, and metabolic cofactors. Our list of tracer compounds which includes H^3, S^{35}, P^{32} and N^{15} has recently been enlarged by the inclusion of O^{18}-labeled amino acid compounds from the Yeda Research and Development Company, Ltd. at the Weizmann Institute of Science in Israel.

IN SEPTEMBER — (1881) — a physician from Washington, D.C. describes the hair-darkening action of pilocarpin, an alkaloid of the Brazilian drug, jaborandi. A 25-year-old petite blonde lady was given hypodermic injections of pilocarpin hydrochlorate to relieve uremia due to chronic pyelitis. Over a period of months her hair changed from a very light color to almost pure black. Hair on other parts of the body also changed color, and the eyes became a much darker blue. Similar hair-darkening was observed in a 14-month infant given pilocarpin for membranous croup.[2]

Today many biochemists are under the impression that hair color is dependent upon melanin, a product of the oxidative metabolism of the amino acid, tyrosine. Their wives, however, know that external factors may change hair color overnight. Fortunately for the chemist whose true interest is amino acid metabolism, Schwarz can supply amino acids of constant, unchanging *purity. The Schwarz Kit of 18 optically standardized amino acids is suitable for the most precise research or industrial purpose. The box is designed for accessibility, safety, and visibility of contents.*



IN SEPTEMBER — (1910) — speculation concerning the chemical basis of heredity continues. In an address to the British Association Section on Zoology, G. C. Bourne states, "All the evidence at our disposal goes to show that the potentialities of germ-cells are determined at the close of the maturation divisions. Following the physiological line of argument, it must be allowed that in this connection 'potentiality' can mean nothing else than chemical constitution. If we admit this, we admit the validity of the theory, advanced by more than one physiologist, that heritable 'characters' or 'tendencies' must be identified with the enzymes carried in the germ cells."[3]

Half a century later it is clear that the theory would be absolutely valid as stated if we substitute "nucleic acids" for "enzymes." Biochemical geneticists and workers in related fields will be interested in the full line of nucleic acid compounds available from Schwarz BioResearch. We supply DNA, RNA, nucleotides, nucleosides, purines and pyrimidines, sugars and sugar phosphates. Many have been radiolabeled. For example, tritiated thymidine and other H^3-labeled nucleic acid compounds are key tools for genetic studies. Write for our latest catalog and price list.

1. Dalton, J.: On the proportion between the quantity of food and the evacuations. Rep. Brit. A. Adv. Sc., 1831, p. 74. 2. Prentiss, D. W.: Pilocarpin — its action in changing the color of the human hair. Science *2*:442 (Sept. 17) 1881. 3. Bourne, G. C.: Address to The British Association at Sheffield. Nature *84*:378 (Sept. 22) 1910.

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BURETTES—Motor Driven, Constant Rate, Precision Grade, 10 or 50 ml, Sargent.

A precise constant delivery device primarily intended for titration with recorders and comprising precision ground Pyrex Brand Glass solution barrels and plungers, operating on a simple displacement principle with the plunger driven at a constant rate by a synchronous motor. Sealing is effected by replaceable Neoprene "O" rings and Quad rings held in special stainless steel collars with spring loading. Motor drive is transmitted to the plunger by a precision ground stainless steel lead screw running in a Nylon following member. Drive is self-limiting at both ends of the lead screw and automatically resumes on reversal.

A separate motor provides rapid motion of the plunger in both directions for refilling from a directly connected reservoir and for discharging excess titrant and flushing.

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Barrel and plunger assemblies are completely interchangeable permitting accommodation of a total volume of either 10 ml or 50 ml. The rate of drive delivers either volume in 10 minutes. Drive and control components are mounted in a cabinet with a protecting stainless steel cover on which the burette assembly is supported. The panel of this case provides pilot light, fuse, rapid drive reversing switch, and starting button which may be locked in for continuous delivery and for automatic applications. The rear panel provides connecting facilities for using the burette with second derivative automatic titrators with automatic shut-off at the end point and for remote operation by direct connection to Sargent recorders S-72150 and S-72151 for fully recorded titrations.

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Accuracy, 0.1% of burette capacity; readability and reproducibility, 0.01 ml with 50 ml capacity, 0.002 ml with 10 ml capacity. Height of base, 5 inches; depth of base, 8¾ inches; width of base, 10 inches; height over header, 23 inches.

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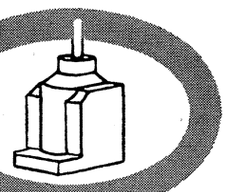

TWO *NEW* GAMMACELLS

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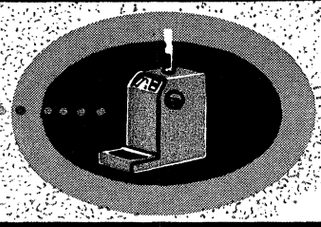

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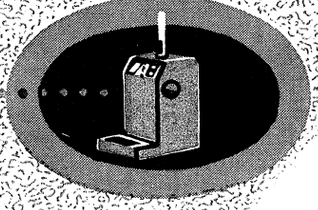

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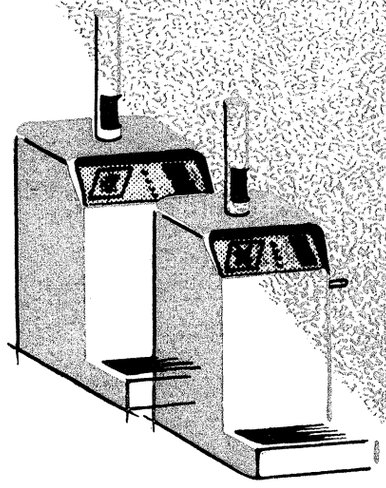

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23 September 1960, Volume 132, Number 3430

SCIENCE

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Win the Argument and Lose the Debate

A Soviet-American exchange program that each year includes several dozen graduate students recently yielded instruction on how increased contact between the two countries can also mean increased friction. Some ill-feeling arose when each side rejected some of the candidates offered by the other. The Americans rejected Soviet students on the grounds that they lacked proper preparation for the work they proposed to do or because Soviet officials had not furnished us with sufficient information to place the students properly. The Soviets rejected American students on the grounds that they had selected topics for study that no self-respecting Soviet scholar would touch. One American wanted to study the history of a certain religious sect, while a second wanted to study the work of a 19th-century political thinker named Mikhail Katkov, but the Soviets are not enthusiastic about religious sects and Katkov, it turns out, was an odious reactionary.

In selecting American students with such topics, the U.S. committee handling the exchange was not being unreasonable. A story in the 21 June New York *Times* explained that research in these fields actually is being conducted in the U.S.S.R. And the *Times*, in its 16 August letter columns, documented this claim by scholarly references to the journals *Voprossi Istorii* and *Voprossi Filosofii* and to the researches of Professor Klibanoff and Dotcents Zatpadov and Sladkevich. This documentation was offered in answer to a letter by V. Yelyutin, the Soviet minister of secondary, special, and higher education. Yelyutin charged that the *Times* story was misleading in making it seem as if the U.S.S.R., not the U.S., was responsible for difficulties in the exchange program.

Another American entered the dispute at this point with the suggestion that if we want to promote exchange with the Russians, then the way to proceed is not by appealing to evidence or sweet reason, but by being more accommodating. In a letter in the 4 September *Times*, Bryant M. Wedge, a member of the Yale faculty who has visited Soviet universities, saw little hope of settling East-West differences by discussion. On the question of the U.S. rejection of U.S.S.R. candidates, which the Soviets found surprising in view of the candidates' possession of Soviet college diplomas, Wedge suggested that, even if we are not clear about the students' qualifications or how to place them properly, they should be accepted. Given our large and diverse educational system, he said, we surely can find room for whomever the Soviet ministry chooses to send us.

Accommodation seems to be an excellent ideal in exchange programs, and perhaps we can do more than we have done, not only in accepting Soviet students but in selecting American students—and topics—as candidates for study in the U.S.S.R. As an exercise in imagination, we might consider how certain subjects would affect us if chosen by Soviet students for study here. Suppose a Soviet student wanted to investigate how in Philadelphia in 1787 the bourgeoisie succeeded in strengthening its dictatorship of the country. This topic is not inconceivable. As noted last year by Andrew R. MacAndrew in the *New Leader*, Soviet historiography has it that the American Constitution was established because the American "ruling classes," having turned the revolution to their own selfish ends, realized that the Articles of Confederation could not deal successfully with "the resistance of the masses."

Under the principle of accommodation, it follows that we should welcome the opportunity to correct such a Soviet student's sense of history, but it also follows that we should not seek a similar welcome in the Soviet Union.—J.T.

worth a thousand words...

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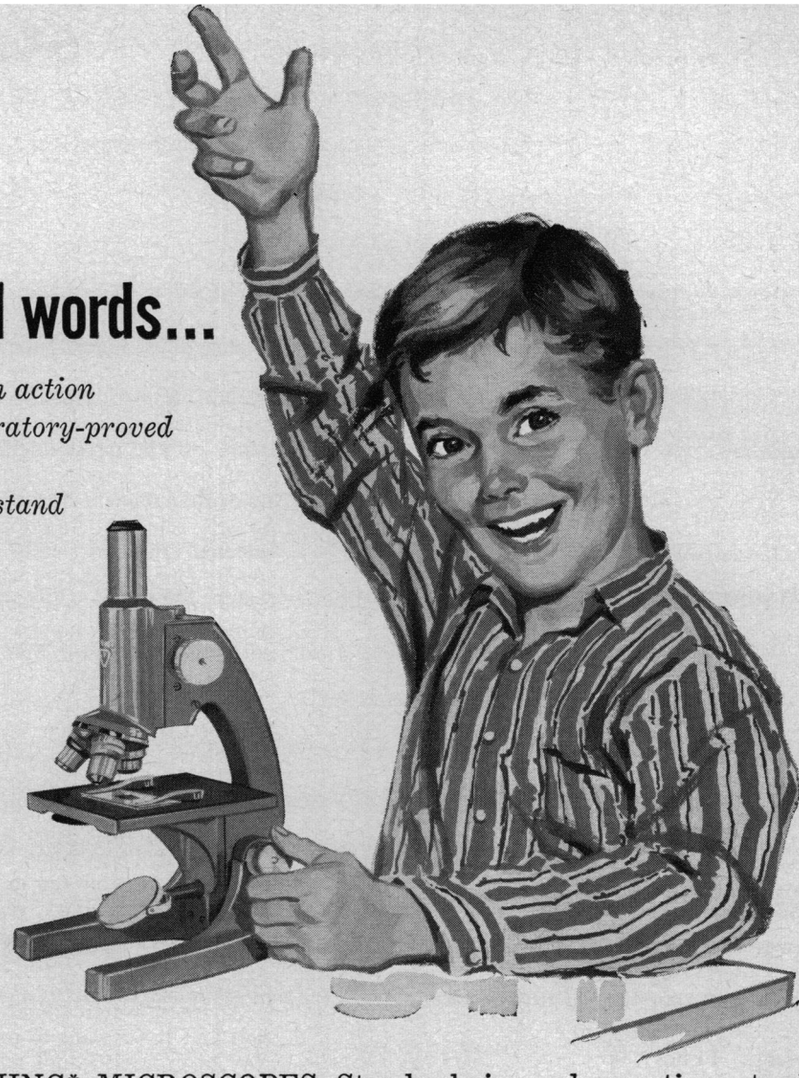

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Meetings

Forthcoming Events

October

13–15. Academy of Psychosomatic Medicine, Philadelphia, Pa. (B. B. Moss, 55 E. Washington, Chicago 2, Ill.)

13–15. Optical Soc. of America, Boston, Mass. (M. E. Warga, OSA, 1155 16 St., NW, Washington 6)

13–15. Pavlovian Conf. on Higher Nervous Activity, New York, N.Y. (Executive Director, New York Acad. of Sciences, 2 E. 63 St., New York 21)

14–15. Society of Photographic Scientists and Engineers, symp., Washington, D.C. (F. M. Brown, Photomechanisms, Inc., Box 67, Huntington Station, N.Y.)

15. American Soc. of Safety Engineers, annual, Chicago, Ill. (A. C. Blackman, ASSE, 5 N. Wabash Ave., Chicago 2)

15–16. American Acad. of Psychotherapists, 5th annual conf., Cleveland, Ohio. (B. J. Barkley, 1856 Coventry Rd., Cleveland Heights 18, Ohio)

15–16. Science and Technology in Israel and the Middle East, 3rd annual, New York, N.Y. (D. C. Gross, American Technion Soc., 1000 Fifth Ave., New York 28)

16. American College of Dentists, Los Angeles, Calif. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis 8, Mo.)

16–22. High-Speed Photography, 5th intern. cong., Washington, D.C. (V. H. Allen, Soc. of Motion Picture and Television Engineers, 55 W. 42 St., New York 36)

16–22. Society of Motion Picture and Television Engineers, semi-annual conv., Washington, D.C. (C. S. Stodter, SMPTE, 55 W. 42 St., New York 36)

17–18. Basic Science in France and the United States, symp., New York, N. Y. (S. Roth, Office of Research Services, New York Univ., Washington Square Center, New York 3)

17–19. Adaptive Control Systems, symp., New York, N.Y. (H. Levenstein, W. L. Maxon Corp., 260 W. 34 St., New York)

17–19. American Oil Chemists' Soc., fall, New York, N.Y. (W. C. Ault, U.S. Dept. of Agriculture, Philadelphia 18, Pa.)

17–20. American Acad. of Pediatrics, Chicago, Ill. (E. H. Christopherson, 1801 Hinman Ave., Evanston, Ill.)

17–20. American Dental Assoc., Los Angeles, Calif. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago, Ill.)

17–21. Neutron Pile Research, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

17–22. Diagnosis and Treatment of Acute Radiation Injury, Geneva, Switzerland. (World Health Organization, Palais de Nations, Geneva)

17–26. Plastics Processing, intern. cong. and exhibition, Amsterdam and Utrecht, Netherlands. (Secretariat, c/o N. V. 't Raedthuys, Tesselschadestraat 5, Amsterdam-W, Netherlands)

18. Oak Ridge Inst. of Nuclear Studies, Oak Ridge, Tenn. (W. G. Pollard, Box 117, Oak Ridge)

18–20. Mathematical Optimization Techniques, symp., Berkeley, Calif. (R. M. Oliver, Dept. of Industrial Engineering, Univ. of California, Berkeley 4)

18–21. American Dietetic Assoc., 43rd annual, Cleveland, Ohio. (M. L. Ross, Simmons College, The Fenway, Boston 15, Mass.)

19–20. American Geophysical Union, Moscow, Idaho. (W. E. Smith, 1515 Mass. Ave., N.W., Washington 5, D.C.)

19–21. Design of Experiments, 6th conf. (by invitation only), Aberdeen Proving Ground, Md. (F. G. Dressel, Office of Ordnance Research, Box CM, Duke Station, Durham, N.C.)

19–21. Space Navigation, symp., Columbus, Ohio. (Institute of Radio Engineers, 1 E. 79 St., New York 21)

19–26. Measuring Techniques and Automation, 2nd intern. cong., Düsseldorf, Germany. (Nordwestdeutsche Ausstellungs-Gesellschaft, Ehrenhof 4, Düsseldorf)

20–21. Hypervelocity, symp., Denver, Colo. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

20–22. Acoustical Soc. of America, San Francisco, Calif. (V. Salmon, Stanford Research Institute, Menlo Park, Calif.)

20–22. Institute of Management Sciences, 7th intern., New York, N.Y. (J. Townsend, IMS, 30 E. 42 St., New York 17)

21–22. Association of Midwestern College Biology Teachers, 4th annual, Mankato, Minn. (L. Zell, Mankato State College, Mankato, Minn.)

21–22. Research Approaches to Psychiatric Problems, symp., Galesburg, Ill. (T. T. Tourlentes, Galesburg State Research Hospital, Galesburg)

21-23. American College of Cardiology, St. Louis, Mo. (G. F. Greco, 114–08 Linden Blvd., Ozone Park 16, N.Y.)

21–25. American Heart Assoc., annual, St. Louis, Mo. (AHA, 44 E. 23 St., New York 10)

22. Midwest Solid State Conf., 8th annual, Lincoln, Neb. (J. W. Weymouth, Physics Dept., Univ. of Nebraska, Lincoln)

23–26. American College of Gastroenterology, Philadelphia, Pa. (D. Weiss, 33 W. 60 St., New York 23)

24–26. Medical and Biological Aspects of the Energies of Space, symp. (School of Aviation Medicine, USAF Aerospace Medical Center), San Antonio, Tex. (J. Harmon, Symposium Coordinator, Southwest Research Inst., P.O. Box 2296, San Antonio 6)

24–27. Hot Atom Effects, symp., Prague, Czechoslovakia. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

25–27. American Standards Assoc., natl. conf., New York, N.Y. (G. F. Hussey, Jr., AST, 70 E. 45 St., New York 17)

26–28. Animal Care Panel, 11th annual, St. Louis, Mo. (ACP, P.O. Box 299, Lemont, Ill.)

26–28. Society for Industrial Microbiology, Conf. on Antimicrobial Agents, Washington, D.C. (SIM, 2000 P St., NW, Washington 6)

27–28. Cellulose Conf., 3rd, Syracuse, N.Y. (Cellulose Research Inst., State Univ. College of Forestry, Syracuse Univ., Syracuse 10)

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27–28. Electron Devices, 6th annual, Washington, D.C. (J. Hornbeck, Bell Telephone Labs., Murray Hill, N.J.)

27–29. American Soc. for Aesthetics, Brooklyn, N.Y. (J. R. Johnson, Cleveland Museum of Art, Cleveland 6, Ohio)

27–29. International Assoc. of Milk and Food Sanitarians, Chicago, Ill. (V. T. Foley, Kansas City, Missouri, Health Dept., 21st Floor, City Hall, Kansas City, Mo.)

28–29. Society for the Scientific Study of Religion, 20th, New York, N.Y. (W. H. Clark, Hartford School of Religious Education, Hartford 5, Conn.)

29–3. Photoelasticity, intern. symp., Chicago, Ill. (P. D. Flynn, ISP, Illinois Inst. of Technology, Chicago 16)

31–2. Association of Military Surgeons of the U.S., Washington, D.C. (R. E. Bitner, Suite 718, New Medical Bldg., 1726 Eye St., NW, Washington)

31–2. Electrical Techniques in Medicine and Biology, 13th annual conf., Washington, D.C. (G. N. Webb, Room 547, CSB, Johns Hopkins Hospital, Baltimore 5, Md.)

31–2. Geochemical Soc., Denver, Colo. (K. B. Krauskopf, Geology Dept., Stanford Univ., Stanford, Calif.)

31–2. Geological Soc. of America, Denver, Colo. (F. Betz, Jr., 419 W. 117 St., New York 27)

31–2. Society of Economic Geologists, Denver, Colo. (H. M. Bannerman, U.S. Geological Survey, Washington 25, D.C.)

31–2. Society of Rheology, annual, Pittsburgh, Pa. (J. H. Dillon, Soc. of Rheology, Textile Research Inst., Princeton, N.J.)

31–4. American Public Health Assoc., San Francisco, Calif. (B. F. Mattison, APHA, 1790 Broadway, New York 19)

November

1–3. International Cong. on Experimental Mechanics, New York, N.Y. (R. Guernsey, Jr., Soc. of Experimental Stress Analysis, General Engineering Lab., General Electric Co., Schenectady 5, N.Y.)

1–16. International Electrochemical Commission, New Delhi, India. (American Standards Assoc., 70 E. 45 St., New York 17)

2–4. Plasma Physics, 2nd annual, Gatlinburg, Tenn. (A. H. Snell, Oak Ridge Natl. Lab., Oak Ridge, Tenn.)

2–4. Society for Experimental Stress Analysis, Berkeley, Calif. (W. W. Murray, Massachusetts Inst. of Technology, Cambridge)

2–5. American Soc. of Parasitologists, Los Angeles, Calif. (F. J. Kruidenier, Zoology Dept., Univ. of Illinois, Urbana)

2–5. American Soc. of Tropical Medicine and Hygiene, Los Angeles, Calif. (R. B. Hill, 3573 St. Gaudens Rd., Miami 33, Fla.)

2-5. American Speech and Hearing Assoc., Los Angeles, Calif. (K. O. Johnson, 1001 Connecticut Ave., NW, Washington 6)

3–4. Electrostatic Propulsion, conf., Monterey, Calif. (J. M. Sellen, Thompson Ramo-Wooldridge, Inc., 8433 Fallbrook Ave., Canoga Park, Calif.)

3–4. Muscle as a Tissue, conf., Philadelphia, Pa. (Division of Research, Lankenau Hospital, Philadelphia 31)

4–5. West-Central States Biochemical Conf., Lincoln, Neb. (J. H. Pazur, Dept. of Biochemistry and Nutrition, Univ. of Nebraska, Lincoln)

4–6. Assoc. of Clinical Scientists, Washington, D.C. (R. P. MacFate, 54 W. Hubbard St., Chicago 10, Ill.)

5. Society for Industrial and Applied Mathematics, Philadelphia, Pa. (G. Kaskey, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia)

7–10. Society of Exploration Geophysicists, 30th annual intern., Galveston, Tex. (C. C. Campbell, Box 1536, Tulsa, Okla.)

8–10. Forensic Sciences, 2nd symp., Washington, D.C. (Director, Armed Forces Inst. of Pathology, Washington 25)

9–10. Use of Secondary Surfaces for Heat Transfer with Clean Gases, symp., London, England. (Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1)

9–11. Clinical Chemistry Methods, symp., Cleveland, Ohio. (A. Hainline, Cleveland Clinic, 2020 E. 93 St., Cleveland 6)

10–12. Geological Soc. of America, 73rd conv., Denver, Colo. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27)

10–12. National Assoc. of Geology Teachers, Denver, Colo. (F. Foote, Dept. of Geology, Williams College, Williamstown, Mass.)

10–13. Pacific Coast Fertility Soc., Las Vegas, Nev. (A. C. Wineberg, 3120 Webster St., Oakland, Calif.)

11–12. Paleontological Soc., Denver, Colo. (H. B. Whittington, Harvard Univ., Cambridge 38, Mass.)

13–16. Society of American Foresters, 60th annual, Washington, D.C. (H. Clapper, SAF, 825 Mills Bldg., Washington 6)

14–17. Magnetism and Magnetic Materials, 6th annual conf., New York, N.Y. (L. R. Bickford, Jr., I.B.M. Research Center, Yorktown Heights, N.Y.)

14–18. American Soc. of Agronomy, Chicago, Ill. (L. G. Monthey, 2702 Monroe St., Madison 5, Wis.)

14–18. Nuclear Ship Propulsion, symp., Taormina, Sicily. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

15–16. Engineering Application of Probability and Random Function Theory, symp., Lafayette, Ind. (J. L. Bogdanoff, School of Aeronautical and Engineering Sciences, Purdue Univ., Lafayette)

16–19. Society of Naval Architects and Marine Engineers, annual, New York, N.Y. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

17–19. Extrapyramidal System and Neuroleptics, intern. symp., Montreal, Canada. (J.-M. Bordeleau, Dept. of Psychiatry, Univ. of Montreal, Montreal)

17–19. Surgery of Endocrine Organs, symp., New York, N.Y. (Office of the Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16)

17–20. American Anthropological Assoc., Minneapolis, Minn. (B. J. Meggers, 1530 P St., NW, Washington 5)

17–20. Southern Thoracic Surgical Assoc., Nassau, Bahamas. (H. H. Seiler, 517 Bayshore Blvd., Tampa 6, Fla.)

18–19. American Medical Writers' Assoc., Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

21–23. Fluid Dynamics, annual, Baltimore, Md. (R. J. Emrich, Div. of Fluid Dynamics, APS, Dept. of Physics, Lehigh Univ., Bethlehem, Pa.)

24–25. American Physical Soc., Chicago, Ill. (K. K. Darrow, APS, 538 W. 120 St., New York 27)

24–26. Central Assoc. of Science and Mathematics Teachers, 60th annual conv., Detroit, Mich. (L. A. Conrey, School of Education, Univ. of Michigan, Ann Arbor)

25–26. American Soc. of Animal Production, Chicago, Ill. (C. E. Terrill, Animal Husbandry Research Div., Agricultural Research Center, Beltsville, Md.)

25–26. National Council for Geographic Education, Cincinnati, Ohio. (L. Kenndmer, Univ. of Texas, Austin)

25–16. Bahamas Medical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

27–1. Latin American Cong. of Neurology, Santiago, Chile. (R. Nunez, Almirante Montt 485, Dep. 11, Santiago, Chile)

27–2. American Soc. of Mechanical Engineers, annual, New York, N.Y. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

27–5. International Federation of Agricultural Producers, 11th conf., New Delhi, India. (IFAP, 1624 Eye St., NW, Washington 6)

28–1. Entomological Soc. of America, Atlantic City, N.J. (R. H. Nelson, 4603 Calvert Rd., College Park, Md.)

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. A coupon for use in mailing inquiries concerning the items listed is included in the post card insert. Circle the department number of the items in which you are interested on this coupon.*

■ ANALOG-TO-DIGITAL CONVERTER is a solid-state instrument with a speed of 10,000 conversions per second at accuracy said to be ±0.05 percent. Display is either 11-bit binary or 3-digit binary-coded decimal plus sign. Four decimal digits and sign can also be obtained. Input impedance is 10,000 ohm/volt. (Packard Bell Electronics, Dept. Sci779, 12333 W. Olympic Blvd., Los Angeles 64, Calif.)

■ SILICON CARBIDE rectifiers are said to withstand temperatures of 500°C and to be one-tenth as subject to radiation damage as silicon. Typical reverse currents are less than 100 μa at 50 volts at 400°C. At 500°C maximum average forward current is 100 ma and maximum peak inverse voltage is 50 or 100 volts. (Transitron Electronic Corp., Dept. Sci780, 168 Albion St., Wakefield, Mass.)

■ OHMMETER measures deviation of resistance from a selected nominal value and displays the result in digital form as a percentage of the nominal value. A range of ±5 percent of total resistance is measured with absolute accuracy said to be ±0.01 percent, the 5-percent range being measured with 3-digit accuracy. Average balancing time is 1 sec. (Electro Instruments Inc., Dept. Sci781, 3540 Aero Court, San Diego 11, Calif.)

■ INFRARED TRANSMITTING GLASS will transmit 77 percent of infrared radiation at 4.0 μ and 38 percent at 5.5 μ in a thickness of 2 mm. Transmission loss at 600°C is 13 percent at 5.5 μ and zero at 4.0 μ. Various shapes and sizes can be mass produced and given an optical finish with standard grinding and polishing techniques. (Corning Glass Works, Dept. Sci789, Corning, N.Y.)

■ VOLTAGE SAMPLER MODULE is designed to follow a rapidly changing voltage wave. It is functionally equivalent to an input operational amplifier connected through a switch to an *RC* filter and followed by a low impedance output amplifier. With the switch closed, the output follows the input in about the same fashion as a 2-μsec delay network. When the switch opens, the voltage is held within 0.05 percent for 1 msec, long enough to be converted to digital form by the manufacturer's converter. (Adage, Dept. Sci791, 292 Main St., Cambridge 42, Mass.)

■ VIBRATION TEST CHAMBER provides vibration access ports through the bottom and through the sides. A hydraulic lift assembly permits raising or lowering chamber height. Flexible silicone diaphragms seal the ports. Temperature range is −100° to +300°F or +100° to +500°F. Refrigeration system can also be provided. (Conrad Inc., Dept. Sci783, 141 Jefferson St., Holland, Mich.)

■ MOISTURE TESTER is designed for intermittent duty with fast drying. Rapid heating and high static pressure from a high-speed blower are said to achieve rapid moisture determination in sand, ceramics, textiles, and other materials. (Harry W. Dietert Co., Dept. Sci784, 9330 Roselawn Ave., Detroit 41, Mich.)

■ WAVE-GUIDE STAND accommodates all wave-guide sizes used in the frequency range 2.60 to 40.0 kMcy/sec. A continuously adjustable set of jaws grips the sidewalls of the wave guide and simultaneously locates the transmission-line center 3 in. above bench level. (Polytechnic Research & Development Co., Dept. Sci785, 202 Tillary St., Brooklyn, N.Y.)

■ TIME PRINTER ACCESSORY for strip-chart recorders automatically prints date, time to the nearest minute, and a remotely selected identification code number. The time clock operates on 60 cy/sec power, and the printing mechanism can be furnished to operate on 24 to 115 volts a-c or d-c. Up to 12 code numbers are selectable. (Royson Engineering Co., Dept. Sci786, Hatboro, Pa.)

■ GAS ANALYZER monitors carbon dioxide concentration under 2 percent in nitrogen gas streams. A thermal conductivity cell immersed in a thermostatted oil bath is used as detector. Accuracy is said to be better than ±0.05 percent CO_2. (Industrial Instruments Engineering Corp., Dept. Sci787, 89 Commerce Rd., Cedar Grove, Essex County, N.J.)

■ MICRO-FURNACE, manufactured by Reichert, mounted upon the inverted stage of a metallographic microscope, permits observation, photomicrography, and cinephotomicrography of thermal-transition phenomena of metals and their alloys while they are subjected to temperatures ranging to 1600°C. The water-cooled high-vacuum furnace can accommodate specimens approximately ¼ in. in diameter. Temperatures are measured and controlled by means of a thermocouple. The furnace is evacuated to prevent oxidation of the specimen. Heating-up period from room tem-

perature to 1600°C is approximately 2 min. Cooling-off time to 200°C is approximately 15 to 30 sec. (William J. Hacker and Co., Dept. Sci790, P.O. Box 646, West Caldwell, N.J.)

■ CLEANING SYSTEM mounts parts to be cleaned on the periphery of a rotary turntable and automatically indexes to successive high-velocity spray-cleaning operations. Solvent and heated, filtered air are directed against all areas of the part. The solvent used is said to be completely free of all nonvolatile materials. (Cobehn Inc., Dept. Sci799, Passaic Ave., Caldwell, N.J.)

■ THERMAL IMPEDANCE MEASURING EQUIPMENT uses pulse technique to measure junction thermal impedance. The junction is heated with d-c power which is pulsed off for 500 μsec at a rate of 10 pulses per second. During the "off" interval, forward voltage drop is measured and compared with the initial drop, the difference yielding the temperature rise. The quotient of temperature rise and applied heating power is defined as thermal impedance. Heating currents up to 50 amp are available. (Wallson Associates, Dept. Sci794, 912-914 Westfield Ave., Elizabeth, N.J.)

■ CAPILLARY GLASS TUBING is available in sizes ranging from 0.0015 to 0.014 in. outside diameter. Tolerances on the capillaries are said to be held to ±0.0002 in. The tubing is offered in standard flint, noncorrosive flint, lead, and heat-resistant glass. Standard length is 6 ft. (Friedrich & Dimmock, Dept. Sci800, Millville, N.J.)

■ CHARACTER GENERATOR is said to generate numbers, characters, and symbols with the quality of fine printing. The output is displayed on a cathode-ray-tube screen. Characters with 5000 television-picture elements of resolution may be generated at a rate of 1000 per second. As many as 5000 individual characters are utilized. A display rate of 100,000 characters per second can be achieved with 150 different characters, each with 100 television picture elements. The generator uses a word-oriented, wired program memory of ferrite cores to store the character shapes. The system, composed entirely of solid-state components, requires less than 2 ft^3 of space. (Columbia Broadcasting System, Dept. Sci792, 485 Madison Ave., New York 22, N.Y.)

■ POLARIZED MOTOR is a d-c motor without commutator. It is activated by synchronous impulses from a solid-state sealed circuit. Starting torque is 4-in.-lb, and running torque at 1 rev/min is 8 in.-lb. Starting current and running current are both 85 ma at 28 volts d-c. Stopping time is 10 msec. Size is 1⅜ in. in diameter by 2½ in. long, and weight is 12 oz. (Cook Electric Co., Dept. Sci793, 2700 N. Southport Ave., Chicago 14, Ill.)

■ VOLTAGE CALIBRATOR covers the frequency range of 1 kcy to 200 Mcy/sec. Calibrating voltages between 0.001 and 1 volt r.m.s. are provided with 1-volt input. Accuracy at 1-volt input and output is said to be ±1 percent from 1 kcy to 10 Mcy/sec, ±2 percent to 50 Mcy/sec, and ±3 percent to 200 Mcy/sec. Input impedance is 50 ohms. (Kay Electric Co., Dept. Sci796, 14 Maple Ave., Pine Brook, N.J.)

■ OPTICAL LENS BENCH includes two end supports carrying two steel bars spaced 4 in. apart and a third bar below. Three sliders, each with vertical rod and collar, a long "V", a short "V", and a circular platform are furnished as standard equipment. Sliders may be removed or placed at any time. (Mason Instrument Co., Dept. Sci802, P.O. Box 1681, New York, N.Y.)

■ HALL EFFECT MULTIPLIERS are designed for applications requiring high output voltage. The core material used can be driven to linear flux densities well over 10 kgauss. Five models,

MC 1, 2, 3, 4, and 5, provide a range of coil currents and inductances. Linearity can be optimized by selection of proper load resistance, about 7 ohms. Linearity is determined by power losses in the device. Typical values are: 5 ma, 0.4 percent; 250 ma, 0.1 percent; 125 ma, 0.025 percent. Typical input impedance is 1.2 ohms; typical output impedance is 0.8 ohm. (Ohio Semiconductors Inc., Dept. Sci795, 1205 Chesapeake Ave., Columbus 12, Ohio)

■ ELECTRON-BEAM FURNACE is said to be capable of melting, alloying, and refining ingots of up to 50 lb of tantalum and of proportionate weights of other metals. The furnace consists of two separate chambers, one containing the electron gun, the other the mold and metal-feeding mechanism. Separate pumps are used to evacuate the two chambers. The electron gun is focused by a magnetic coil. The main power supply is a 60-kw unit delivering up to 3 amp at voltages to 20,000. It is interlocked with vacuum gages, pumps, and cooling water to prevent damaging operation. (NRC Equipment Corp., Dept. Sci797, 160 Charlemont St., Newton 61, Mass.)

■ ELECTRONIC COMMUTATORS are solid-state devices that can sample low-level differential instruments such as strain gages and thermocouples at a rate up to 10,000/sec and accuracy said to be ±1 percent or better of full scale at levels of 5 mv or greater. The units contain up to 90 channels. A 30-channel unit weighs 2.5 oz and has less than 1 $in.^3$ volume per channel. (General Devices Inc., Dept. Sci803, P.O. Box 253, Princeton, N.J.)

■ RUGGEDIZED TELEVISION SYSTEM consists of a camera and camera control capable of being operated up to 2000 ft apart. No additional housing is required for the camera to operate in all environments in which the equipment could be used. The system will operate at temperatures from −20° to +160°F, in ambient noise levels of more than 185 db, and with no limit on altitude. The system has transistor circuitry exclusively. An automatic light-level compensator adjusts for light-level changes over a 2000-to-1 range. A wide variety of accessories is available. (Thompson Ramo Wooldridge Inc., Dept. Sci810, Michigan City, Ind.)

■ MIXER of rotary type uses a mixing chamber of transparent plastic. Dimensions of the chamber are 6.5 in. in diameter by 12 in. long. The chamber rotates in two changing planes to insure completeness of mixing. (Testing Machines, Inc., Dept. Sci811, 72 Jericho Turnpike, Mineola, N.Y.)

■ THERMOSTAT BATHS, one for thermometer calibration and another for viscometry, have transparent sides. Temperature range is up to 230°C. A circulating plate is said to permit control of temperature fluctuations in the working space within ±0.001°C for water and ±0.005°C for oil. An auxiliary thermostat keeps the emergent stem of the contact thermometer at constant temperature and permits micrometric adjustment of temperature. The units are constructed of stainless steel with transparent areas 22.5 by 10.5 in. and 12.5 by 10.5 in., respectively, for the thermometer calibration bath and the viscometer bath. (Instrumentenfabriek P.M., Dept. Sci816, Tamson N.V., The Hague, Netherlands)

■ AUTOMATIC PLOTTER has a working area that measures 47.25 by 47.25 in. Maximum operating speed in 3 in./sec, and slowest operating speed is 0.003 in./sec. Accuracy is said to be ±0.0015 in. Input may be in the form of tape or cards. Position of *X* and *Y* rails is shown by a projection-type display. An optical line-following device is offered as an accessory. A Flexowriter is used to provide keyboard input, punching of tape, reading of tape, and typing of printed record. (Aero Service Corp., Dept. Sci806, 210 East Courtland St., Philadelphia 20, Pa.)

■ STRETCHABLE CABLE is constructed with a rubber core with insulation of nylon and conductors of copper wire, bronze tinsel, or copper tinsel. A natural rubber core is used in commercial types; military types have a silicone rubber core. Elongation of the former is 300 percent for single-conductor cable and 275 percent for multiple-conductor cable. Corresponding elongations of the military types are 250 and 225 percent. (National Radio Co., Dept. Sci807, Malden, Mass.)

■ LEVELING BASE for a variety of instruments uses three leveling screws mounted at the corners of a triangular platform. A circular level, mounted at one corner, guides adjustment. (W. & L. E. Gurley, Dept. Sci826, Troy, N.Y.)

■ PRESSURE TRANSDUCER uses as sensitive element a free-edged circular diaphragm of Ni-Span-C that forms the movable common plate between two capacitor plates. Pressure change is measured by change in capacitance. Hysteresis effects are said to be less than 0.03 percent and sensitivity better than 0.01 percent of full scale. Full scale ranges are available from 1 to 100 lb/in.^{2} First resonance of an altimeter using the transducer is greater than 1650 cy/sec, and time constant is 0.004

sec for 63-percent response. Operating temperature range is −55° to +100°C. (Rosemount Engineering Co., Dept. Sci825, 4900 W. 78 St., Minneapolis 24, Minn.)

■ OPTICAL BENCH with three slides is offered with standard optical accessories such as carriers for center and side slides, micrometer centering carriers, concentric ring sets, lens chucks and lamphouses. The main bench is equipped to mount an auxiliary bench, machined and scaled exactly as the main bench, at right angles to the main bench when systems involving beam splitters are being tested. The auxiliary bench is 21 in. long. (Ealing Corp., Dept. Sci804, 33 University Rd., Cambridge 38, Mass.)

■ CLINOMETER ACCESSORY that adapts a precision clinometer for use in a vertical position consists of a special base, with adjustments for making the axis of rotation of the circle normal to the supporting surface, and a 4.75-in.-diameter work table for measurement of angular displacement of small parts. The clinometer is available in 10-sec and 1-sec sensitivities. (Engis Equipment Co., Dept. Sci805, 431 South Dearborn St., Chicago 5, Ill.)

■ DIGITAL CONTROL SYSTEM is continously slaved to the instructions from user-supplied equipment and will continuously supply the signals necessary to position an encoder to the point where the encoder data are coincident with the three-decimal-digit destination supplied by the user. The system will supply a stop command when the encoder and destination signal are coincident, and sign-of-the-difference signals to assure proper direction-of-rotation commands. (Datex Corp., Dept. Sci819, 1307 S. Myrtle Ave., Monrovia, Calif.)

■ PNEUMATIC CONTROLLERS are available in models for proportional control, with 1-to-400 percent proportional band, and reset control with a rate of 0.1 to 50 repeats per minute. They are offered for control of pressure from vacuum to 10,000 lb/in.^{2}; temperature from −100° to +1000° F; flow and differential pressure; humidity from 0 to 100 percent, relative; and differential liquid level. The frequency response curve is essentially flat to 400 cy/min for proportional control and 325 cy/min for proportional plus reset. (Bristol Co., Dept. Sci817, Waterbury, Conn.)

■ PEN MOTOR for 40-mm recording systems provides rectilinear motion. An interchangeable electric stylus is available. The following specifications are cited when used with the manufacturer's Model DC-101 compensated driver amplifier: coil resistance, 16 ohms; d-c current sensitivity, 28 ma/mm; linearity, 2 percent of full scale; frequency response, d-c to 120 cy/sec (3 db down); damping, approximately 30 percent of critical. An auxiliary winding provides velocity voltage feedback. (Massa Division, Cohu Electronics, Dept. Sci801, 5 Fottler Rd., Hingham, Mass.)

■ VACUUM FURNACE is a continuous firing furnace in which work boats are moved through individual stages, including the firing chamber. Pressure in the latter can be maintained as low as 0.01 μ-Hg continuously. Temperature of the heat zone is continuously adjustable. Various sizes are available. (Kahle Engineering Co., Dept. Sci815, 3322 Hudson Ave., Union City, N.J.)

■ TEMPERATURE CONTROLS are transistorized instruments using thermistor sensing elements. The series 536 that covers the range −50° to +600°C with sensitivity 0.3°F is furnished with either on-off or proportional action and with optional indicator circuit. Also available are similar instruments that function as indicators only. (Fenwal Inc., Dept. Sci824, Pleasant St., Ashland, Mass.)

■ ELECTRON-BEAM EVAPORATING UNIT, for installation in laboratory or commercial vacuum equipment operating at 3×10^{-4} mm-Hg or lower, is capable of vaporizing all metals. The unit includes an electron-beam gun, extra filaments, power supply, control panel, and electrical feed-throughs. Beam-

current rating is 250 ma at 10 kv. Optional accessories include a 1000-volt bias supply and a motor-driven feed to supply evaporating metals continuously to the vapor source. Operation is on 120-volt, 60-cy/sec power. (Alloyed Corp., Dept. Sci818, 35 Cambridge Parkway, Cambridge 42, Mass.)

■ ATOMIC FREQUENCY STANDARD for airborne applications weighs 65 lb and has a volume less than ½ ft^3. Frequency stability is said to be better than 1 part in 10^9 for the life of the equipment under environmental conditions in aircraft operations. (National Co., Dept. Sci808, Malden, Mass.)

■ SURFACE-TENSION MEASURING INSTRUMENT uses the du Noüy method of measuring pull on a ring with semiautomatic operation. The torsion wire that moves the test ring is twisted at a slow, uniform rate by a reversible synchronous motor. At the moment the ring breaks free of the surface, the support arm touches a contact and a relay stops the motor. The applied torsion is indicated on a scale calibrated from 0 to 90 dyne/cm. (Fisher Scientific Co., Dept. Sci821, 717 Forbes St., Pittsburgh 19, Pa.)

■ MICROWAVE OSCILLATOR features plug-in generator heads in standard steps of 1 to 2, 2 to 4, 4 to 8, 8 to 12.4, 6.5 to 11.5, and 12.4 to 18 kMcy/sec. Sweep frequency is continuously adjustable from 0 to band-width extremes. Two adjustable frequency markers are provided. Residual FM is ±0.0025 percent, and drift is ±0.02 percent. (Alfred Electronics, Dept. Sci822, 897 Commercial St., Palo Alto, Calif.)

■ LENSES for image intensifiers form images on a surface of 4.00-in. radius of curvature convex to the objective. They are corrected for 16:1 and 4:1 conjugates. Aperture is $f/0.87$. Used in pairs, the lenses are utilized for 1:1 magnification coupling between the flat phosphor of one image tube and the convex cathode of the next tube, covering a 1-in. diameter field. (Farrand Optical Co., Dept. Sci823, Bronx Blvd. and E. 238 St., New York, N.Y.)

■ SIGNAL GENERATOR uses a separate crystal-controlled oscillator-amplifier to generate each of 50 fixed frequencies in the range from 50 kcy to 900 Mcy/sec. The individual units are packaged in groups of ten and are selected by switches. Output is held to a constant level independent of frequency. Attenuation up to 110 db is provided in 1-db steps. Frequency stability of 5×10^{-7}/wk is said to be achievable. Frequency multiplying circuits are used above 75 Mcy/sec. (Telonic Industries, Dept. Sci827, Beech Grove, Ind.)

■ PUMP of peristaltic type accommodates hoses of any size up to 1 in. Flow is variable from a few milliliters per minute to nearly 500 gal/hr. A reversing switch permits flow in either direction. Delivery per revolution is said to be constant enough for metering applications. (Schueler & Co., Dept. Sci828, 75 Cliff St., New York 38, N.Y.)

■ CENTRIFUGE is said to show long-term drift less than 1 part per million per week. Deviation from average angular velocity is specified as less than 1 part in 50,000. Range is 0.5 to 20 grav. Angular velocity is adjustable in 60 discrete steps measured by a magnetic pulse system and electronic counter. Capacity is 25 lb in a 12-in. cube. A radius comparator measures any variation in arm radius as a function of speed. (Genisco Inc., Dept. Sci829, 2233 Federal Ave., Los Angeles, Calif.)

■ TEST TABLE for gyros and gyro systems weighing up to 150 lb is a servo-driven, two-axis instrument. Constant rates between 0.15 deg/hr and 1200 deg/sec are available. Up to 24 circuit slip-ring and brush-block assemblies can be provided for each axis. Units are available with inductive type angular pickoffs said to be precise to ±3 sec. (Power-Tronic Systems, Dept. Sci831, 10 Pine St., New Rochelle, N.Y.)

■ AIR POLLUTION TESTER is a compact portable apparatus for air pollution testing in emergency or preliminary field work. The unit employs a colorimeter to estimate amounts of eight gaseous pollutants and can also be used to indicate presence of ten particulate pollutants. The tests are made by a train of reagents and color solutions through which the air is pumped. The colors developed are compared against color standards which have been previously calibrated in terms of micrograms of pollutants per cubic foot. (Central Scientific Co., Dept. Sci834, 1700 Irving Park Rd., Chicago, Ill.)

■ NEUTRON ACTIVATOR provides a source of 14 Mev neutrons with a time average output of 10^8 neutrons/sec at a rate of 100 pulses per second and pulse duration 5 μsec. Neutrons are produced by the reaction of deuterium and tritium. Neutron output can be varied by adjustment of either the voltage used to accelerate the deuterons or the pulse rate. A control cabinet permits remote operation of the source. The activator is shipped ready for operation. (Radiation Counter Laboratories, Dept. Sci837, Nucleonic Park, Skokie, Ill.)

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Letters

The Drug Industry

Because so much of a superficial nature has been written as a consequence of the Senate's hearings on the drug industry, I have been particularly interested in the somewhat more thoughtful analyses prepared by *Science*. Your article last April [*Science* **131**, 1299 (1960)] showed a strong effort to maintain complete objectivity. But I have been puzzling for some time now over your report of 16 June, under the heading "The drug inquiry: a curious affair that has netted some solid results" [*Science* **131**, 1794 (1960)]. In brief, I find this report disappointing.

In the first place, you use the phrase "whatever complaints can be made about the style of the investigation." Covered by this brief, qualifying phrase is a perfectly outrageous demonstration of misleading, headline-hunting tactics. By implication, you take issue with such tactics.

However, you immediately go on to state that the "solid results" have "for the most part developed out of the publicity given the hearings, which the hearings won, in part, through the way in which they were conducted." Thus, you seem to endorse the use of questionable means to reach an end. And I cannot see that publicity is responsible for any results except unfair and misleading ones.

What do you call "solid results"? It seems clear to us that you are saying just this: after months of thin pickings, in which the drug industry could be pilloried only by misleading headlines, the Senate subcommittee came up with solid results when it turned its sights onto government agencies. Let me make it clear that if this is the real implication of what you are saying, I certainly do not espouse it, for I cannot condone the defamation of a fine agency such as the Food and Drug Administration on the basis of one or two incidents. If, on the other hand, you are saying that these "solid results" have come in regard to our industry, I can only ask, what are you referring to?

May I also refer to your comments on the "high-powered promotion race." While no one can reasonably deny the extent of this competitive manifestation. I think that most of your readers who are familiar with our industry will disagree with you that "there is pressure on every company to match the promotional effort of the least responsible companies." Likewise, I am confident that your readers will reject the generalization that "much of [this barrage of promotion] tends to be misleading." And, in the same sentence,

I scarcely think your readers will adopt the assumption that this promotion is misleading "since its purpose is to sell goods rather than to inform the doctor."

Admittedly, our perspective, as members of an industry operating in a business environment, is bound to be weighted in favor of our vigorous—and we think generally efficient—methods of promotion. But, for all its weaknesses, we believe our system brings prompt and thorough information to the physician and allows him the maximum opportunity, at greatest personal convenience, to be well informed on the range of medicines our industry has placed at his disposal.

Finally, you raise a fundamental question about the appropriateness of allowing the drug industry to function within the structure of the competitive enterprise system. One's immediate reaction to this is to ask, why then should food, water, shelter—the things that affect not merely health but sheer survival—be supplied under the stimulus of the profit system? Cannot business incentive serve health equally well? I submit that our industry has served the public interest as well as or better than any other I know of.

I recognize that the social, economic, and political issues involved cannot be dismissed casually, but I worry about a philosophy that seems to suggest that health be "quarantined" into the government domain.

G. F. ROLL
Smith Kline and French Laboratories, Philadelphia, Pennsylvania

The "solid results" referred to were the indications that the climate of opinion brought about by the investigations had put the Food and Drug Administration in a position to initiate reforms which they had felt were advisable but which for years had been difficult to achieve because there had been little public interest in what the FDA wanted to do. One example is the recent tightening of regulations governing the information that must be included in drug promotion pieces. Another is the FDA proposal for a new factory inspection law.—ED.

Cannibalism

I was quite interested in Jay Boyd Best's recent article "Diurnal cycles and cannibalism in Planaria" (*1*) but question the use of *cannibalism* to describe the behavior observed. Webster's *New Collegiate Dictionary* defines a cannibal as "a human being that eats human flesh; hence, any animal that devours its own kind." Recent notes in ornithological journals report incidences

of one bird killing and eating another of a different species (*2*). If these instances are accepted as cannibalism, should eating of song birds by avian predators such as hawks be termed cannibalism also? Some species, such as the blue jay (*Cyanocitta cristata*), which are not ordinarily predators will kill and eat young of other species (*3*). Stewart (*4*) describes as cannibalism the eating by one captive tufted titmouse (*Parus bicolor*) of another killed by a rat; yet this probably would not have occurred in free-living individuals.

Scavengers and carrion feeders will often eat dead members of their own species (I have observed this in gulls). Cannibalism is also said to occur in those colony-nesting gulls which kill and eat the young of neighboring nests (*5*), in storks and other species which eat their own young ("kronism") (*6*), and in owls in which siblings apparently eat one another (*7*). These latter types of "cannibalism" may function in population dynamics as "feedback mechanisms" to adjust the number of the year's offspring to the available food supply.

It seems to me that to call these (and other) kinds of behavior "cannibalism" directs attention away from analysis of the true adaptive significances of the observed phenomena. I suggest that the term *cannibalism* be restricted to improbable occurrences of adult animals feeding on other adults of the same species in the wild.

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References and Notes

1. *Science* **131**, 1884 (1960).
2. See article and citations in J. K. Terres, *Auk* **73**, 289 (1956) and R. H. Backus, *ibid.* **71**, 471 (1954).
3. See article and citations in D. H. Lamore, *Wilson Bull.* **70**, 96 (1958).
4. *Auk* **72**, 83 (1955).
5. N. Tinbergen, *Herring Gull's World* (1953).
6. E. Schüz, *Die Vogelwarte* **19**, 1 (1957).
7. I. Collingwood, *Auk* **76**, 222 (1959); **77**, 256 (1960).

Jack Hailman is to be thanked for his contribution to linguistic precision. I stand corrected. On the other hand, the restricted definition proposed as a substitute for Webster's does not strike me as particularly useful. Of far richer import are Hailman's remarks hinting at what he believes to be the biological significance of cannibalistic (in Webster's sense) behavior. It is to this more beguiling problem that I would like to address the remainder of this letter.

The most interesting thing about cannibalism (in Webster's sense) is not that it occurs but rather why it does not occur more often than it does. By what cues, stimulus patterns, and behavioral restraint mechanisms is an animal that normally preys voraciously upon a wide spectrum of other species more or less inhibited from preying on its own kind? As a working hypothesis it would seem far more parsimonious to consider cannibalism to be an extension of an animal's normal spectrum of prey to include members of its own species than to consider it a specialized adaptive mechanism for adjusting population to food supply. Cannibalism could be expected, in the former view, to ensue whenever the hunger "drive" overrode the psychological mechanisms normally prohibiting predatory behavior directed against the animal's own species. That it may also function as a feedback mechanism in population dynamics, as suggested by Hailman, seems more or less incidental. Let us for convenience refer to Hailman's view as *A* and to the view which I choose to espouse as *B*.

Some patterns of attack specificity were observed among the planarians described in my report in *Science*. The immature *Dugesia tigrina* used in the experiments were kept in colonies of approximately 30 per bowl during the time they were being fasted. It was found that feeding reduced the incidence of attack of *D. tigrina* upon *Cura foremani* to zero. If cannibalism (in Webster's sense) had been common

among the *D. tigrina*, they would have been sated at the time of testing and attacks upon the *C. foremani* would not have been observed. Thus, the probability of predatory attack of immature *D. tigrina* upon *C. foremani* must be much greater than the probability of attack upon each other. Nor were *C. foremani* observed to attack each other. Yet both species will attack and eat a wide variety of other small organisms—for example, *Tubifex* worms, mosquito wrigglers, and brine shrimp—and large, sexually mature *D. tigrina* will attack and eat smaller immature *D. tigrina*. Thus, even among the planarians, which are about the most primitive animals possessing a real central nervous system, there is considerable specificity in regard to predatory behavior directed against close relations. The cues inhibiting or releasing such behavior in planarians are still largely unknown.

Hypotheses *A* and *B* imply different sets of consequences, and these consequences could be used to distinguish which of the hypotheses is valid. To decide between them one might ask the following questions.

1) Within the set of animals having the physical capacity to kill and eat a member of their own species, is the incidence of cannibalism in a species positively related to the diversity of other species preyed upon by the members of the species in question? Hypothesis *A* would imply no such relation; *B* would. Consider Hailman's own citation of the fact that owl siblings kill and eat one another. Apparently siblings of less voracious predators do not. Why? As a teleological mechanism to adjust population to food supply, cannibalism should be equally useful for all species.

2) Is cannibalism as frequent among predators and omnivores that hunt and travel in packs as it is among those that are solitary hunters when the breadth of prey spectrum between the two types is comparable? I do not believe hypothesis *A* would predict any essential difference. Hypothesis *B* would predict a higher probability of cannibalism among the solitary hunters when they are placed together, because group living would favor the evolutionary selection of more powerful inhibitory mechanisms against cannibalism.

3) Among those species which are physically incapable of eating other members of their own species but which do possess the capacity to kill other members of their own species, does one observe an enhanced rate of killing of members of their own species in the absence of an adequate food supply? According to *A* one should, since the advantages of such an action as a population regulator are as effective as cannibalism; *B* would predict that one would not.

JAY B. BEST
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Systematic Collections

Before the regulation on deposition of types proposed by the conferences on systematic collections [A. B. Grobman, *Science* **131**, 938 (1960)] is put into effect, "stable institutions" should be required to obtain from some properly qualified and independent authority a statement certifying just which kinds of organisms now are adequately curated and will be so curated in the future. Duplicating curatorial concentration on certain favored groups is so great as to warrant more than a suspicion that staffs of all such stable institutions in North America, even if combined, would not be in a position to look after specimens of every sort of extant organism. Institutions desiring certification also should be required to prove that they know how to retain specimens in a condition to function with some degree of usefulness as types, or else that they are en-

gaged in research to such an end. Types of one economically important but neglected group, common almost everywhere in the world, usually are in the same sort of pickle (literally and figuratively) as they were a century ago, but if they are not, then they are in a still less satisfactory condition. All such types are slowly deteriorating. No effort is being made, so far as I know, in any stable institution anywhere in the world, to discover better techniques for preserving these animals.

The certifying authority also should be required to satisfy itself that the museum rules regarding types really will promote the advance of knowledge. One of several instances that can be cited is as follows. Species *x* was erected in 1871 on the basis of a single specimen, of which only the external characteristics were described, and those all too briefly. The authority on the group examined the type in 1888 but could add no information of importance, for he was not permitted to make a dissection. The species can belong to any one of six genera distinguishable from each other only by their internal anatomy. Each of some dozen monographs has had to waste space in vain repetition of the little that was known 70 years ago about this species *incertae sedis*.

G. E. GATES
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Without reviewing the substance of Gates' remarks, with which I am in substantial agreement, I should like to point out that the conferences referred to did not discuss "regulations," "certification," or "certifying authorities." The conferences adopted some resolutions which I regard simply as recommendations to appropriate authorities by a group of informed specialists. No legalisms were implied.

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Visual Effects

The photograph of the Arizona Meteor Crater on your cover for 22 July is excellent for the well-known demonstration of the effect of inverting the image. Held upside down, the crater appears to be a great mound. What makes this photograph especially good is the fact that it is taken from such a high point that the horizon does not show. Most astonishing effects may be obtained by holding the picture about 18 inches from the eyes and rotating it smoothly, at a rate of about 360° per minute, either clockwise or counter-

clockwise. At certain moments, when the picture is 90° or so from normal, the crater appears to be a great mass of rock completely detached from the ground. With somewhat more rapid rotation, and very steady fixation of the white area in the center of the crater, I tend to develop an amusing semblance of vertigo.

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The High Cost of Reading

To read is to learn, and to know is to foresee and be strong. All this is easier if one has books of one's own, the more of them the better. But scholarly books are expensive, painfully so for those who need them most, the young and the unlearned.

New books are expensive because they are costly to produce, they sell in small numbers, and publishing houses must remain solvent. Financial aid in their distribution might make it possible to sell scholarly works at prices all those who wished them could afford. If more copies of a book would sell, unit production costs would decrease. Once such a program got started it might be that small sums of money would greatly increase the number of books made available to those who want them.

This new form of aid to the education of scholars and scientists seems to be a natural extension of the role of philanthropic foundations. Continuing a tradition of specialization, and in order to provide some measure of long-range effectiveness, a foundation interested in such a program might select a definite field of knowledge in which to help books reach their destined readers. Large foundations might choose large fields: virology, nutrition, cellular biology, linguistics. Less wealthy foundations could establish their identity by supporting more circumscribed fields: psychology of perception, history of biology, philosophy of science.

Financial aid in the publication of scholarly books is not a new idea, but heretofore such help has not been notably effective in making books cheaper. What is needed is some form of aid that would let a $6 book sell for $3, a $10 book for $4; perhaps no scholarly book should cost an interested individual more than $5 or $6. The selling price ought to be a test of serious interest and not a test of ability to pay. Anybody willing to spend $5 on a book on the chemistry of amino acids, or on comparative linguistics, deserves to have the book.

A system would have to be found which would preserve the tradition of

free enterprise in the production and selling of books; our scientific publishers and booksellers are doing a fine job, and no one would want them disturbed. In fact, the type of program suggested here would strengthen the industry and the trade. The system should enable an individual to get the books he wants without much ado; there should be no test of the "need to have" or "need to know." To a layman in these matters, for booksellers simply to bill a given foundation for part of the price of each book sold from among those it supports would seem an acceptable solution; experts probably could think out something better, even if less simple. Public libraries, universities, and business firms would continue to pay the full price of supported books. The distribution of journals could be similarly helped; some of them, especially the ones in newer fields, are frightfully expensive. There is precedent for a journal's selling for less to individual subscribers than to organizations: subscription rates for the *Philosophical Review* of Cornell University are $3 per year for individuals and $6 per year for institutions. Regrettably this example is not widely followed.

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Science Teaching

The report by Howard E. Gruber, "Science teachers and the scientific attitude" [*Science* **132**, 467 (19 Aug. 1960)], focuses attention on a critical problem in the preparation of science teachers.

In what ways can teachers be equipped to change the pattern of science instruction from one involving the mere cataloging of isolated scientific facts to one which reveals how scientists make use of the power of the human mind to perceive, think about, and eventually integrate seemingly unrelated arrays of impressions into broad conceptual schemes?

With the rate of growth of knowledge constantly increasing, the teacher who tries to present a body of facts (biology, chemistry, physics) without evoking some degree of understanding and appreciation of unifying fundamentals is bound to lead his students into a morass of frustrating confusion.

Since teachers-to-be are influenced to a great extent by the ways in which they themselves are taught, instructors of science training courses should emphasize and illuminate the processes of science and give the future teachers as many firsthand experiences with them as possible.

Prospective teachers who, in this way, come to know the real flavor of the intellectual enterprise called science will be in a better position to transmit to their students the spirit of man's endless search to comprehend the world around him.

Teachers with such training will make sure that students do not get the impression that all the major discoveries already have been made; that the basic facts and principles of science are unchangeable; that there is nothing left for them to do but to learn about what others have done. Instead, these teachers will engender the feeling that there is always more to explore; that the road to discovery is wide open; that the horizons of science are unlimited.

Teachers with such training will know how to use curiosity to generate in their classrooms the kind of provocative stimuli that impel research scientists to pit their minds against the challenges of nature. They will know how to establish a free atmosphere in which individual initiative and ingenuity can flourish and in which each student is encouraged to express his own ideas no matter how far-fetched they may seem.

In *Walden,* Thoreau expressed the idea that "if a man does not keep pace with his companions perhaps it is because he hears a different drummer. Let him step to the music which he hears however measured or far away." What would be the impact on student interest and growth if this idea were to be adopted as one of the foundation stones of science instruction?

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Pseudo Science and Censorship

The letter by H. C. Dudley on "Pseudo science and censorship" [*Science* **132**, 378 (12 Aug. 1960)] requires additional comment in rebuttal. Dudley makes a plea for fair-mindedness and questions the right of anyone to censor another's pronouncements as being "preposterous" or "crackpot."

Although examples may be quoted wherein reputable discoveries were denounced by contemporaries, examples of the reverse are truly legion. For an excellent compendium of wild ideas, crazy machines, crackpot inventions and theories, and general "magic black box" hoaxes, one may well read *Fads and Fallacies in the Name of Science,* by Martin Gardiner (Dover, New York, 1957).

Gardiner sets up a rather useful group of ground rules for separating

the honest effort in a new field from the work of the venial deluder or psychopathic crank. Thus, on pages 12 and 13 he outlines five excellent criteria which will trip up the crank.

Dudley's sense of fair play is admirable but does not, apparently, include the judicious selectivity required so desperately in our modern society. So often, today, individuals worry so about the rights of others and the problems of the minority that they allow the minority to subvert the ideals and steal the rights of the majority.

One is reminded of the tale of "The bear who let it alone" in James Thurber's *Fables for Our Times*. The moral of the tale is very relevant to conditions today. "You might as well fall flat on your face as lean too far over backwards."

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Starvation with and without Painful Hunger Pangs

Kelman (*1*), Wittenberg (*2*), and Ross (*3*) regarded starvation as too painful to justify its use in studies on animals such as Denenberg and Karas (*4*) made. The gnawing pangs of hunger are commonly considered to be the most disagreeable accompaniment of prolonged starvation, and hunger generally makes even a few days of fasting difficult. However, Kelman, Wittenberg, and Ross apparently did not take into consideration the fact that disagreeable hunger sensations usually decrease or disappear after the first few days in prolonged starvation without any food. Unfortunately, even widely accepted authorities like Cannon and Carlson did not agree about the manifestation of hunger during prolonged starvation, although both regarded the hunger experienced during a few days of starvation as consisting mainly of uncomfortable or gnawing sensations produced by periodic contractions of the fasting stomach (*5*, *6*). Cannon maintained that hunger disappeares after the first few days in prolonged starvation, while Carlson maintained that hunger persists. Cannon's view was based on the reports of others but not on any study made by him or his students. Carlson's view was based on a study made on himself and an assistant while they fasted about 5 days.

Eight years ago before I learned of Carlson's view by reading his monograph on hunger (*6*), I accepted the explanation of hunger or normal appetite advanced by Fletcher (*7*). Fletcher distinguished between a normal appetite and a false appetite but not between hunger and appetite. He considered normal hunger or appetite to be mainly of

mental origin, false appetite to be often a manifestation of stomach craving. My observations largely seemed to support Fletcher's views. In 1913, I fasted 26 days, and my impression was that the reference of hunger to the stomach tended to disappear after about the fifth day. It therefore seemed that Carlson and his assistant simply did not fast long enough to note that the reference of hunger to gastric contractions decreases or disappears in prolonged starvation. Moreover, I believed that Carlson (and Cannon's student, Washburn) had merely found a better explanation of the desire to eat which Fletcher considered to be false appetite. A discussion with Carlson of my experience and findings led to his making a study of hunger on me at the University of Chicago, while I fasted 15 days in the summer of 1917. Actually, observations were made daily before, during, and after this fast and an additional 8-day fast, or during a total of 10 weeks in which I lived in Carlson's laboratory (*8*).

The periodic gastric or hunger contractions were found to be manifested throughout the 15-day fast, and the desire to eat was always increased more or less when the gastric contractions occurred. Carlson therefore felt that his previous view concerning the persistence of hunger during prolonged starvation had been supported. However, the increase in my desire to eat with the occurrence of gastric contractions was less after the sixth day of fasting. Carlson attributed this to a decrease in appetite, not to a decrease in hunger, because the records of the gastric contractions showed no change. He had previously explained in the same way a change in sensations noted after the second or third day of his 5-day fast. Neither Carlson nor Cannon ever made a clear distinction between hunger and appetite, and, as indicated in a letter published as an appendix to Carlson's report (*8*), I remained unconvinced that the sensations produced by the so-called hunger contractions represented the basic element in normal hunger.

Nevertheless, after my fasting in 1917 I seemed to find a closer relation between the need of food, the desire to eat, and the gastric hunger contractions than I had found before or during the fasting, and I realized that Carlson's and Cannon's explanation of hunger would have to be taken into consideration in any attempt to find a better explanation. I therefore gave my epigastric hunger sensations close attention, especially when I made changes in my dietary regimen. Thus, in 1924 I found that the periodic gastric contractions could be felt without any desire to eat whatever, under appropriate nutritional conditions. This was first noted when my stomach became empty early in the evening after I had deliberately eaten a large meal of easily digested and rapidly absorbed food early in the day. Subsequent observations made under less extreme conditions clearly indicated that the basic desire to eat (hunger) is more directly related to a central need of food than to emptiness of the stomach or the hunger contractions (*9*).

Before the foregoing finding was published, Carlson enabled me to begin a study with the use of facilities at his laboratory to determine whether a relation existed between the secretory activity of the fasting stomach and epigastric hunger sensations. Some of the gastric sensations seemed explainable by simple or spastic contractions of the muscles of the stomach, but others seemed to involve irritation or burning by acid. Observations on the secretory activity of the fasting stomach were usually made before and after observations were made on the motor activity with the aid of an inflated balloon in the stomach, in 1917. Variations in the gastric acidity were then noted, but no definite relation to the desire to eat or to the hunger contractions was noted. In 1925 I found that by making gastric aspirations every half hour, data were obtainable on both the secretory and the motor activity of the fasting stomach, and an interrelationship between the two functions was revealed (*10*). By alternately using the aspiration method and the balloon method of study, it became obvious that the gastric hunger contractions were simply the final gastric emptying contractions and that the number of contractions that could be felt was greatly increased by the presence of an inflated balloon in the stomach. There was no evidence that the fasting gastric functioning was significantly altered by the use of an aspiration tube—a conclusion reached after about 500 aspirations; over 3500 additional aspirations were then made. In a study made with Kleitman it was also found that a nonnutritive substitute for food tended to promote the development of hunger contractions instead of serving to prevent them while basal metabolism tests were being made (*11*).

At the same time that I began making observations on the secretory activity of the fasting stomach, in 1925, I began making variations in my protein intake in the hope of discovering, by chance, how protein is craved. My attempts to live on low protein or vegetarian diets between 1908 and 1918 always led to the development of a practically irresistible craving for meat. Raw beef was greatly appreciated under such circumstances and fully satisfied the craving, or more than sat-

isfied it in a few days. This craving seemed to be an instinctive call for more or better protein, but no explanation of the manner in which the craving was manifested and dispelled suggested itself. However, it soon became evident in 1925 that the gastric acidity of fasting increased with protein restriction and decreased with restoration of protein (*12*), and when protein restriction was carried to an extreme, the easily recognized protein craving or protein hunger manifested itself and soon became excruciating epigastric hunger pangs (*13*). These were not directly related to the gastric hunger contractions but took my breath away and were first objectively recorded by disturbing my breathing when a basal metabolism test was being made. The painful sensations seemed to be produced by irritation of the duodenum or parapyloric region by highly acid gastric contents when they were being discharged from the stomach. The duodenum or parapyloric region probably was also made hypersensitive by the protein restriction or protein starvation. At the same time the gastric secretion was evidently kept at a high level through consumption of plenty of low-protein food.

As an alternative to simple protein restriction, I also tried fasting in 1925 to produce protein starvation. My original intention was to fast only 1 or 2 days intermittently, but I took advantage of an opportunity to serve as a subject in a study of the effect and after-effect of prolonged fasting on mental performance (*14*) and thus undertook my longest fasts, of 33 and 41 days, respectively. Prolonged fasting involves more or less dehydration, partly because of carbohydrate starvation, and the gastric secretion was found to be depressed more or less after the first few days. No epigastric protein hunger pangs were experienced during the prolonged fasts, but displays of fat meat seemed almost irresistible toward the end of the fasts. After the fasts, the gastric acidity became higher than before fasting, and I experienced more or less protein hunger. It also was difficult to restrict the food intake again until after I had become fatter than before fasting. During these long fasts, tests were made to determine the effect of drinking more water than I needed (500 ml). The result was that the gastric acidity became increased after the water left the stomach, and the gastric hunger sensations were also increased (*15*).

I never tried fasting without drinking water, but Cannon (*16*) cited the experience of Viterbi, a political prisoner, who kept a diary while he abstained from drinking as well as eating until he died on the 18th day. Apparently, hunger disappeared sooner and more completely after the first two days than would have

been the case had he drunk water, because of the dehydration involved, and death was hastened.

In any case, it seems of interest that the lack of an adequate amount of an essential food like protein is likely to be accompanied by more pain than starvation without any food or water.

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Training of College Teachers

I note in your editorial "Real professionalism" [*Science* **132**, 439 (19 Aug. 1960)] that the National Education Association is now attempting to impose state licensure and a requirement "to study the theory and practice of education in the course of their professional education" on college and postgraduate educators.

I have long been disenchanted with the training too many of the school educators receive at the "teachers colleges," whose curriculum is so heavily laced with courses on how to teach but seems so weak in the subjects to be taught. Are we now to inflict the same "uniformity" (or is it mediocrity) on the collegiate instructors?

Perhaps I am too naive in my belief that the two essential characteristics of a good teacher are (i) enthusiasm and (ii) thorough knowledge of and interest in his subject.

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Brain Dysfunction

A report by Wells and Wolff [*Science* **131**, 1671 (1960)] offers a slim but adequate excuse for me to make some remarks which I have been saving up for some time.

The authors cite a fascinating experi-

ment in conditioning of cerebral responses, finding significant differences between "normals" and persons evidencing severe anxiety. This observation in itself would be of sufficient interest, but the authors have gone on to use the data in a rather backhanded fashion to imply that the differences must be due to brain damage of some sort, hinting that with sufficiently sensitive techniques, they might "demonstrate other evidences of impairment" which are the real, actual, true cause of functional behavior disorders and not some magical kind of "neurosis" or "psychosis" as some people think. Perhaps I am unfair to Wells and Wolff, but I have heard essentially this view expressed by enough members of the working and teaching medical profession to convince me that it is widespread.

In support of this view that brain damage lies behind every psychological malfunction is an impressive array of clinical information demonstrating that psychological malfunctions can be and are caused by certain kinds of brain damage (although brain damage sometimes shows a disconcerting failure to affect behavior at all). There is no evidence at all to show that every functional disorder is the result of structural damage to the brain. The science least likely to resolve this implied problem is the science of electroencephalography.

The electroencephalograph measures the gross electrical activity of the brain, which results from the fields and currents generated in unknown patterns by an unknown set of neurons somewhere near the surface of the brain. The electroencephalograph can thus detect changes in activity of large assemblies of neurons, and because of this and because of the complexity of the signal, can differentiate between grossly different patterns of brain activity. In the same manner, a high-impedance probe inserted into the main frame of a computer could be used to detect (empirically) changes in the routing and number and time patterns of electrical signals; a patient observer might correlate these changes with certain gross malfunctions in the computer and use them for diagnosis, as the electroencephalogram is often used.

Suppose, however, that one day the computer technician attached his probes and recorded the patterns of signals and found some extreme changes which failed to resemble any of the "normal" traces. Should he decree an emergency operation? Perhaps, or perhaps not; he will have to find out first (i) whether there is a mistake in the program so that the computer has started dividing by zero; (ii) whether a new type of program is being used so that the patterns of activity are not typical of the usual sort of program; (iii) whether the machine has been told to do something it cannot do; and (iv) whether any of the other things which can have the observed effect without failure of any part of the machine (and there would be many of them) have happened. True, certain typical disorders are likely to have typical effects on the "electrohardwareogram," so that after one has observed the coincidence enough times he feels confident in making certain diagnoses, but it is entirely possible, if not probable, that merely by programming the machine *just so* one could simulate a tumor in a transistor or a lesion in a loop.

A medical student once protested to me, after listening to some of my propositions concerning a model for behavioral organization, "But you can't know anything about function without knowing structure!" In the brain, I suspect that the opposite is true: you can't know anything about structure (that is, organization) until you first know function (what the structure does). I suspect that the medical student sometimes uses machines of which he understands the function considerably better than the structure, and I know for fact that even some of the most sophisticated of com-

puter users may well consider a study of flip-flops, diode storage times, and bit density on tape a waste of their time, leaving that to those who want to build, not use, computers. The best way to learn how computers work is certainly *not* to start by studying the metallurgy of copper wire, vacuum tube or transistor theory, and the quantum mechanics of conduction processes. One could know all that there is to know about these "fundamental" aspects of a computer and still be completely, or at least largely, ignorant of the various functions which a computer can carry out so usefully. One could know all there is to know about synaptic processes, cell metabolism, and the routing of impulses through the brain and still not be able to make heads or tails of what the blamed thing is *for*. Only through a thorough analysis of the things which people can do, and orderly construction of a model representing these functions and their interrelationship, can one understand "brain activity." Only then can one group the various structures he has found and has yet to find into meaningful assemblies which tell him anything, which bear any comprehensible relationships to each other. I stood by once and heard a neurosurgeon comment to a colleague, during a cleaning-up process where a brain tumor had been, "Look there—that's all good brain." This might be called the simplest concept of function; as long as there's enough good brain left to secrete behavior, you're OK.

I don't claim that psychologists or cyberneticists have yet published anything that is very helpful in helping us understand brain structure, but I will assert that no neurologist has ever published anything (limited sample admitted) that helps us understand why our neighbors' children are so inferior to ours.

Behavioral science and neurology are still a long way apart, and the attitude of many neurologists toward the psychological approach is no help in getting them together. The childlike faith that sufficiently fine measurement and sufficiently thorough chemical analysis will explain behavior may sustain one through periods when nothing seems to explain anything, but it *is* a faith, not a fact, and ought not be referred to as if it were proven and self-evident. The essence of science is measurement, and measurements yield numbers; the numbers remain numbers until some human being fits them into his concept of a system which performs certain functions; only then do the numbers mean anything at all. And if the human being had not started with some guess about function, he never would have made a meaningful measurement.

I argue, therefore, that not only is

the functional approach essential and prerequisite to understanding of any structure but that any scientist who does more than fill catalogs full of numbers uses the functional approach all the time, willy-nilly. He does so because that is one of the functions which human beings are built to carry out.

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William Powers states a viewpoint which we support and have done much to document. Our only regret is that he should have misinterpreted the statements made in our original communication and have attributed to us a position which we deprecate. Far from implying that the differences in "normal" and "anxious" subjects "must be due to brain damage of some sort," as Powers deduced, we stressed that "studies of the microscopic structure of the nervous system have revealed no significant changes in the brains of persons suffering from the common neuroses and psychoses." The remainder of our communication presented evidence that one might be able to measure electrographically dysfunction in this group of chronically anxious subjects who have no known demonstrable damage to structure. Although Powers purports to find us hinting that structural damage is the cause of neurosis or psychoses, there is no such statement or suggestion anywhere mentioned or implied; nor indeed do we subscribe to such a view.

Our brief report concerned one electrographic method which might be used to evaluate brain function or dysfunction, regardless of the basis of the impairment. We would reaffirm our original statement that "perhaps more sensitive methods of measuring responsiveness in the electroencephalogram may demonstrate other evidence of impairment [of function] in the 'functional' disorders of the brain."

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Conversions

Pembroke J. Hart in his letter on conversions [*Science* **132**, 256 (22 July 1960)] uses a conversion factor of 1.1516 statute miles per nautical mile. This is the factor given in most current reference works, yet since 1 July 1954 the Department of Commerce and the Department of Defense have been using the international nautical mile, defined as exactly 1852 meters, for which the conversion factor is 1.1508 statute miles per nautical mile.

Prior to 1 July 1954 the United States used a nautical mile of 6080.20 feet (1853.248 meters). The international nautical mile at the time of its adoption by the United States was equivalent to 6076.1033 U.S. feet, but effective 1 July 1959 the United States adopted the international yard, equivalent to 0.9144 meter. Therefore the international nautical mile is now equivalent to 6076.11549 international feet.

It is apparent that the term *nautical mile* is ambiguous and, when encountered in a scientific paper, is difficult to interpret. As Hart points out, conversions in the metric system are much simpler.

I suggest that the use of *nautical mile* be restricted to air and surface navigation, where it has real value, and that metric distance units be used in space flight and rocketry.

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Pembroke J. Hart, in his letter on conversions, evidently used for his conversion the "old" nautical mile, which for the United States was 6080.20 feet and for the British, 6080.0 feet. The former would give his ratio of 1.1516 (1.15155).

The "new" nautical mile or international nautical mile, as defined by the International Hydrographic Bureau, was adopted by the United States on 1 July 1954; this length is 6076.1033 feet (*1*), and the ratio is 1.1507575.

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P. J. Hart's letter complaining about two instances of imprecise conversions from metric to English units is meant to point up one of the advantages of converting to the metric (decimal) system universally. I wish to use it for a different lesson. We should rid ourselves of the pedants who translate a news item about a 4540-kilogram spaceship into 10,009 pounds, as well as the squares who round off the conversion factor and come out with 9988 pounds. I don't have access to the original report but suppose that it came out of the U.S.S.R. as a news item, not as a scientific datum. The aim was to command admiration, not to provide a basis for computing the burning time of the rocket motor. Rendered into English (U.S.), the weight of the satellite, as a news item, is 5 tons.

Now for the generalizations: (i) "If you wish to have what you say remembered, put it in the words that your

hearer will remember it in." (ii) Greater precision is not warranted in the statement than is available in the data.

Hart missed the opportunity to be an exemplary pedant; instead of arriving at 10,009 pounds from the handbook table he could have used the precise conversion factor and come up with 10,008.98542814 pounds.

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Humane Treatment of Animals

The bill S. 3570 recently introduced into the Senate by Senator Cooper and others, "To provide for the humane treatment of animals . . .," has been strongly attacked both in *Science* [**132**, 7 (1960)] and in the *Bulletin of the National Society for Medical Research.* These attacks have given what I think to be a false idea of the nature and intent of the bill, and of the motives of its sponsors, and prompt me to make a carefully considered statement of my own opinion.

The issue of humane treatment itself is a moral one: To what extent are we justified in inflicting pain and discomfort on other organisms in our search for knowledge? Bill S. 3570 takes the position "that living vertebrate animals used for scientific experiments shall be spared unnecessary pain and fear; that they shall be used only when no other feasible and satisfactory methods can be used to ascertain biological and scientific information for the cure of disease, alleviation of suffering, prolongation of life, or for military requirements; and that all such animals shall be comfortably housed, well fed, and humanely handled." This is a statement with which, I think, most biologists would agree in principle; personally I should feel more comfortable if the words *potentially valuable* were inserted after the words *scientific information,* but I think that the efforts of the National Society for Medical Research, the Animal Care Panel, and the American Physiological Society over the past several years have been directed toward the general aims stated above.

The second issue posed by the bill is a practical political one: Granted that humane treatment is desirable, is legislation, and in particular this legislation, the best means to assure it? The alternatives would seem to be voluntary action by the investigators or local control by individual communities. The charges recently brought against Stanford University and the College of Medical Evangelists in California show that local action under the influence of extremist pressure groups may still endanger medical research; it seems probable that the existence of federal legislation of the type proposed in S. 3570 would do much to protect laboratories against this sort of local attack. The question of voluntary action is a more debatable one. In my own experience I have never come across an instance of wanton cruelty to experimental animals, but I have encountered numerous cases of neglect due to callousness, inadequate facilities, inexperience, or carelessness; again, it would seem that S. 3570 would help to eliminate such instances.

The reasonable objections which have been made to the specific provisions of S. 3570 are well summarized in the *Science* editorial: "Advance approval of experimental plans by the Department of Health, Education, and Welfare, burdensome record keeping, annual or more frequent reports to HEW, additional costs . . . and a new and unnecessary amount of red tape." As I read the bill, it seems to me that the requirements are not greatly beyond those now in force. Every application for federal research funds requires submission of an experimental plan which is approved by a panel of scientists. I hope that all of us who publish results of animal experiments do at least the amount of record keeping specified by the bill. Every federal research grant now requires an annual report. The only additional features are that the experimental plan must specify what animals are to be used and what

type of experiments are to be performed; there is nothing in the bill requiring advance approval of every minor change in experimental procedure. The report, also, must specify the animals used and the procedures employed, but there is nothing in the bill to say that this must coincide exactly with the plan proposed. Compliance with the provisions of the bill will cost more, insofar as the existing laboratories do not provide adequate facilities for the animals used, but this should result in better experimental results as well as more humane care.

The National Society for Medical Research has devoted much attention to the provision for inspection of facilities and for certificates of compliance with regulations to be laid down by the Secretary of Health, Education, and Welfare; this is presumably the red tape with which *Science* is concerned. At present, every institution receiving grants from federal agencies is visited—or if you wish, inspected—by officers of those agencies. On the basis of past experience, I think that we have nothing to fear from these officers, who have abundantly demonstrated that their main aim is to further research of the highest quality. Any regulations which HEW might lay down under an act of the sort proposed would, I think, not depart from this aim. In any event, the bill gives no police powers to HEW or anyone else, so that work sponsored by any but federal agencies would not be in any way affected.

In sum, I cannot find in this bill the evils which the National Society for Medical Research or *Science* profess to see, and I would urge my colleagues who are interested in animal experimentation, humane treatment, or both, to read the bill with care, to make their own appraisals on the basis of their own judgments, and to communicate these judgments to their representatives in the Congress.

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I read with considerable interest your article on the Cooper bill, S. 3570 [*Science* **131**, 1659 (1960)]. It seems a holy and ennobling thought that our animal friends should be generously accorded some measure of protection from our mighty and benevolent government. Your article, however, referred simply to experimental "animals"; I should hope that the sponsors of this bill were more explicit in their definition of the organisms to be protected. Do they include viviparous mammals only? mammals only? warm-blooded vertebrates only? vertebrates only? chordates only? vertebrates and invertebrates, including protista and bacteria? vertebrates and invertebrates,