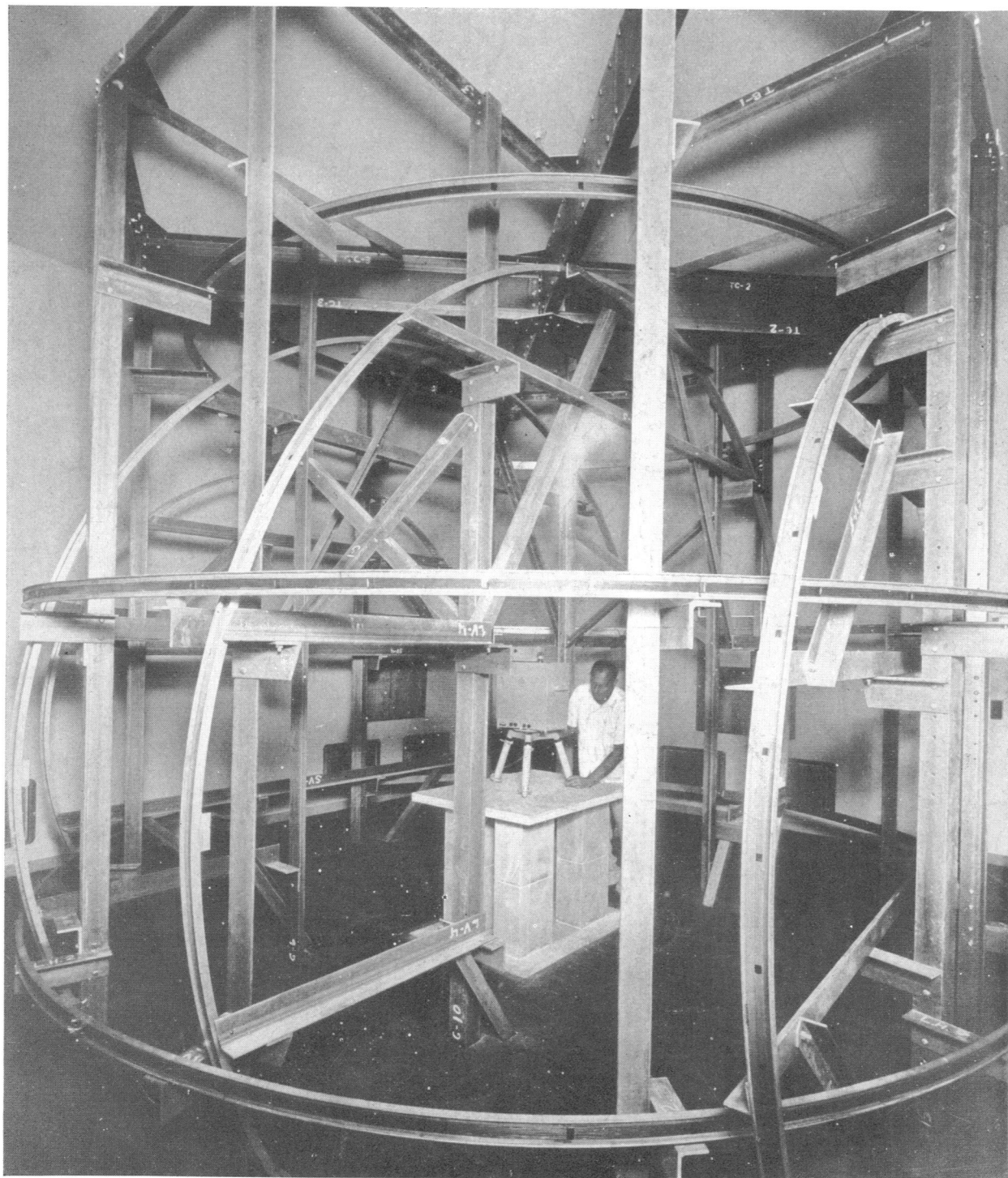


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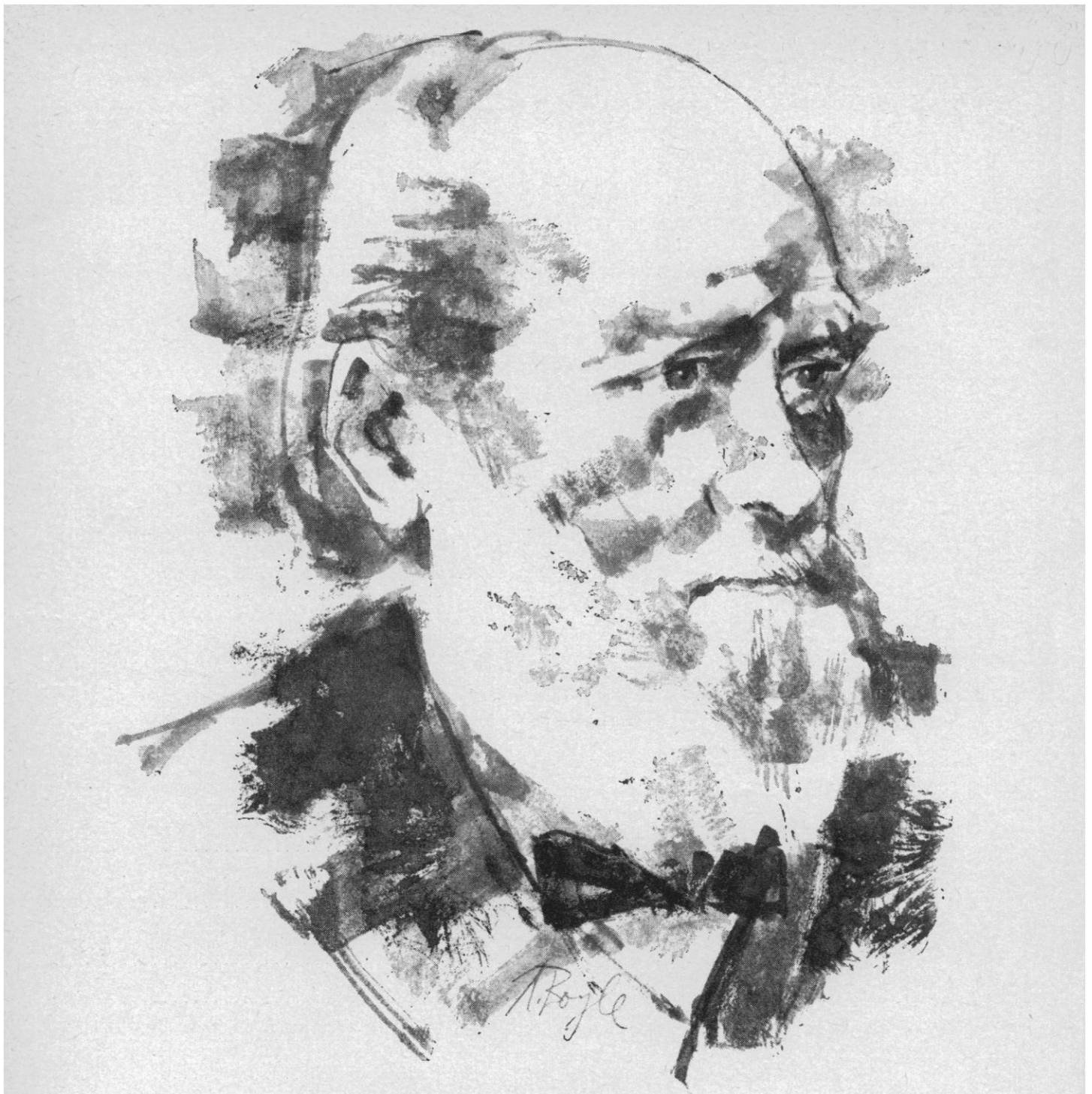


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Charles Darwin...on evolution

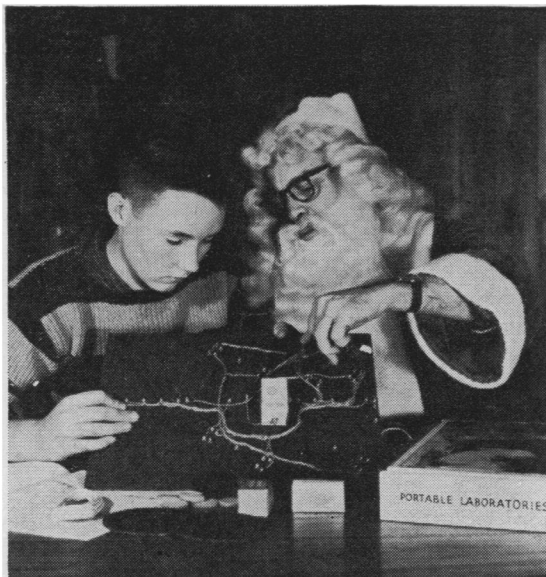
"It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us.... Thus, from the war of nature, from famine and

death, the most exalted object we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

— *Origin of Species*, 1859

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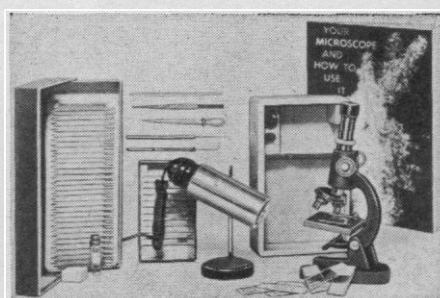
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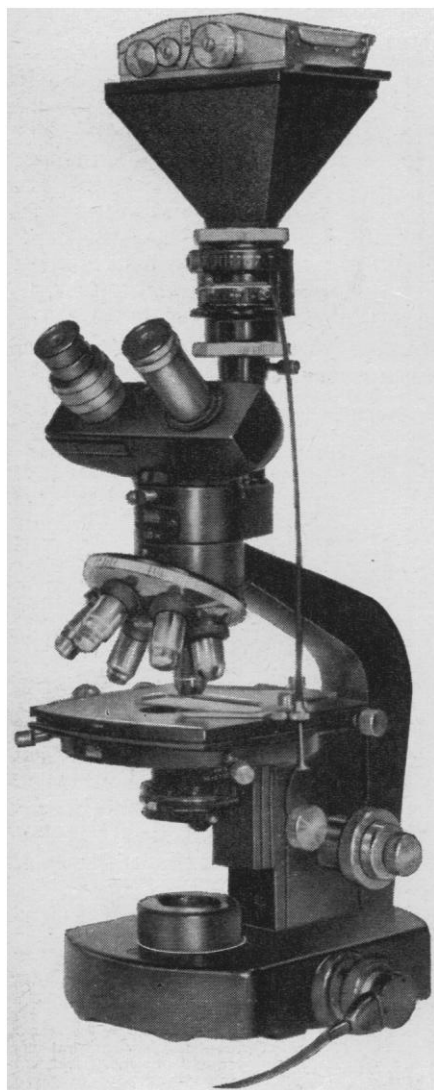
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Letters

On the Two Cultures

I was especially interested in the comments of C. P. Snow, printed as an editorial in *Science* [130, 419 (21 Aug. 1959)]. Those of us in the science teaching field are reminded of the existence of the two cultures both by our association with colleagues who represent each of them and by student comments and attitudes.

Some years ago William James wrote an essay entitled "On a certain blindness in human beings." While having been very much aware of this blindness for a long time, I am still disturbed after more than 35 years of college teaching to see how little impact scientific ideas have had on some segments of the college community. I was forcibly reminded of this on two occasions last year when students who were being subjected to the requirement of some course work in science while majoring in a humanities area protested inclusion of factual material in examinations. One of these students commented that as an English-journalism major he was taught to "think in ideas rather than in facts." The same student objected to scientific writing being couched in technical terms.

There is also the attitude on the part of humanities and even of some social-science specialists that scientists are a rather uneducated group, that real education consists of knowledge of literature and philosophy, acquaintance with which is mandatory, whereas ignorance of science somehow enhances one's intellectual respectability. A short time ago I heard a philosopher speaking over a television network. While admitting that science was one way of looking at the world, he seemed to think of it as a rather distorted one, and of philosophy as the true way.

We scientists are not guiltless. I find some of my scientific colleagues using *liberal arts* as a term of opprobrium, designating those who have the one culture, to which "science" is much superior. We have also placed some rather formidable hurdles before the aspirant to scientific knowledge and have sometimes assumed that unless he is capable of understanding in the critical sense the mathematical jargon in which some scientists must express their findings, he is incapable of understanding what the scientist is about. We have often looked upon the man who attempts to translate scientific information into the less rigid terminology of the layman as almost guilty of desecration.

The gap needs bridging. The vocabularies of both groups need to be ex-

panded to include reading knowledge of the other culture's literature. This is a very real challenge to both groups and especially to those who try to teach at the undergraduate level. Wordsworth might write that he would rather be "a pagan, suckled in a creed outworn," but he could not be, any more than Thoreau could live in complete independence at Walden Pond.

GEORGE M. ROBERTSON
Grinnell College, Grinnell, Iowa

Your quotation from Sir Charles P. Snow properly points out the serious shortcomings of science education. But I feel that it is incorrect in one important respect.

Sir Charles assumes that there is a substantial proportion of intelligent people who are incapable of grasping mathematical concepts. A similar view is held by many concerning the existence of people who are ineducable in science. Although a certain amount of such ineducability is probably inevitable, I think that the extent of it is grossly overestimated.

There was a time only three centuries ago when a majority of the population was considered incapable of mastering the 3 R's. Long division was at that time a college subject.

Science and mathematics education are at a similar early stage of development. Almost no real science is taught until age 12. Thereafter, science education (and to a lesser degree mathematics education) is hit-and-run, improperly presented, and generally inadequate. It is largely taught as a mass of facts. Experimentation, observation, and critical thinking are almost totally absent. In many schools mastery of terminology is sufficient to pass an objective test, a poor substitute for real science.

Techniques and materials have been developed to arouse curiosity and interest and challenge children's abilities at an early age. But these techniques and materials are not yet in widespread use.

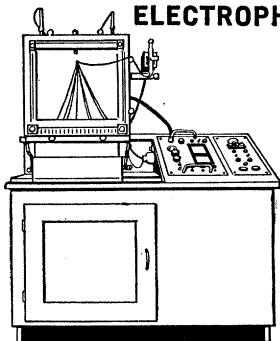
For example, for many young people experiments with magnets and simple circuits at age 6 will do more to develop scientific attitudes than hours of book study at age 16. Cutting and pasting cardboard tetrahedrons and prisms instead of paper dolls, and making interesting designs with ruler and compass can prepare a child for a smooth transition to formal geometry. Simple puzzles and interesting experiments will help to lay the basis for satisfying successful experiences and serve to prevent future mental blocks and failures.

Until proper techniques of science and mathematics education are actually in widespread use at school and at home, it is too early to think in terms

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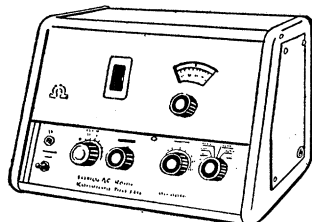
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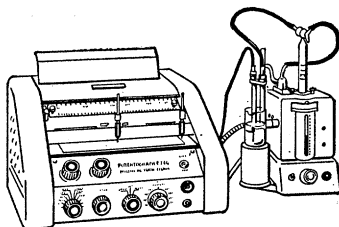
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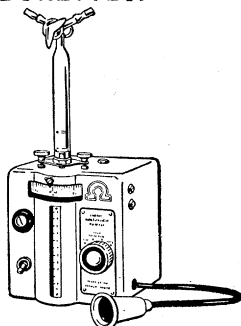
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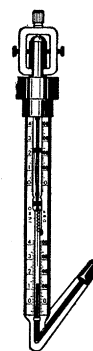
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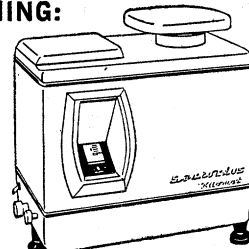
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Publications and Basic Research

In his article "Basic research in industry" J. C. Fisher [*Science* **123**, 1653 (1959)] attempted to gauge the extent of basic research in U.S. industry by a count of scientific publications. I suggest that Fisher's basic assumption may contain a much larger error than he recognized.

Fisher assumes that a count of publications gives a "relatively good picture of the quantity and distribution of basic research effort." He also states, "Publications were counted indirectly, by counting abstracts . . . in the 1955 volume of *Chemical Abstracts*. . . . It is only approximately true that *Chemical Abstracts* finds and abstracts all publications concerned with basic research and rejects all publications concerned with applied work. However, the proportion of abstracts dealing with applied work appears to be *reasonably small and invariant*" (italics mine). It is this latter premise which my associates and I question.

Through the courtesy of Fisher, we obtained a list of the titles of those articles which he counted in the 1955 volume of *Chemical Abstracts* for Esso Research and Engineering Company, Humble Oil and Refining Company (which carries out research and development under contract to Esso Research), and two other leading petroleum research organizations. We have analyzed the articles so listed and find that the bulk of these articles would, in our opinion, be classed as other than basic research. Furthermore, the proportion of papers which we would class as basic research varies greatly, from about 10 to 48 percent of the total listed in *Chemical Abstracts*.

Fisher's tabulation of papers for Esso Research and Engineering Company also was incorrectly low, due to his assignment of ten Esso Research papers to Standard Oil Company (Indiana). A paper originating from Standard Oil Company of Ohio was also attributed to Standard Oil Company (Indiana). These errors perhaps arose because various companies use the Standard Oil name. The papers appearing in 1955 *Chemical Abstracts* were published from the Standard Oil Development Company, the predecessor to Esso Research and Engineering Company.

A final comment—there has been a marked increase since 1953-54 in the

amount of basic research being done by private industry. I am sure Fisher would be the first to suggest that this subject warrants an up-to-date and quantitative analysis.

W. T. KNOX

Esso Research and Engineering
Company, Linden, New Jersey

I wish to thank W. T. Knox for finding the error in Table 1 of my article, wherein ten papers belonging to Esso Research and Engineering Company were mistakenly attributed to Standard Oil Company (Indiana). The wrong figures were

Rank	Company	No. of publications
13	Standard Oil (Indiana)	48
48	Esso Research and Engineering	13

The correct figures are

Rank	Company	No. of publications
15	Standard Oil (Indiana)	38
28	Esso Research and Engineering	23

The change affects the position of Standard Oil (Indiana) relatively little, moving it from 13th to 15th position. Esso Research and Engineering is more significantly affected, moving from 48th to 28th position. The error came about because Esso Research and Engineering changed its name from Standard Oil Development during the period covered by the study, and the earlier name did not appear in my check list of companies and affiliates (*Poor's Register of Directors and Executives*, 1956). I extend my apologies to Esso Research and Engineering for the error.

The Standard Oil of Ohio paper mistakenly attributed to Standard Oil (Indiana) seems to be an example of the random errors that arose because of company names that were missing, wrong, or incompletely given in *Chemical Abstracts*.

The assumption that a reasonably small and invariant proportion of abstracts dealt with applied work is not as good as I had thought, and I must agree with Knox's criticism of this point. My associate, J. B. Newkirk, has made an independent study of this matter and feels that only about half of the chemistry research and two-thirds of the physics research was properly classifiable as basic. Although the proportion of basic work abstracted by *Chemical Abstracts* is smaller than I had thought, I believe that the general conclusions of the study remain valid. Certainly a more up-to-date study is in order to show the considerable growth of basic research in industry since 1954.

JOHN C. FISHER

General Electric Company Research
Laboratory, Schenectady, New York

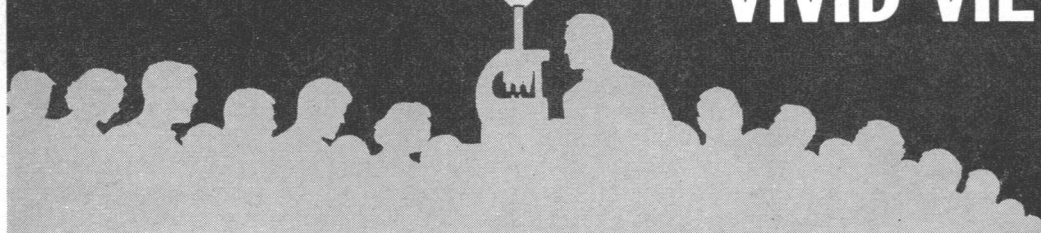


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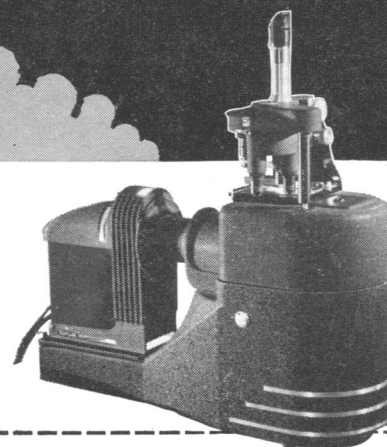
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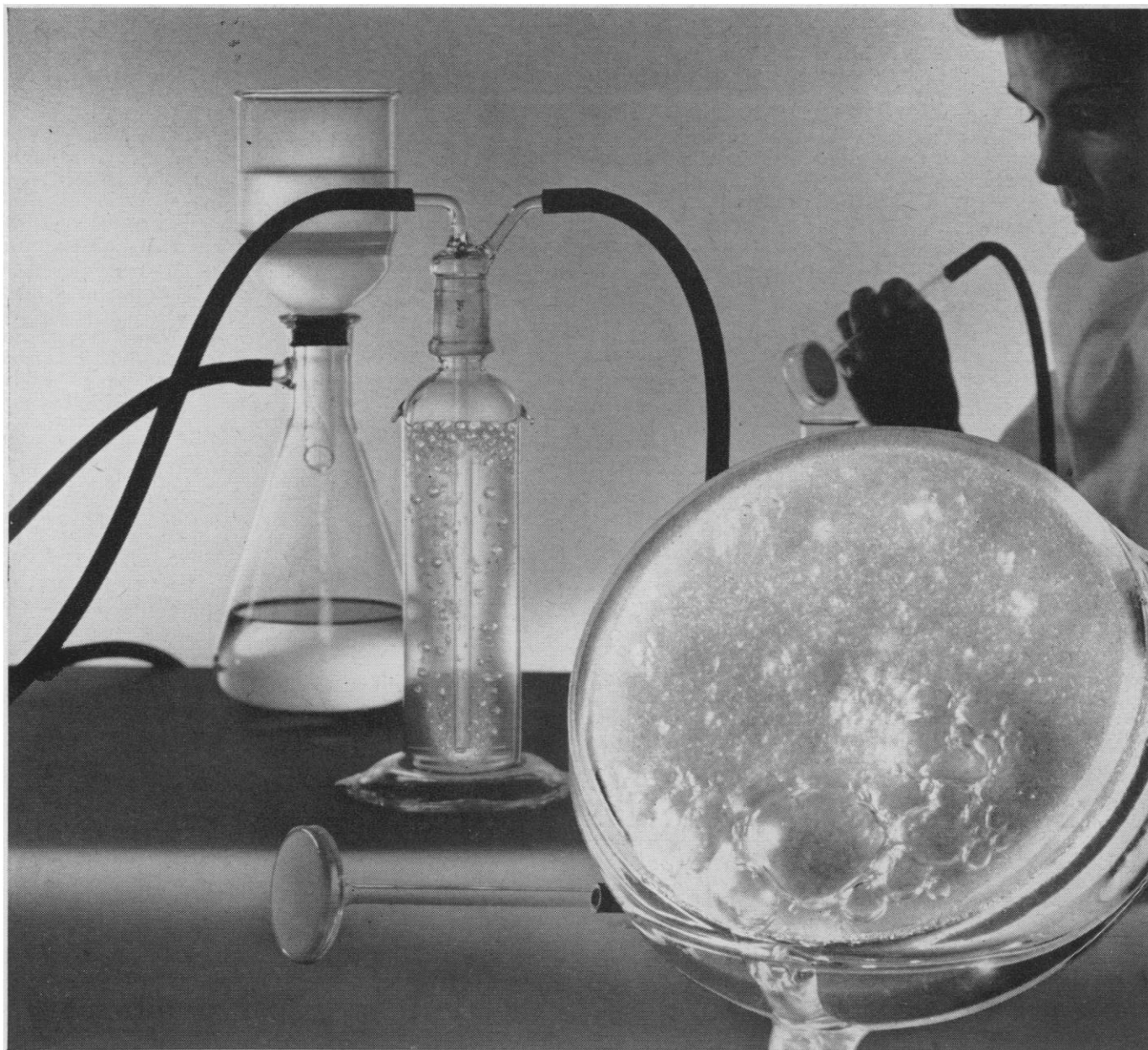
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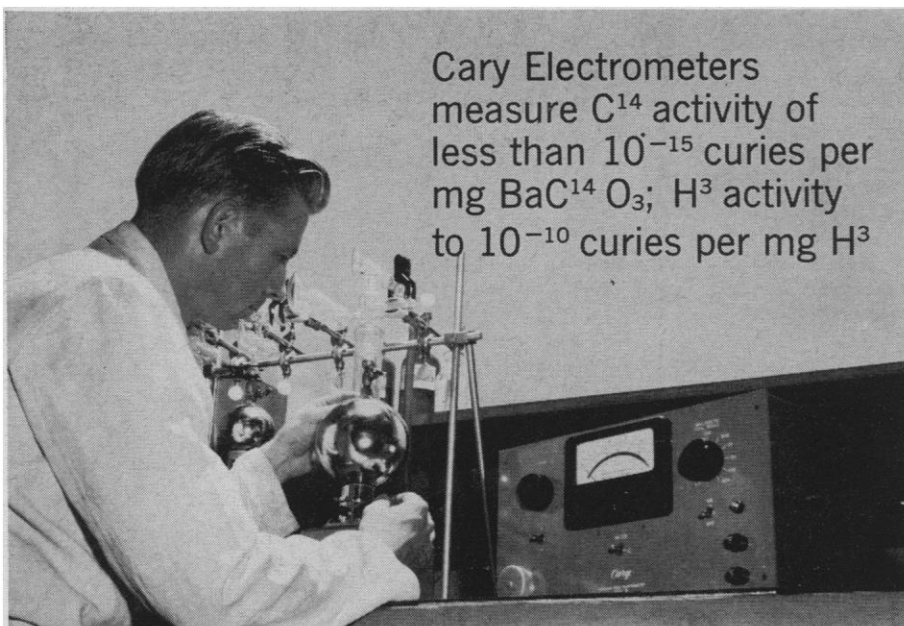
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Washington 5, D.C.

11-12. Salt and Water Metabolism, symp., New York, N.Y. (A. P. Fishman, New York Heart Assoc., 10 Columbus Circle, New York 19.)

11-12. Texas Acad. of Science, Austin. (L. Kenamer, Dept. of Geography, Univ. of Texas, Austin 12.)

16-18. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, P.O. Box 229, St. Joseph, Mich.)

25-27. Indian Mathematical Soc., 25th conf., Allahabad, India. (B. N. Prasad, Allahabad Univ., Lakshmi Niwas, George Town, Allahabad 2.)

26-30. American Assoc. for the Advancement of Science, annual, Chicago, Ill. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 46 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Committee on Science and the Promotion of Human Welfare (B. Commoner, School of Botany, Washington Univ., St. Louis 5, Mo.). 27 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (Brother G. Nicholas, Dept. of Biology, Univ. of Notre Dame, Notre Dame, Ind.). 27 Dec.

Academy Conference (A. M. Winchester, Stetson Univ., De Land, Fla.). 27-28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. Dubin, Director of Biochemistry, Cook County Hospital, Chicago 12, Ill.). 26-27 Dec.

American Geophysical Union (W. C. Krumbein, Dept. of Geology, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Meteorological Soc. (K. Spengler, 3 Joy St., Boston, Mass.).

American Nature Study Soc. (E. L. Will, State Univ. Teachers College, Oneonta, N.Y.). 26-30 Dec.

American Physiological Assoc. (F. A. Hitchcock, Ohio State Univ., Columbus). 28 Dec.

American Political Science Assoc. (J. Robinson, Dept. of Political Science, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Psychiatric Assoc. (E. L. Bliss, General Hospital, Salt Lake City, Utah). 28-29 Dec.

American Soc. of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, Inc., New York 36). 28-29 Dec.

American Soc. of Naturalists (A. D. Hasler, Dept. of Zoology, Univ. of Wisconsin, Madison). 27-28 Dec.

American Soc. of Plant Taxonomists (L. R. Heckard, Dept. of Botany, Univ. of Illinois, Urbana). 28-30 Dec.

American Sociological Soc. (J. S. Coleman, Dept. of Sociology, Univ. of Chicago, Chicago 37, Ill.). 28-29 Dec.

American Statistical Assoc. (R. F. Winch, Dept. of Sociology, Northwestern Univ., Evanston, Ill.). 29-30 Dec.

Association of American Geographers (A. Cutshall, Univ. of Illinois, Navy Pier, Chicago 11). 29 Dec.

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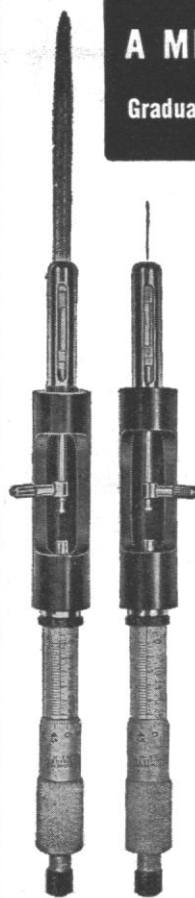
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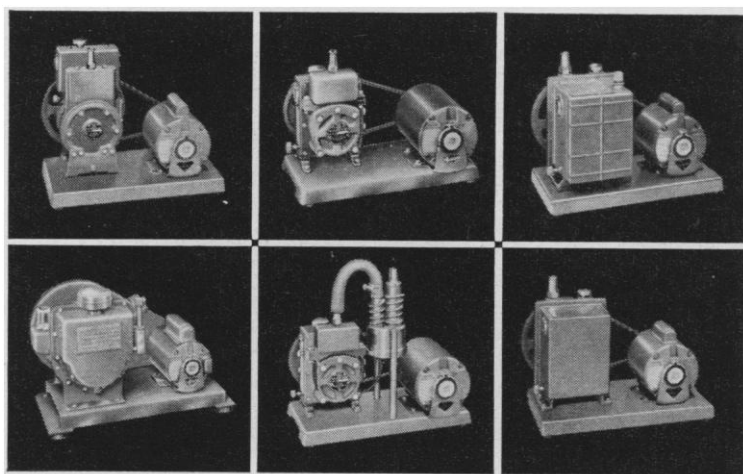
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Association for Computing Machinery (W. F. Cahill, Goddard Space Flight Center, Silver Spring, Md.). 29 Dec.

Astronomical League (E. Halbach, 2971 S. 52 St., Milwaukee 19, Wisc.). 26 Dec.

Beta Beta Beta (Mrs. F. G. Brooks, P.O. Box 515, Ansonia Station, New York 23). 27-28 Dec.

Chicago Acad. of Sciences (R. A. Edgren, Chicago Acad. of Sciences, 2001 N. Clark St., Chicago 14, Ill.). 29-30 Dec.

Conference on Scientific Communications (G. L. Seielstad, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.). 28-29 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 28 Dec.

Ecological Soc. of America (W. C. Ashby, Dept. of Botany, Univ. of Chicago, Chicago 37, Ill.). 28-30 Dec.

Honor Soc. of Phi Kappa Phi (L. R. Guild, 634 S. Western Ave., Los Angeles 5, Calif.). 30-31 Dec.

Illinois Geographical Soc. (Miss M. Grant, Morton Junior College, Cicero, Ill.). 28 Dec.

Institute of Management Sciences (M. M. Flood, College of Engineering, Univ. of Michigan, Ann Arbor). 29 Dec.

Metric Assoc. (J. T. Johnson, Ravenswood YMCA, 1725 Wilson Ave., Chicago 40, Ill.).

Mycological Soc. of America (D. P. Rogers, Dept. of Botany, Univ. of Illinois, Urbana).

National Assoc. of Biology Teachers (H. E. Weaver, 202 Men's Old Gym, Univ. of Illinois, Urbana). 26-30 Dec.

National Acad. of Economics and Political Science (J. Rothrock, Pan American Union, Washington 6). 29 Dec.

National Assoc. for Research in Science Teaching (J. C. Mayfield, Univ. of Chicago, Chicago 37, Ill.). 26-30 Dec.

National Assoc. of Science Writers (P. Fraley, Evening Bulletin, Philadelphia, Pa.). 27 Dec.

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 30 Dec.

National Science Teachers Assoc. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington, D.C.). 26-30 Dec.

National Soc. for Medical Research (R. A. Rohweder, NSMR, 920 S. Michigan Blvd., Chicago 5, Ill.). 29 Dec.

National Speleological Soc. (T. C. Barr, Jr., Tennessee Polytechnic Inst., Cookeville, Tenn.). 28 Dec.

Philosophy of Science Assoc. (W. A. R. Ley, Roosevelt College, Chicago, Ill.). 28 Dec.

Scientific Research Soc. of America (D. B. Prentice, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Sigma Delta Epsilon (Miss E. S. Anderson, Stratford Hotel, 25 E St., NW, Washington, D.C.). 26-30 Dec.

Society for General Systems Research (R. L. Meier, Mental Health Research Institute, Univ. of Michigan, Ann Arbor).

Society for the History of Technology

(M. Kronzberg, Dept. of History, Case Inst. of Technology, Cleveland, Ohio).

Society of the Sigma Xi (T. T. Holme, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Society of Systematic Zoology (R. E. Blackwelder, Southern Illinois Univ., Carbondale). 26-30 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Univ. of Tennessee, Knoxville). 27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington, D.C.). 29 Dec.

27-30. American Anthropological Assoc., Mexico City. (W. S. Godfrey, Jr., Logan Museum, Beloit College, Beloit, Wisc.)

27-30. American Astronomical Soc., Cleveland, Ohio. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

27-30. American Folklore Soc., Mexico City. (MacE. Leach, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

27-30. American Statistical Assoc., Washington, D.C. (D. C. Riley, 1757 K St., NW, Washington 6.)

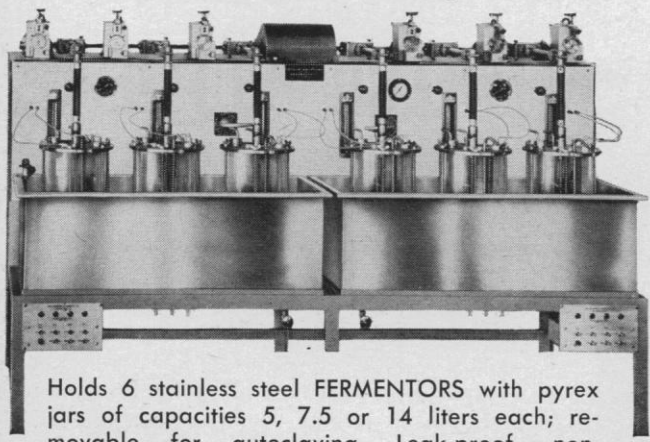
27-30. Institute of Mathematical Statistics (weather control), Washington, D.C. (J. Neyman, Statistical Lab., Univ. of California, Berkeley 4.)

28-29. American Chemical Soc. (Div. of Industrial and Engineering Chemistry), symp., Baltimore, Md. (M. A. H. Emery, ACS, 18 and K Sts., NW, Washington D.C.)

(See issue of 16 October for comprehensive list)

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