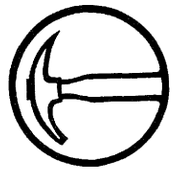
SCIENCE

11 October 1968

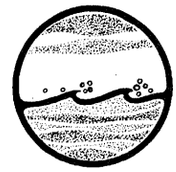
Vol. 162, No. 3850

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

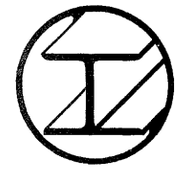
AGRICULTURAL
Na–.00032
K–.0007
Ca–.0001
Mg–.000025



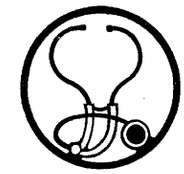
GEOLOGICAL
Au–.0035
Ag–.0010
Te–.015
Pt–.032



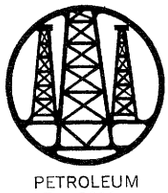
POLLUTION
Zn–.00035
Cr–.00030
Ni–.0050
As–.4



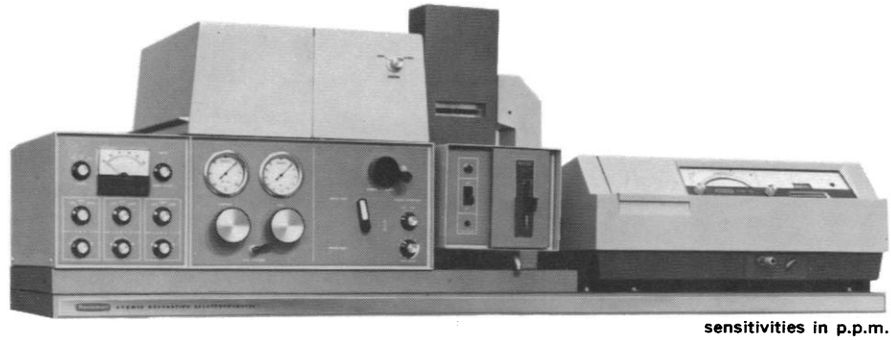
METALLURGICAL
Ni–.0050
Sn–.25
Al–.12
Tr–.012



CLINICAL/MEDICAL
Ca–.0001
Fe–.0011
Li–.001
Zn–.00035



PETROLEUM
Fe–.0011
Ni–.0050
Pb–.012
V–.025
Cu–.00030



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CHEMICAL
Cr–.00030
Mn–.00015
Ni–.0050
Si–.050
Te–.015

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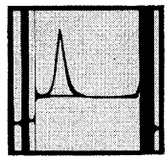


1 Schlieren photographs of molecular boundaries can be taken

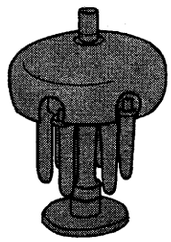
- ☐ A. Only on an Analytical Ultracentrifuge
- ☐ B. With major modifications on some Preparative Ultracentrifuges
- ☐ C. With a simple accessory on most Beckman Preparative Ultracentrifuges

ANSWER: C...and the photos are great for rough S rates, teaching, etc.

2 If the Type 30 rotor can pellet 30 S ribosomes in 7 hours, the new high performance Type 60 ti fixed angle rotor can pellet 30 S ribosomes in

☐ 2.1 hours ☐ 3.5 hours ☐ 5 hours

ANSWER: 2.1 hours, not including acceleration and deceleration times.



3 The new high performance swinging bucket rotors are fabulous, but you still can't use different sized buckets on a single rotor in the same experiment

☐ True ☐ False

ANSWER: False. The new SW 27 has two types of buckets; both can be used together as long as the rotor balances.

4 The new shapely Beckman zonal rotors

- ☐ A. Fit all Beckman Preparative Ultracentrifuges
- ☐ B. Can separate smaller particles than any previous zonal rotor
- ☐ C. Handle corrosive salt solutions

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Looking down on scattered cumulus clouds from an altitude of about 60,000 feet near Amarillo, Texas. High-resolution cloud data could be used to monitor the effects of man's attempt to modify cloud growth and the weather. See page 287. [National Severe Storms Laboratory, ESSA, Norman, Oklahoma]

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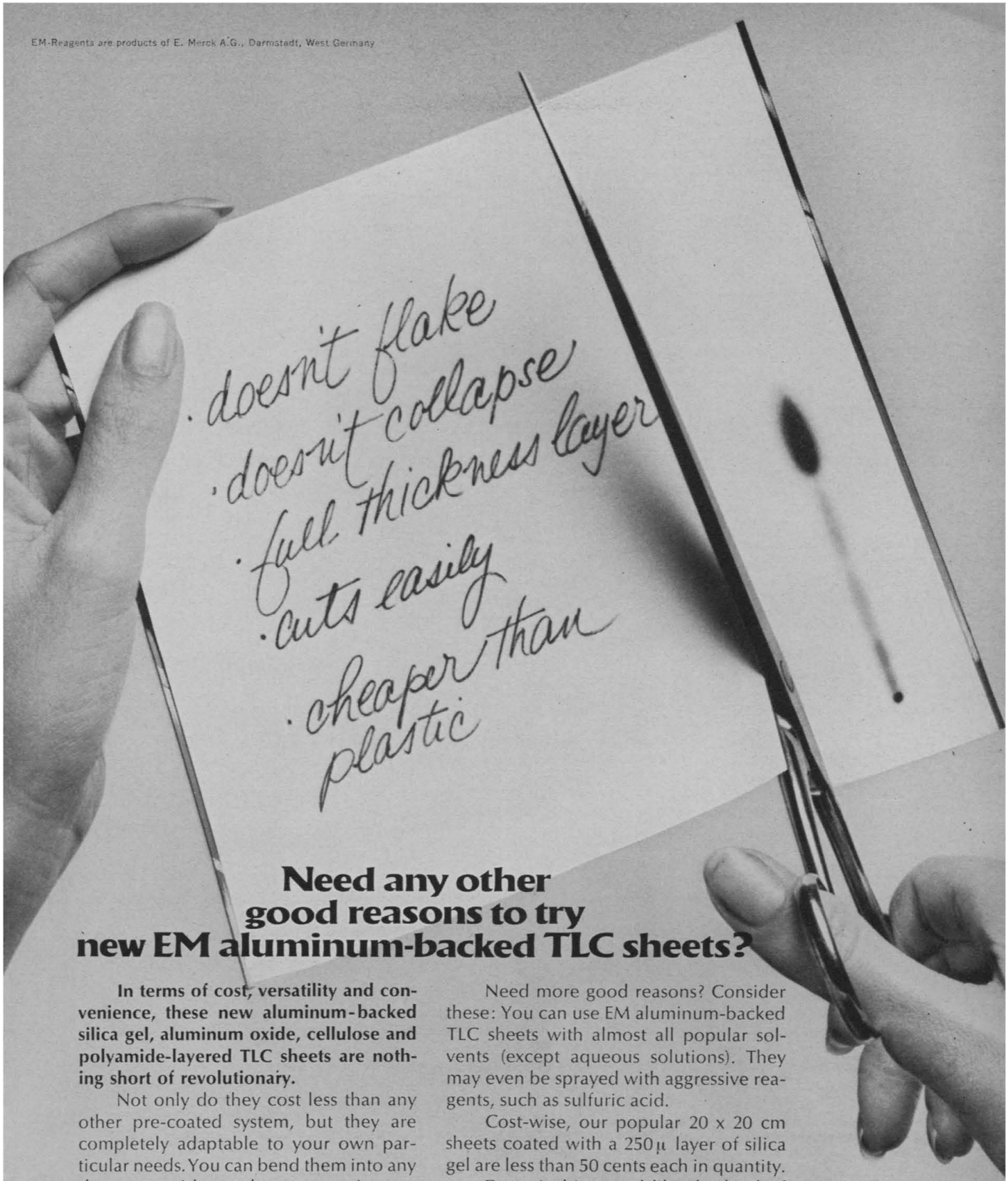

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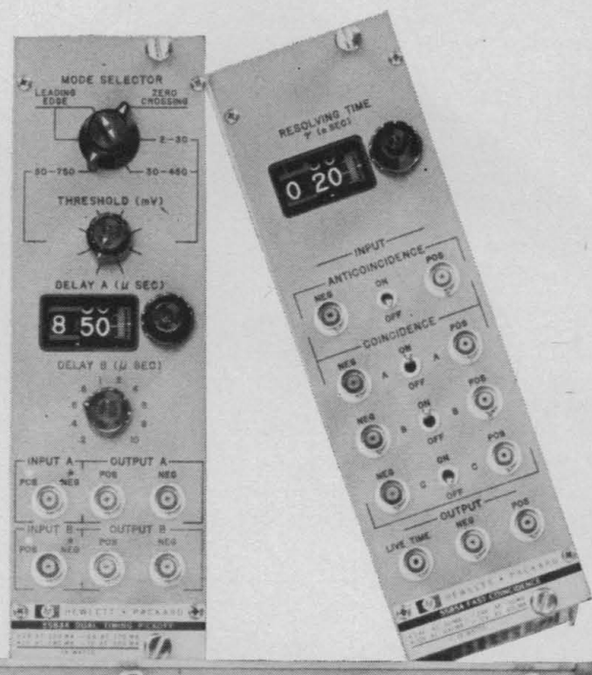

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5585A Fast Coincidence, $900
5582A Linear Amplifier, $550

5583A Single Channel Analyzer, $550
5590A Scaler-Timer, $1675
5580A/B NIM Power Supply, $775/$825

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Sometimes three seminars bunch up like that in the same week, and then we might go several weeks without any. Arnold Weissberger just catches the academics he wants, as their schedules permit. Academics get seminared to death on both the giving and the receiving ends. Nevertheless Weissberger manages to sell the idea that if they lecture here and then spend the afternoon chatting around our laboratories they might run into work challenging enough to interest a seminar back home. Tit for tat. Reassuring when campus feels we have knowledge to trade.

In extending seminar invitations to certain active scientists and not to other equally accomplished ones, Weissberger aims at no direct connection with work that anybody in the audience interrupts to come to the seminar. If the pattern of his invitations does affect the scientific climate of our research laboratories, that is precisely what is expected of him. Man born in 1898 had better be pretty young in 1968 to carry that much responsibility for our future.

For knowing who is strong in what, Professor Emeritus* Weissberger (author of some 100 scientific papers of his own) derives a bit of advantage from having been editor since 1945 of the series of volumes entitled "Technique of Organic Chemistry," editor since 1950 of the series "Chemistry of Heterocyclic Compounds," co-editor since 1963 of "Physics and Chemistry of the Organic Solid State," "Organic Analysis," and "Technique of Inorganic Chemistry." On the practical side, over 100 patents in color photography and organic chemistry have been issued to him since he came to Kodak Research Laboratories from Oxford University in 1936. In 1964 he retired as an employee and rejoined immediately as a consultant. He remains smart enough to avoid the mistake of giving more consultation than he receives, particularly from members of the seminar audience on speakers to invite.

*The title stems from a premature retirement in 1933 from the Leipzig faculty.

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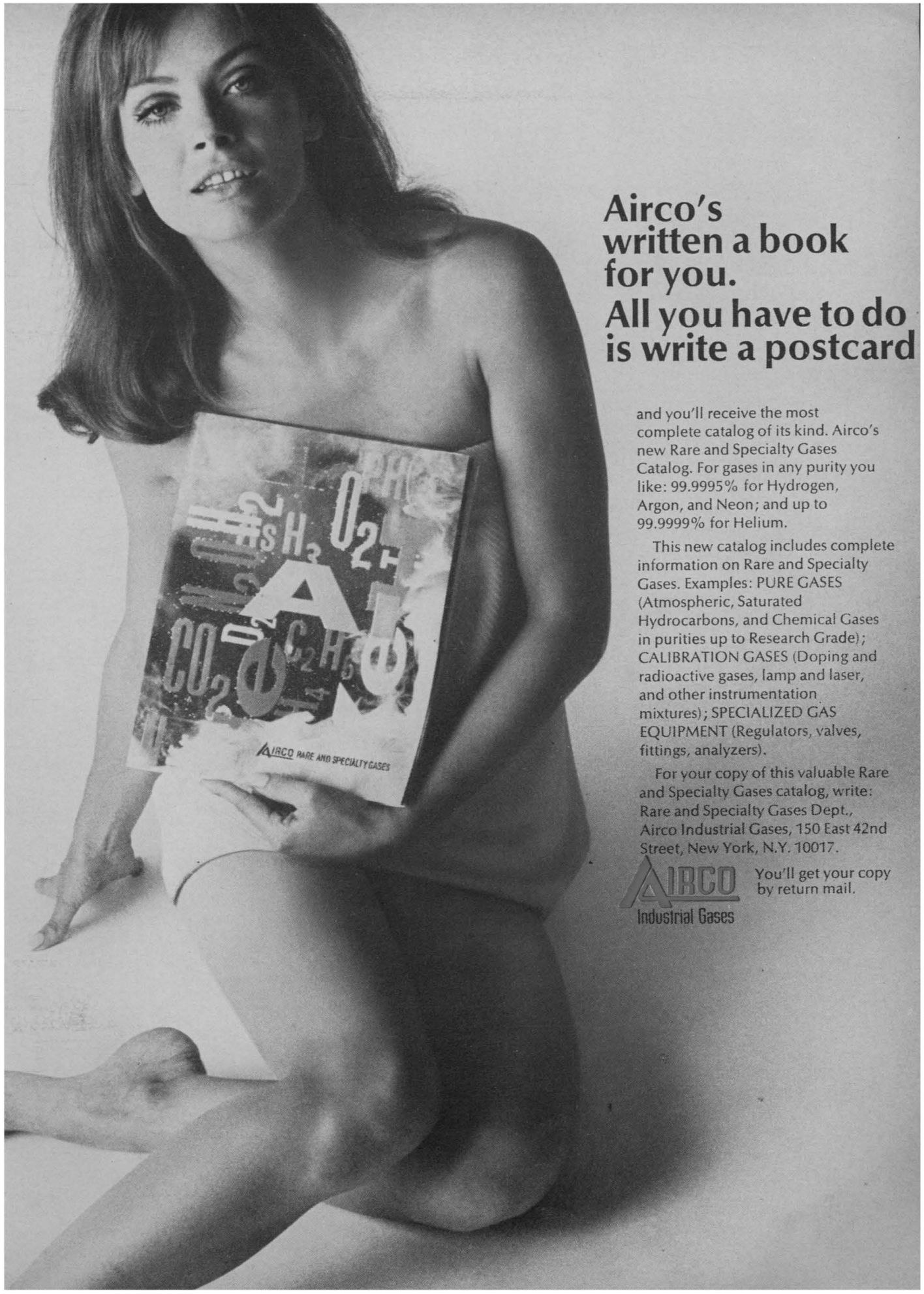

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so, but nevertheless constructive. There is now, in this country, too much fractionalization and dissension between groups of one sort or another. Perhaps we can be the first to call a halt to name-calling and petty bickering, and get on with the business of creating some kind of future for this country. In this spirit, then, let me be the first to open with an honest salvo and close with some tentative, but hopefully constructive, ideas.

As the ranking minority member of the Appropriations Subcommittee charged with funding the NSF and NASA, and as a member of the Senate Defense Appropriations Subcommittee, permit me to observe that the admitted lack of expertise on the part of a majority of members of Congress in areas relating to scientific achievements is, regrettably, matched only by the lack of appreciation on the part of many research scientists, engineers, and technical managers of congressional processes and problems. On occasions so rare that I can scarcely recall, have I ever received comments from those in the scientific community relative to how their operations might possibly be improved, where the waste is, where the duplication is, where the inefficiency lies, what the real difficulties and problems are and how they can help. Quite frequently, however, I receive mail from individuals asking for more and more funds from the federal treasury, and one theme is fairly dominant—cut some place else in the budget, but do not cut my research project. Gentlemen, we have only so much money to expend. We are limited, to a great degree, by revenue taken in by the Treasury if we are to make the financing of our national debt manageable. Within our admitted lack of expertise, coupled with an appalling lack of national goals or a system of priorities, I think we do a fair job of spreading out the federal dollar. We could do better, though, with some constructive help from the scientific community from an objective and realistic appraisal of the circumstances and of existing realities, and we could benefit from the establishment of some system, either a Joint Committee or something similar, which would view research on an overall basis, which would review national goals and aspirations and which might have an opportunity to make a stab at setting up some type of priority list, insofar as funding needs are concerned. I would think, also, that the country might well benefit if, paraphrasing both Donald Hornig and the "now" generation, the scientific community would become "involved," would drop the cloak of mystery, and take the time to explain, not just to us in the Congress, but to Mr. Taxpayer as well, just what it's all about. This would be a tremendous contribution and definitely a forward, positive step in the national interest.

GORDON ALLOTT
United States Senate,
Washington, D.C.

Reducing Hail: The U.S. Plan

In telescoping news of a research program on the suppression of hail into a single paragraph in the 6 September issue (p. 995), *Science* may have misled its readers concerning the research in this field currently being carried out under NSF sponsorship by the National Center for Atmospheric Research, the Environmental Science Services Administration, and Colorado State University.

It is true that the Russians have reported success in reducing hail damage to crops in certain areas by firing anti-aircraft shells containing silver iodide directly into hailstorms. But the implication that a similar program is now underway in the United States is misleading.

The American operational effort is likely to be quite different, and it is several years away. The most likely vehicle for getting the silver iodide into the clouds now appears to be lightweight rockets fired from aircraft. Before such an operational test can be carried out, however, additional research is required to answer questions concerning (i) the mechanics of Great Plains hailstorms and specifically the nature of the "hail accumulation zone" in such storms; (ii) radar techniques for identifying potential hailstorms and for timing the rocket firings; (iii) techniques for measuring the extent and intensity of hailfall from seeded and unseeded storms; and (iv) development and test of the rockets. It is on these subproblems that NCAR, ESSA, and CSU are engaged.

Meanwhile, a plan for a national program to proceed from research to tests of operational methods is now under consideration by the Interdepartmental Committee for Atmospheric Sciences, a subgroup of the Federal Council on Science and Technology. The details of such a plan will have to be discussed

thoroughly, not only among the participating agencies and research groups but also with public officials in the area, before large-scale field operations are carried out.

JOHN W. FIROR
National Center for Atmospheric Research, Boulder, Colorado 80302

Inventions Beg Application

The high level of abstraction employed by Emmanuel G. Mesthene ("How technology will shape the future," 12 July, p. 135), in discussing the ways in which technology will affect the future may have led him to neglect some down-to-earth economic considerations. For example, he writes: "There is nothing in the nature or fact of a new tool, of course, that requires its use . . . but there is a high probability of realization of new possibilities that have been deliberately created by technological development, and therefore of change consequent on that realization." Is there *really* a high probability of application of newly invented tools?

A careful review of the evidence would, I believe, indicate that the probability of eventual application of any invention is, on the average, rather low as many disappointed inventors will testify. Ray Vernon, Tom Schelling, or any of his other economist colleagues at Harvard could have pointed out to Mesthene that invention is not enough: there must also be a mechanism which guarantees that opportunities will be recognized and seized. Knowledge and enterprise must be present. The merits of a new technology to businessmen are related to costs and profits. History is filled with examples of inventions that went without commercial application for years, or were introduced but failed, or were never adopted because market conditions were not propitious. Many patents on new ideas have never been exploited commercially and probably never will be.

Expanding on Mesthene's borrowed analogy, I would say that a new device may be like a newly opened door which invites one to enter, but the anticipated costs and satisfactions of crossing the threshold are a key factor in shaping one's decision.

JAMES D. THEBERGE
Inter-American Development Bank, Washington, D.C. 20577

11 October 1968, Volume 162, Number 3850 **SCIENCE**

The Inexorable Exponential

Many people view growth as akin to progress, achievement, and the good things of life. In contrast, a steady-state situation is viewed darkly. A 5-percent annual increase in the gross national product is considered healthy, while failure of the economy to attain an increase would be considered a cause for great alarm. The most valued form of growth is a steady increase each year. This can be expressed by the equation $x = x_0e^{kt}$, where x is the variable, x_0 is its value at time $t = 0$, and k is the growth rate. When $kt = 0.693$, $x = 2x_0$. Thus a growth rate of about 3 percent a year leads to a doubling time of 23 years. Such a rate seems sedate enough, but, as time passes, further doublings occur, so that ultimately the value of x goes to infinity. In any practical situation this is impossible, and, as Platt has pointed out, continuous growth often leads to great problems for society.

In the early part of this century our population growth was a source of great pride, while the more nearly static populations of some European countries were considered indications of decadence. Lately our attitude about population has been changing.

Despite our new realization that some kinds of growth are not good, this lesson will not be applied generally for a long time because of our inherent prejudice in favor of growth. Today the public is becoming concerned about the way nature is being despoiled. However, few seem to realize that most ecological problems can be traced to some aspect of exponential growth. In attempting to prevent further deterioration of the environment, ecologists and conservationists may find that their strategy of piecemeal attack on specific situations wins battles but loses the war. The toughest enemy is the inexorable exponent.

An example of the kind of problem ecologists face comes from the electric power industry. To satisfy public demands, the industry has increased its installed capacity at the rate of 6 to 7 percent per year for many years. Typical projections assume a similar rate of increase far into the future. All of us are indebted to this industry and the conveniences that it brings us. Take away dependable electric power and there remains a shambles. Yet the projected expansion will create great tensions. Already there are siting problems and complaints of thermal pollution. Air pollution and dangers connected with the nuclear industry will increase. At some point society must conclude that an exponential expansion in power output is not desirable.

Scientists are in the midst of traumatic sequelae to an unsustainable exponential growth in the support of research. Over a period of about two decades, beginning in 1940, federal expenditures for research and development rose by about 25 percent per year. When such growth was sustained for some years, the beneficiaries expected it to continue indefinitely. They were inclined to accept exponential growth as a law of politics or nature. Even as recently as a few years ago it was widely held that federal support for science should increase at the rate of 15 percent a year. This was at a time when the G.N.P. was growing at the rate of about 5 percent. Scientists might hope for, and argue for, a rate of growth somewhat larger than the G.N.P., but the larger the disparity, the quicker the disappointment.

Society has been, and still is, on a great growth kick. If we are interested in a long-term future for man, we will regard rapid growth with suspicion. We will look for, and point out, the unexpected and unpleasant consequences of exuberance long-continued, and seek to moderate it before irreparable damage has been done.—PHILIP H. ABELSON

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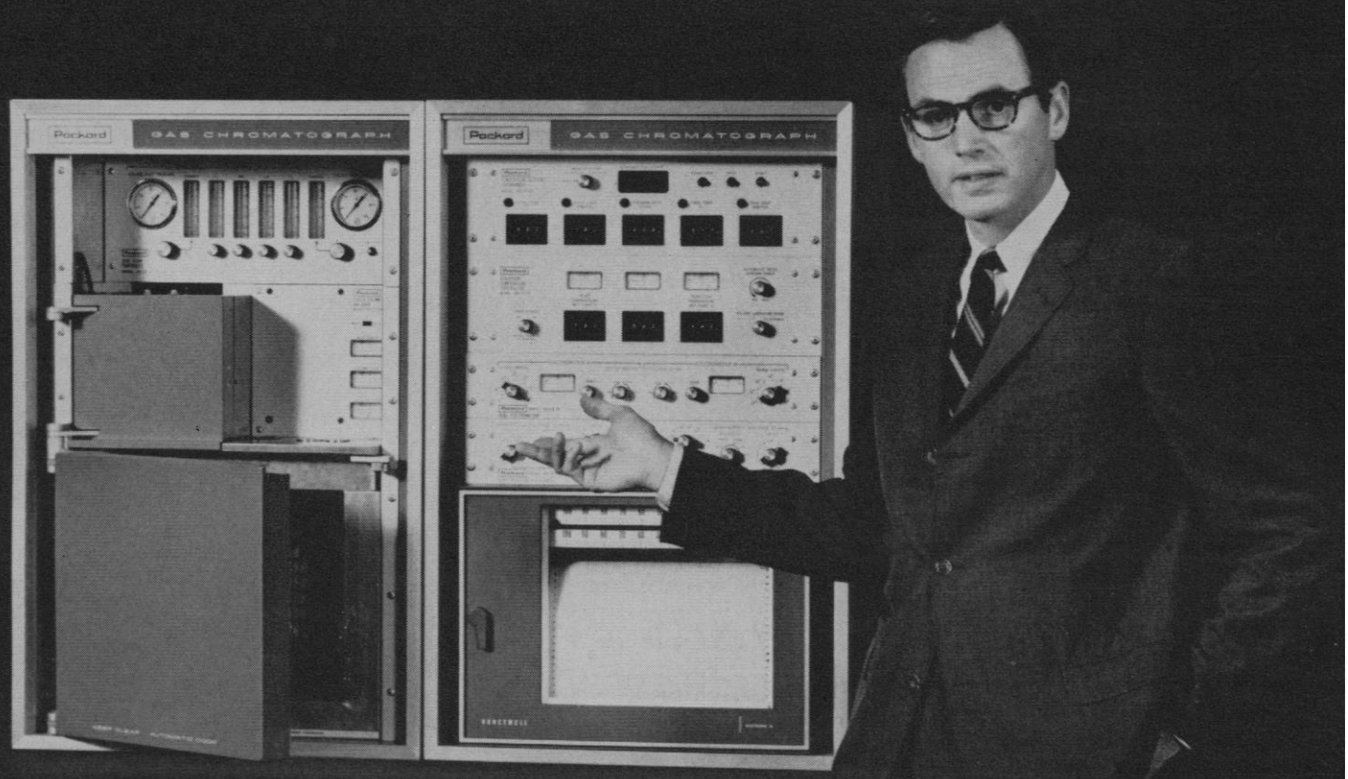

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