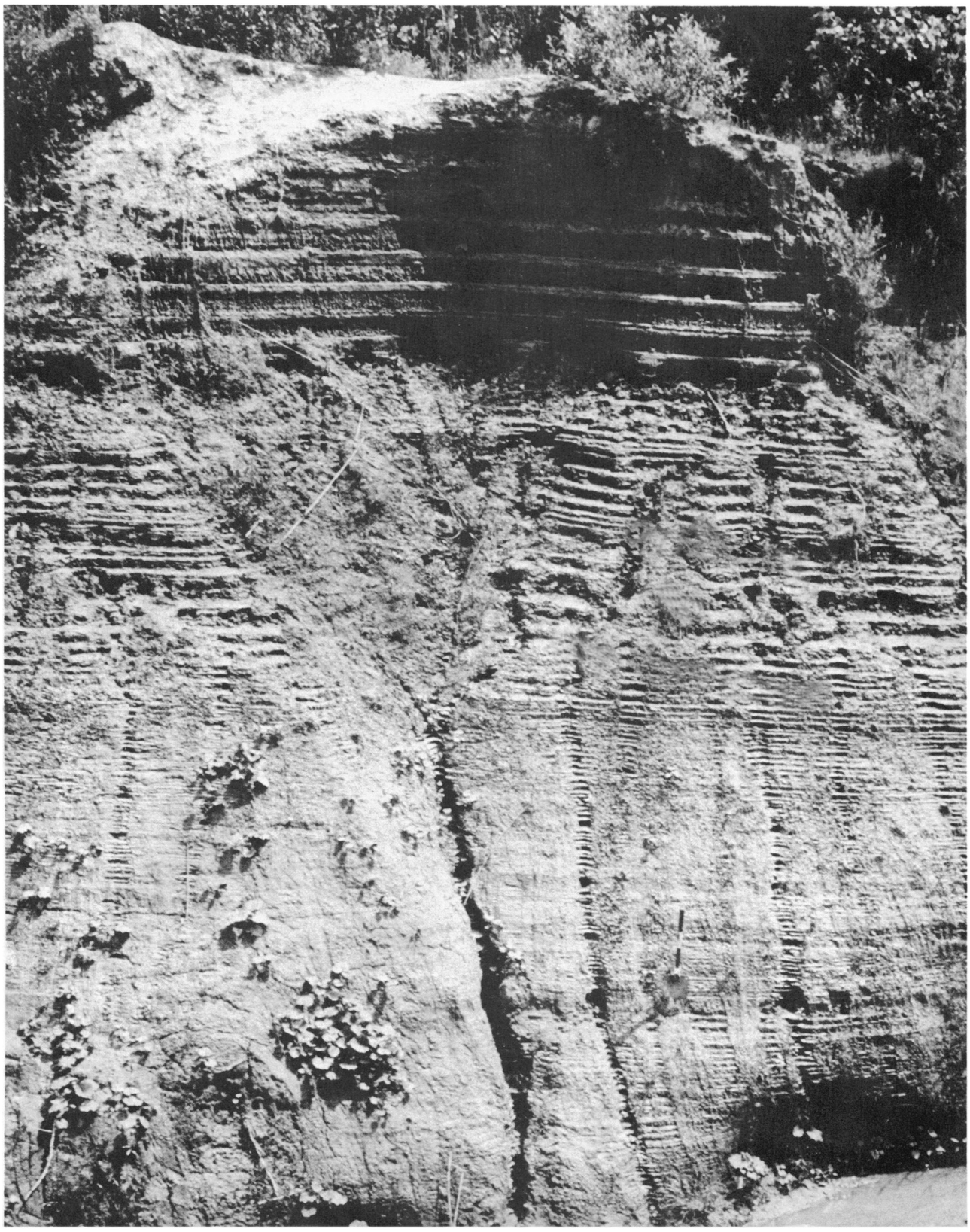
SCIENCE

3 October 1975

Volume 190, No. 4209

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Now there are 34 Rotors for Beckman L-5 Ultracentrifuges

These two new rotors join 32 other Beckman preparative ultracentrifuge rotors–16 fixed angle, 10 swinging bucket, 5 zonal, and 1 continuous flow–to meet virtually any separation need.

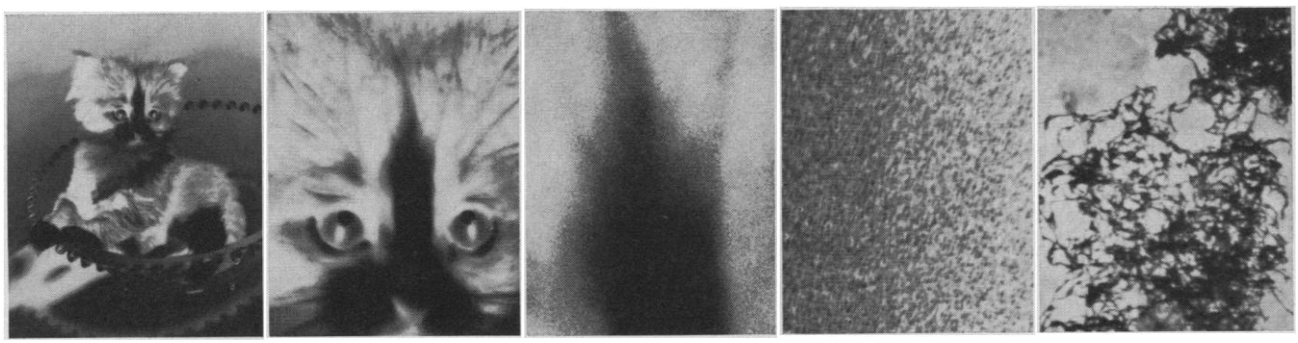
Both these new rotors are unique.

The Type 25 in the foreground is the first ultracentrifuge rotor to hold 100 samples. It generates 70,000 to 90,000 g, depending on the location of the tube in the rotor. This high force, together with the small-diameter 1-ml tubes, gives rapid, high quality separations of such materials as lipoproteins.

The 45,000-rpm Type 45 is the first of a new generation of rotors which are specially contoured to give them a more favorable weight-to-capacity ratio. This one, of titanium, is the only fixed-angle rotor capable of spinning more than a half liter at forces in excess of 200,000 g.

The four versions of the L-5, their rotors and accessories, are described in Data File 400/174. For your copy, write Beckman Instruments, Inc., Spinco Division, 1117 California Avenue, Palo Alto, CA 94304.

Beckman®



Here kitty, kitty, kitty, kitty!

Between the eyes, the upward arrow. All done with the statistics of distribution of skeins of ultramicro silver filaments. For color, little clouds of dye.

When magnification is carried too far, the subjective effect called graininess manifests itself. It correlates with granularity, a physically measurable quantity. That's not just playing with words. Graininess, quite appropriately, is the sensation one gets when looking at a handful of grain. If instead of lying helter-skelter in your palm the kernels were uniformly spaced, graininess would no longer be the word for the sensation, even though you were still seeing individual grains. It's randomness that elicits the graininess sensation.

Except at extreme right above, one is seeing only random variations in spacing and overlapping of the individual silver skeins or dye clouds. We quantify these variations as deviations from density 1.0 when scanned in a densitometer with a 48-μm aperture. For all kinds of uniformly exposed Kodak films, the root-mean-square of the deviations multiplied by 1,000 and appropriately rounded off becomes "diffuse rms granularity value."

Here is how these values relate to the words we use to state graininess:

45, 50, 55	"Very Coarse"
33, 36, 39, 42	"Coarse"
26, 28, 30	"Moderately Coarse"
21, 22, 24	"Medium"
16, 17, 18, 19, 20	"Fine"
11, 12, 13, 14, 15	"Very Fine"
6, 7, 8, 9, 10	"Extremely Fine"
5 or less	"Micro Fine"

Emulsion progress over the years has consisted largely of lifting the upsloping line that plots light sensitivity against granularity. Result: the number of pictures taken per year goes up much faster than acres of film manufactured—less material required for more and better results with less in the way of equipment and folderol. Good for the customer. Good for us.

KITTY IS MISSING! Circulars are to be run off bearing the kitty's picture. But, since the printing press either does or does not deposit ink at any given point on the paper, the information about that all-important streak on the head is to be conveyed through arrayed dots of varying size.

Dealers in materials for the graphic arts (check the Yellow Pages) can supply KODALITH AUTOSCREEN Ortho Film 2563 (ESTAR Base). It makes possible a simpler procedure to convert a photo to dots than used for the illustrations in the magazine you are now reading. The sensitivity of its emulsion varies cyclically with a frequency of 133 per inch. This results in a grid of dots whose size varies with brightness distribution over the image. The film is quite slow; for direct photography, instead of making halftones from existing photographs, only still-life subjects are practical. But that might be quite useful if instead of finding your lost cat you just want to reproduce photographs decently with a duplicating machine. The film can be exposed in a conventional view camera.

Details in Kodak Publication No. Q-20 ("Making Halftones with KODALITH AUTOSCREEN Ortho Film 2563"), available from above dealers or Kodak, Dept. 412-L, Rochester, N.Y. 14650.

KITTY MAY BE HIDDEN IN HOLOGRAPHIC FRINGES. Why people should want to render an image holographically they don't always say. At any rate, it is reported in *Applied Physics Letters* for August 1, 1975 that KODAK Holographic Plate Type 120-01, employed in a stunt described in 1840 by Sir John F. W. Herschel, yields what is believed to be the highest diffraction efficiency (for red-light reconstruction) ever reported in an infrared-recording material, with spatial frequency better than 1300 cycles/mm. It was Sir John who revealed the existence of the infrared in the first place, and then he found that it erased latent image in a light-exposed photographic material. Now it turns out that infrared holographic images can be recorded by Herschel-effect erasure in prefogged 120-01 plates. Doesn't seem to work on our other high-resolution emulsions. See *Applied Physics Letters* for details. Type 120 plates are stocked by dealers in holographic specialties.

Kodak

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SCIENCE

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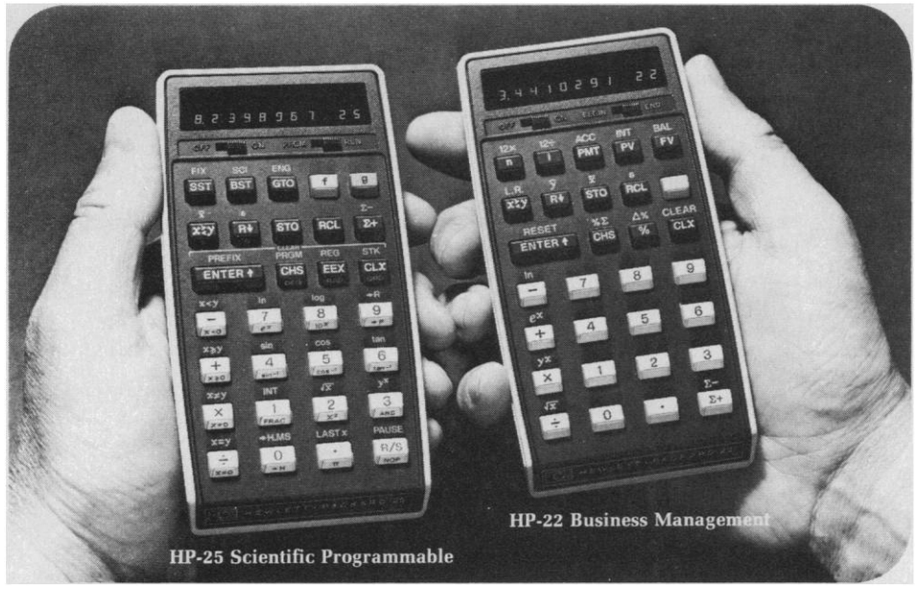
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress. Postmaster: Send Form 3579 to SCIENCE, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.

COVER

Varved sediments of glacial Lake Hitchcock in an abandoned brickyard in Willimansett, Massachusetts. Each varve represents 1 year of lake-bottom deposition consisting of a summer layer of silt and sand and a winter layer of clay. One hundred and thirty varves are exposed at this site. See page 48. [K. L. Verosub, University of California, Davis]



Two more members join HP's family of small miracles.

The secret of all HP's small miracles is in the keys, and the array of special functions they perform. (Just take a moment to examine the keyboards in the photograph.)

But there is one key common to all. It says ENTER, and is both literal and figurative. Literal in that you use it to enter data to be computed. Figurative in that it opens the door to answers you can trust: simply, directly, conveniently.

Like the rest of the family, these two new hand-held calculators feature HP's advanced design, 4-register stack, and special logic system. The small miracle is that each leads its class in power, weighs a mere 6 ounces, and costs less than $200.

HP-25 Scientific Programmable Calculator. $195*.

Preprogrammed to solve 72 scientific, engineering, and mathematical functions with keystroke ease, the HP-25 has the power you need to solve technical problems.

But that's just the beginning. Its comprehensive keystroke programming capability lets you solve repetitive and iterative problems—even some complicated ones that force you to wait in line for computer time—at your desk, in minutes or even seconds. The HP-25's programming power includes a 49-step memory; direct and conditional branching using as many as 8 relational tests; integer/fraction truncation and absolute value keys; and a full editing capability that lets you see what your program looks like, step by step, and lets you look at intermediate results by means of controlled pauses in the program.

The new HP-25 also has 8 addressable memories, each capable of register arithmetic. And it's the first hand-held to offer not only *fixed* and *scientific* but also *engineering* notation (i.e., exponent displayed as a multiple of ±3, as in giga and nano).

HP-22 Business Management Calculator. $165*.

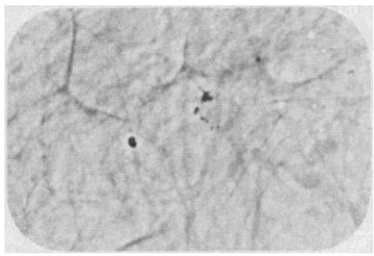
Combining the preprogrammed power of three present-day calculators, this new model solves virtually every number problem that a business manager faces. Its easy-to-use keyboard includes:

- A complete range of financial keys for evaluating time-and-money problems; compound interest and internal rate of return; annuity and annuity due comparisons; and margins, mark-ups, discounts, and percent differences.
- Advanced statistical functions including accumulations; mean and standard deviation; linear regression and linear estimate; and growth curves.
- A powerful range of mathematical functions such as log, antilog, exponentiation, and root extraction.

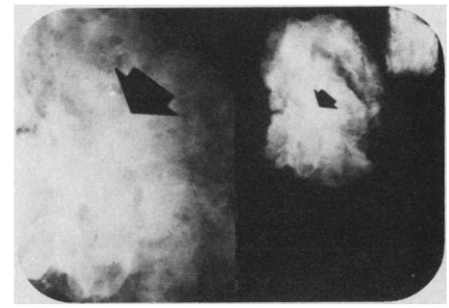
Both hand-helds come complete with battery pack and recharger, soft vinyl carrying pouch, and comprehensive owner's handbook. In addition, the HP-25 includes a 162-page book of applications programs concerning mathematics, statistics, finance, surveying, navigation, and games.

See the HP family of professional hand-helds at quality department stores or campus bookstores. Call 800-538-7922 (in California, 800-662-9862) for the name of the retailer nearest you.

Preoperative mammogram (in this case, a xeroradiograph) shows a partially calcified nonpalpable breast lesion.



The suspicious region is biopsied and the excised tissue radiographed with the Faxitron. Because this small lesion is not palpable to the surgeon, immediate x-ray examination of the tissue is essential to show whether or not the lesion has been removed.



The specimen x-ray reveals the calcifications shown in the mammogram, confirming that the surgeon has indeed excised the proper area. In addition, the specimen x-ray identifies calcified sites that may not have been visible in the mammogram.

Specimen x-rays: mandatory adjunct to mammography for early detection of cancer.

At the Virginia Mason Clinic in Seattle, an HP cabinet x-ray permits fast radiographic analysis of excised breast tissue for detection of cancer-indicative microcalcifications.

Specimen radiography has proved to be a "mandatory adjunct to mammography" according to the Virginia Mason Clinic in Seattle, Washington, where pathologists have used the procedure for seven years in detecting and localizing breast calcifications.

Using a Hewlett-Packard 43805 Faxitron cabinet x-ray, pathologists have radiographed more than 800 breast biopsies since 1968, when the unit was donated to the clinic by the Washington State Division of the American Cancer Society. Specimen radiographs from the Faxitron have made possible the detection of calcifications within breast lesions which are not grossly apparent: calcifications as small as 10 to 20 microns can be identified, permitting diagnosis at an early, more curable stage.

Because specimen x-rays can be made quickly during surgery, while the patient is anesthetized, the Faxitron has become important in cases where a mammogram indicates a calcification that is not clinically palpable. Specimen radiography is mandatory in such situations because it is the only way the surgeon, operating on a lesion that cannot be felt, can verify whether or not the correct area has been removed. With the easy-to-operate Faxitron available in the pathology lab, pathology personnel can very rapidly take their own high-resolution films without prolonging the surgery. Diagnosis can be quick because the specimen radiograph enables the pathologist to pinpoint the critical areas for histological examination.

Although primarily used at Virginia Mason Clinic for breast biopsies, the Faxitron also lends itself to examination and detection of bone lesions and vascular lesions of various body organs.

The 43805N Faxitron is certified by Hewlett-Packard to meet the stringent 1975 safety regulations of the Bureau of Radiological Health. Price of the unit is $4100*.

For more information on these products, write to us, Hewlett-Packard, 1505 Page Mill Road, Palo Alto, California 94304.

Mail to: Hewlett-Packard, 1505 Page Mill Road, Palo Alto, CA 94304.
Please send me further information on

( ) HP-25 Scientific Programmable Calculator
( ) HP-22 Business Management Calculator
( ) HP 43805N Faxitron Cabinet X-ray

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00549

You want the ozone question So does

And most scientists agree there is time to find the answer.

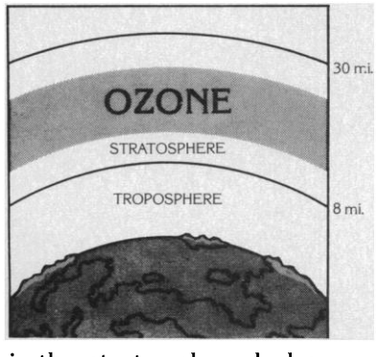
Fluorocarbons are liquids and gases used in refrigeration, for air conditioning, and as propellants in about half the aerosol spray cans sold in this country. Some say that these useful, normally safe compounds will cause a health hazard by attacking the earth's ozone layer. We believe this is an oversimplification.

The point is, to date there is no conclusive evidence to prove this statement. To understand, then, why there is a controversy, it is necessary to unsimplify the issue. We must treat the real world on its own terms, and they are complex.

The model that raised the question.

Ozone is continually created and destroyed by natural forces scientists are seeking to understand. The ozone depletion theory, based on a computer model of the stratosphere, was reported in 1974 by two chemists at the University of California.

This mathematical model calculates how fluorocarbons

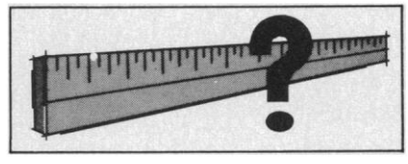


in the stratosphere behave under the influence of a series of variables (such as temperature, altitude, sunlight, chemical concentration) to affect the ozone layer.

In order to estimate hypothetical reactions, and because little is actually known about the real ones, the modelers made a number of assumptions about the way the upper atmosphere behaves.

The unmeasured yardstick.

Before any judgments can be made using this model as a stratospheric yardstick, its accuracy must be determined.



Does it describe the real, three-dimensional world? To find this out, the validity of the modeler's basic assumptions must be determined.

Turning assumptions into facts.

Before a valuable industry is hypothesized out of existence, more facts are needed. To get these facts Du Pont and the other fluorocarbon manufacturers are funding independent technological investigations in universities and research laboratories. Under the direction of acknowledged scientific experts, this research is designed to either prove or disprove the assumptions most important to the computer case against fluorocarbons.

Some research has been carried out since the model was first presented. Scientists now have a better idea of the accuracy of the assumptions in the model.

ASSUMPTION: The ozone-depleting reaction with chlorine from fluorocarbons takes place at a rate that demands an immediate decision on fluorocarbon use.

FACT: Recent determinations of reaction rates disclose that the ozone/chlorine reaction actually takes place at a slower rate than that assumed by the model. In addition, the same research has shown that the reaction of chlorine with stratospheric methane proceeds at a faster rate. Since this reaction tends to remove chlorine from the ozone layer, the net effect of both reactions is to lessen the originally-calculated impact of fluorocarbons. In fact, the impact was overstated by 300%.

RESEARCH: To guide future measurements of stratospheric reactions, a laboratory program has been funded to measure the reactions of chlorine compounds and ozone under simulated stratospheric conditions.

Most scientists agree there is time to conduct the research needed to settle the controversy one way or the other... before a final decision is made on fluorocarbon production and use.

ASSUMPTION: There is no other way to get fluorocarbons out of the atmosphere except by the ozone-depleting reaction.

FACT: One well-known class of chemical reactions not considered in the model is that of chlorine compounds in the

answered one way or the other. Du Pont.

atmosphere in heterogeneous reactions.

In an article in SCIENCE (Feb. 14, 1975), Professors S. C. Wofsy, M. B. McElroy, and N. D. Sze of Harvard University caution that "If additional removal processes could be identified... or if additional sinks could be identified for stratospheric odd chlorine, the atmospheric and biological impacts of [fluorocarbons] would be reduced accordingly."

RESEARCH: Atmospheric chemistry involving ion molecule reactions has been described in recent months by several investigators. Reaction rates with ion molecules are known to be extremely fast and are believed to occur primarily in the lower stratosphere.

Thus, ion molecules could react with fluorocarbons, allowing them to be removed from the atmosphere.

ASSUMPTION: Fluorocarbons are the only significant source of chlorine available for interaction with ozone in the stratosphere.

FACT: Many chlorine-containing materials are present in the atmosphere in varying concentrations. Of particular significance, large amounts of methyl chloride and carbon tetrachloride have been discovered in the troposphere and stratosphere.

In addition, new calculations on the injection of gaseous chlorine compounds into the stratosphere from volcanic eruptions have shown this as a significant contributor of chlorine not taken into account by the model.

RESEARCH: Scientists are completing an inventory of chlorine-containing compounds in the atmosphere. It must be determined how nature deals with chlorine from these natural sources, before it can be shown that chlorine from fluorocarbons might pose a threat to the ozone layer.

Additional research.

A fluorocarbon industry research program is funding the development of a computer model that will better reflect the complex chemistry of the stratosphere.

In addition, other studies are under way to broaden our understanding of the total ozone production/destruction balance. These will concern themselves with other stratospheric reactions affecting ozone.

A panel of highly qualified academic scientists will advise on the technical programs covering various facets of the problem. This panel of independent experts will review the projects, providing a critical opinion on the pertinence of each, the probability of their success, and the completeness of the overall investigation.

Conclusion.

Much more experimental evidence is needed to evaluate the ozone depletion theory. Fortunately, as most scientists agree, there is time to gather this evidence. Du Pont has joined with other fluorocarbon manufacturers to provide funds for work by independent university scientists. Governmental agencies are also conducting research to help in the assessment of the theory.

Should the theory be proven correct after all the evidence is in, Du Pont, as we have stated, will stop the manufacture and sale of the offending compounds.

In the meantime, we believe that to act without the facts—whether it be to alarm consumers, or to enact restrictive legislation—is irresponsible. Final decisions cannot be made with only the information at hand.

The independent research described above is presently being carried out by scientists at the following institutions:

Cambridge University—England
Environmental Research and Technology, Inc.
Massachusetts Institute of Technology
State University of New York
The Battelle Memorial Institute
The University of Reading—England
University of California
University of Denver
University of Illinois
University of Maryland
University of Michigan
Washington State University
York University—Canada
Xonics, Inc.

This is the second in a series of discussions by Du Pont to offer a perspective on an important subject. If you would like copies of either this or the first discussion, please write to: FREON*, Room 24517, Du Pont Company. Wilmington, DE 19898.

*Du Pont's trademark for fluorocarbon refrigerants and aerosol propellants.

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3 October 1975, Volume 190, Number 4209 **SCIENCE**

Support of Basic Research

A recent National Science Foundation report indicates that, in constant dollars, support for basic research in 1975 is expected to decline by 8 percent from the 1974 level. And, according to *The Chronicle of Higher Education*, "this is the sharpest percentage decline ever recorded by NSF." Other accounts from across the country indicate that industry and state expenditures for basic research, particularly in colleges and universities, are following the same downward trend.

However, what concerns me most is how the academic science community and the federal granting agencies react in this crucial period. During such times of fiscal and political stress, a psychology tends to develop which could do untold harm to the fundamentals of the nation's basic research activities. There is, for example, a tendency on the part of granting agencies to support only the "safe" research, and the scientific community more often than not capitulates to this practice. Part of the problem is that as public opinion shifts, research that seems "relevant," and hence safe, changes. For example, a few years ago the government was eager to support research on environmental problems. Today, environment is relatively "out" and energy is "in." Thus support tends to become erratic. These attitudes, combined with congressional pressures, can in time erode and destroy the quality of American science. We *must* continue to support our superior scientists steadfastly; at the same time we must urge administrators and program directors in granting agencies to encourage the unconventional approach to a problem—that is, be willing to invest risk capital.

One significant modification of the awarding of research funds would enable young scientists to be less inhibited and more creative in their thinking and approach to fundamental problems. Departmental grants could be awarded specifically to support research by junior faculty. In this way, our young scientists would have a 3- to 5-year period to prove themselves early in their careers. Upon receiving tenure, the scientists would then apply for a regular grant and would be judged by the normal peer review process.

Who is equipped to judge where a breakthrough is likely to occur—the Congress or even experienced science administrators? The answer is, of course, the scholar who is willing to gamble his time and career on following his hunches. In the process of such effort, he will work much longer hours and with far more energy and enthusiasm than if he is following dictums laid down by Washington.

The central, critical core of modern science is the body of work known as nondirected, basic research. In reality the "health" of a nation's science effort is a function of the quality of basic research being done. It is incumbent on those responsible for the nation's well-being to provide adequate support for research of high quality. In turn, scientists carry the burden of educating decision-makers as to the critical importance of basic research. Of course there are often charges that scientists cannot provide an exact definition of quality. However, I believe the important issue is not the *definition*, but the *recognition* of quality. Scientists are able to provide this recognition and have done so effectively through the peer review process. The validity of this process has been demonstrated by the application of basic knowledge for the betterment of our society.

What is at stake, then, is more than just a few research grants or contracts; it is the nature of American science itself. Our biggest challenge will be convincing decision-makers at all levels that a budget cut here or lack of support there, while insignificant individually, add up almost imperceptibly over time. Today's cries for across-the-board cuts or more applied "relevant" research will give way to tomorrow's "if only we had supported those efforts back in the '70's."

If we are to preserve our extraordinarily productive research operation, especially in our universities, we must understand that the more difficult the times become, the more critical it is to support our basic scientists at a steady, predictable rate.—WILLIAM D. MCELROY, *Chancellor, University of California at San Diego, La Jolla 92037*

Western Electric Reports:

Ion implantation with a new twist.

Western Electric produces millions of semiconductor components a year for use in Bell System telecommunications equipment. An essential step in the process is "doping"—introducing a precisely controlled impurity into the semiconductor material to alter its electrical characteristics. Until now, that's generally been done through diffusion techniques which entail masking a semiconductor wafer and "baking in" impurities—basically a broad brush process.

Bell Labs engineers felt that using ion beams to implant the dopants would be better than diffusion techniques. Ion implantation would improve the performance of some existing devices and would permit the design of new devices that require very precise control during manufacture.

But until recently, conventional ion implantation systems had serious drawbacks for heavy doping of wafers at fast production rates.

Electrical systems, in which a moving beam scans a stationary wafer, tolerate only relatively low currents before the beam starts to spread apart. And low currents mean low production rates.

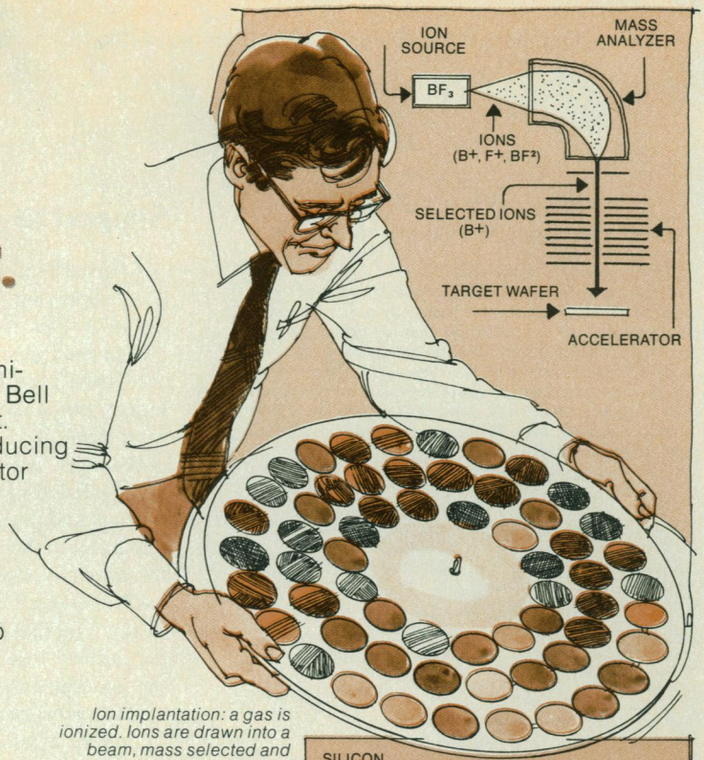
Mechanical (x-y) systems in which wafers are moved back and forth across a stationary beam, can use high currents but are unacceptably slow.

Now, engineers at Western Electric's Engineering Research Center in Princeton, N.J. have developed a new rotating mechanical scanner that overcomes the low speed limitation while still accommodating a high beam current.

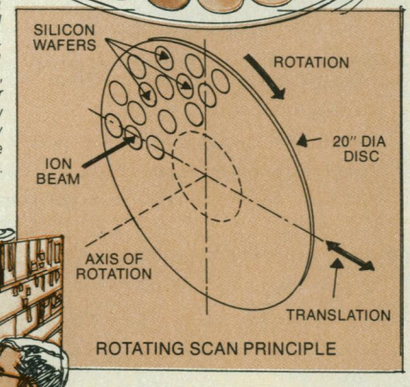
The heart of the rotating scanner is a 20-inch aluminum disc which holds 60 silicon wafers in concentric rings. The disc rotates at about 1000 rpm as it moves from side to side through the path of a stationary ion beam. The beam traces a long overlap spiral on the disc.

To ensure uniform dosage, a digital control system adjusts the speed of the disc's side-to-side motion as the spiral moves toward the center of the disc.

Benefit: Rotating ion implantation techniques are one more manufacturing innovation that allows the Bell System to meet your communications needs reliably and economically.



Ion implantation: a gas is ionized. Ions are drawn into a beam, mass selected and implanted into target wafers. With the rotating mechanical scan method, a 3-inch silicon wafer can be implanted in a few seconds. Conventional x-y mechanical scans require about a minute.



The scanning device is a disc which spins on an axis parallel to the ion beam. The second direction of scan is provided by translating the entire rotating disc in the plane of the disc and perpendicular to the beam.

Ion implantation techniques are used in the manufacture of semiconductor devices used throughout the Bell System from switching and transmission gear to terminal equipment.

Western Electric