

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

19 April 1974, Vol. 184, No. 4134



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COVER

Thermofor catalytic cracking unit at a refinery.

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.

Is it an instant picture of...

the destructive test of an axle?

the proliferation of a virus?

a forgettable lab setup?

the scene of the crime?

the eye of a green turtle?

the divisional sales chart?

chromosomal aberrations?

page 173 of Gray's Anatomy?

an electrocardiogram read-out?

a line conversion of half-tone art?

the three-millionth 8¢ Eisenhower stamp?

a hairline fracture of the fourth vertebra?

a copy of that irreplaceable 35mm slide?

your new diode, magnified 13 times?

a metallograph of vanadium steel?

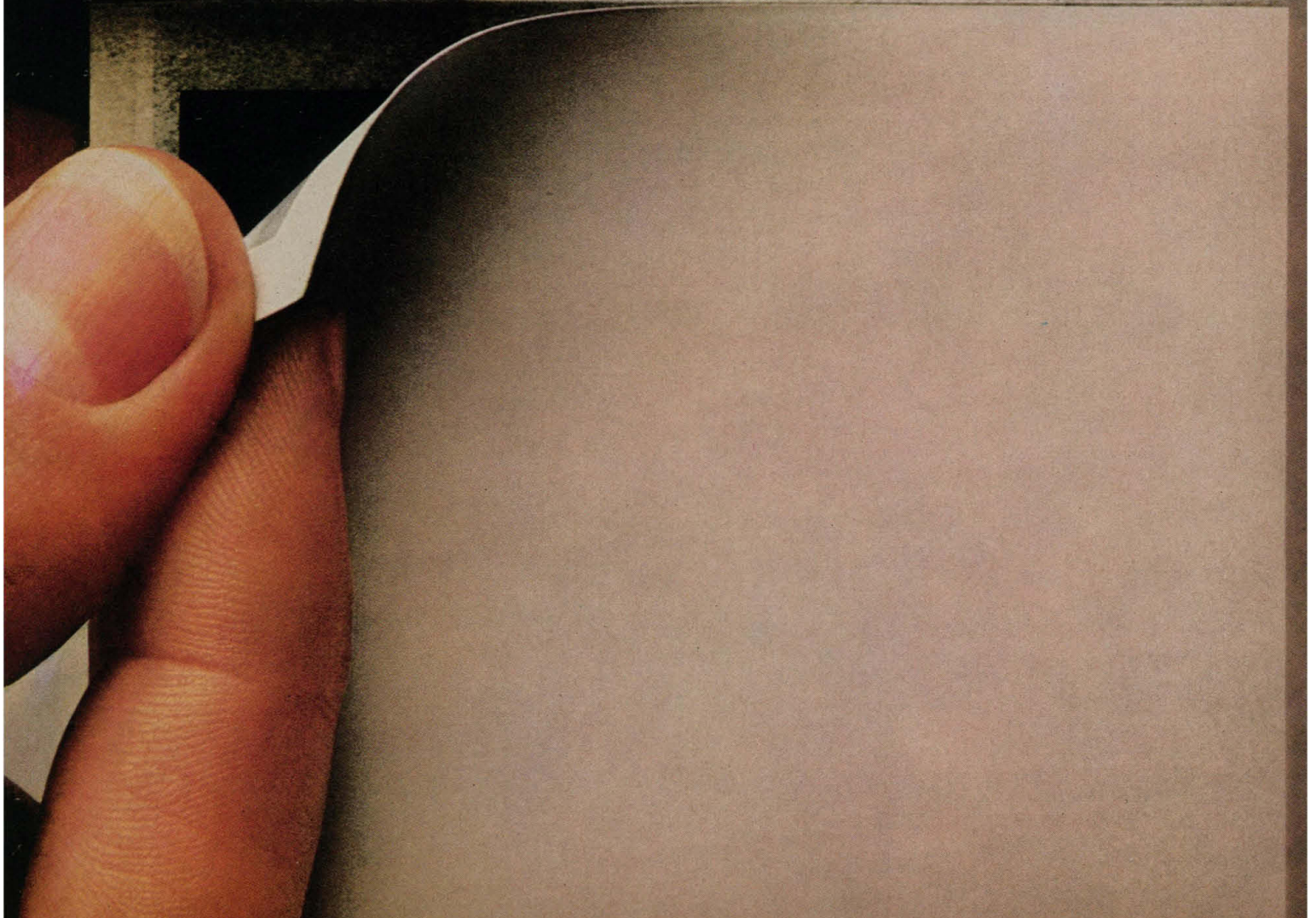
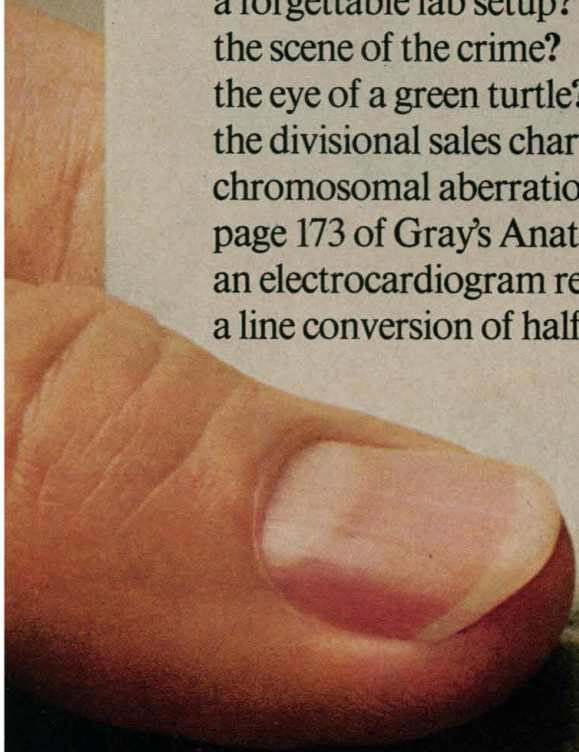
reduced type for mechanicals?

an enlarged lymph node?

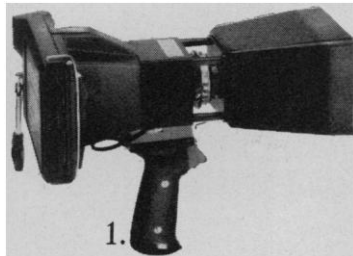
the electrophoresis results?

the world's worst malocclusion?

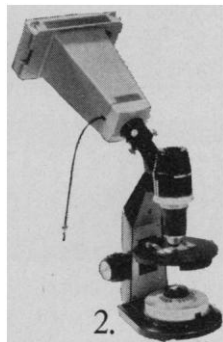
the world's best-corrected malocclusion?



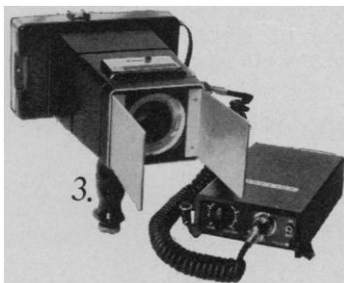
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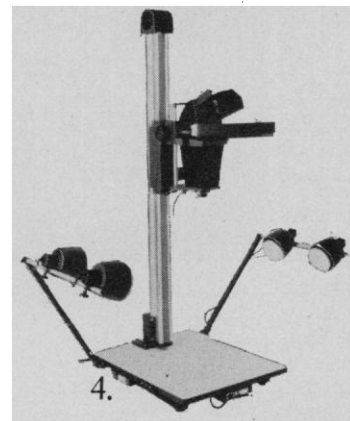
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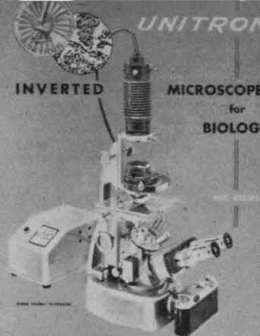


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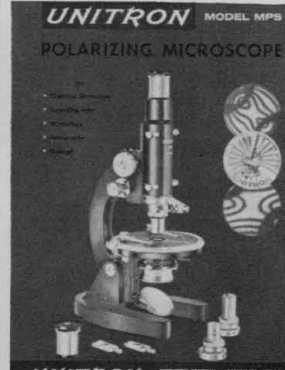
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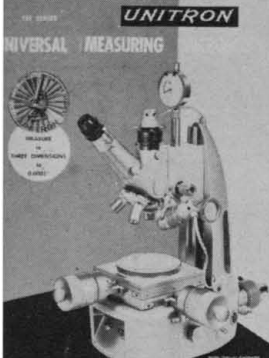
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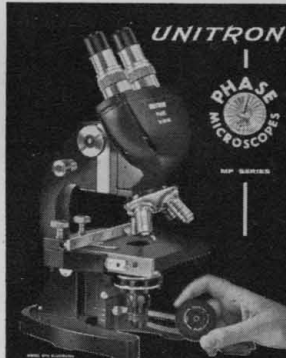


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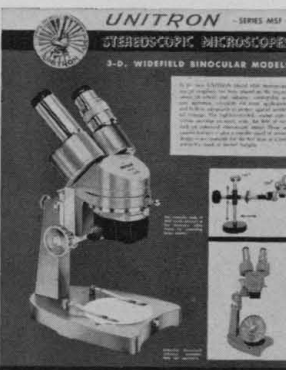
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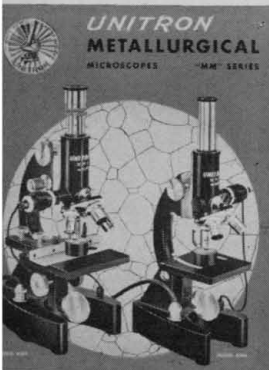
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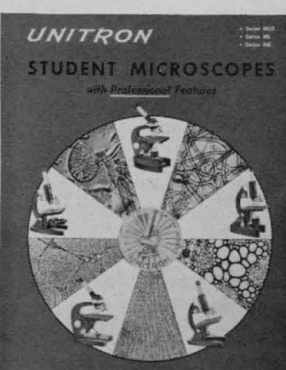
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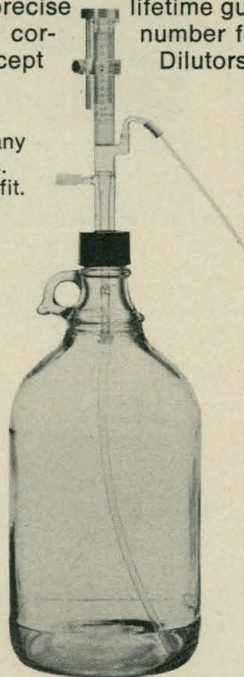
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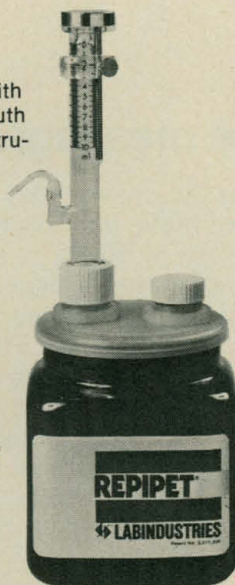
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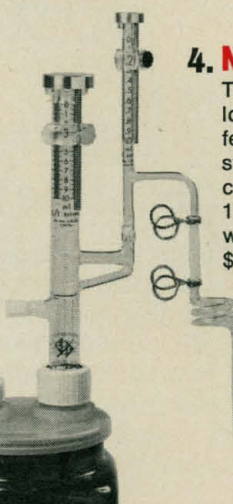
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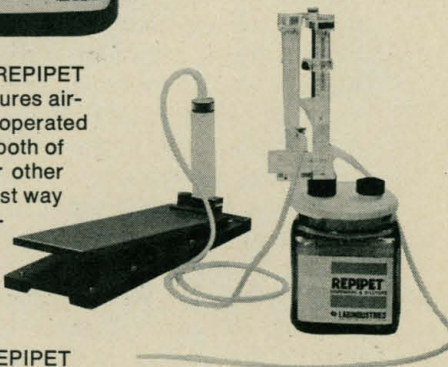


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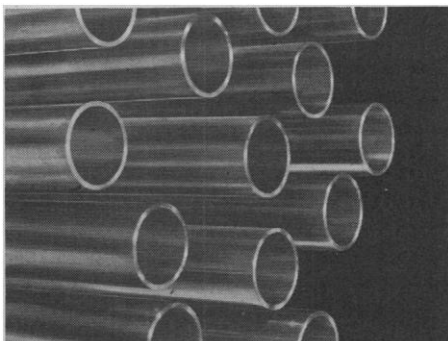


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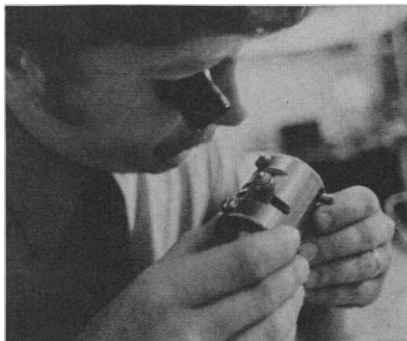
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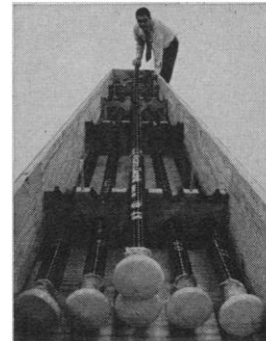
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Solid state devices capable of generating the required high frequencies were developed at Bell Labs. But the system would work satisfactorily only within the controlled environment of a nearly geometrically perfect tube, or waveguide. It would require the development of the first new physical transmission medium in a third of a century—millimeter waveguide.

Increases in long distance calling have made millimeter waveguide an idea whose time has come. In 1969, working with Bell Labs, Western Electric's Engineering Research Center established a branch laboratory at Forstgate, N. J. to solve the problems integral to producing an economical waveguide medium.

Some examples: How to make 30-foot lengths of steel tubing to micro-tolerances never before consistently attained. How to plate precisely .0005 of an inch of copper all along the insides of the lengthy tubes. How to couple the tubes to each other with their centers precisely aligned for the length of the system.

Often the answers lay in the development of new manufacturing techniques. Western Electric engineers developed computer-designed rollers for the straightening equipment to be used by steel tubing suppliers. They innovated a plating process in which the tubes are rotated horizontally as the copperplating solution is circulated through them. They designed flanges which are welded to the tubes with electron beams, and a centering device that helps in machining the flanges precisely.

And they so far outperformed previous expectations that the waveguide's size could be increased for lower transmission losses—and fewer repeater stations will be necessary.

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Greenwich. **4** The Royal Observatory, founded in 1675.

5 The National Maritime Museum where you'll see John Harrison's chronometer.

6 The Oxford University Museum of the History of Science, which houses an unparalleled collection

of scientific instruments dating back to 250 A.D.

7 The chambers in which Roger Bacon spent the last 14 years of his life.

Cambridge. **8** The rooms of Isaac Newton at Trinity College.

9 The home of Francis Crick who, along with J.D. Watson, won the Nobel Prize for the discovery of the double helical structure of DNA.

10 The ante-chapel of Trinity College where you'll ponder the works of four of Trinity's illustrious sons: Sir Francis Bacon, Sir Isaac Newton, Isaac Barrow and William Whewell.

11 The Cavendish Laboratory Museum.

12 Sheffield, where you'll tour an 18th-century industrial village—complete with homes, factories, machinery and the like.

13 The Royal Scottish Museum in Edinburgh.

14 Glasgow University and a look at the work of William Thomson, Baron Kelvin.

Norway. **15** Kon-Tiki and a visit with Thor Heyerdahl.

Upsala, Sweden. **16** The Apothecary shop in which Carl W. Scheele discovered oxygen.

17 Linnaeus' house and garden.

Copenhagen. **18** The Post and Telegraph Museum for a reconstruction of Hans Christian Oersted's discovery of the magnetic properties of an electric current in wire.

19 The island of Ven where Tycho Brahe built the last naked-eye observatory.

Haarlem, the Netherlands, boasts **20** The Teyler Museum and an enviable collection of scientific apparatus from all over Europe.

Leyden. **21** The National Museum of the History of Science. **22** The telescope through which Christian Huygens discovered Saturn's rings. **23** Anton von Leeuwenhoek's microscopes. **24** Fahrenheit's thermometers.

Scheveningen. **25** The Gemeente Museum houses the world's very best collections of musical instruments and a history of acoustics.

26 Antwerp's Folklore Museum, where you'll study witchcraft, popular medicine and herb lore.

Bruges. **27** The Hospital of St. John with its 13th-century ward and 15th-century dispensary.

Brussels. **28** The Museum of Venerable Art.

Paris. **29** Laboratoire Curie.

30 The Institut Pasteur.

31 Le Conservatoire National des

Arts et Métiers contains memorabilia and apparatus of such scientists as Pascal, Lavoisier, Gay-Lussac, Volta, and Becquerel.

32 The College de France, the scene of work by Magendie (established experimental physiology), Laënnec (the stethoscope) and Claude Bernard (physiology).

33 The Museum of Natural History.

34 The École Polytechnique.

35 Basel, Switzerland, the home of Paracelsus.

Bern. **36** Einstein's rooms.

Como, Italy. **37** Museo Alessandro Volta.

Milan. **38** Museo Nazionale della Scienza e Technica Leonardo da Vinci.

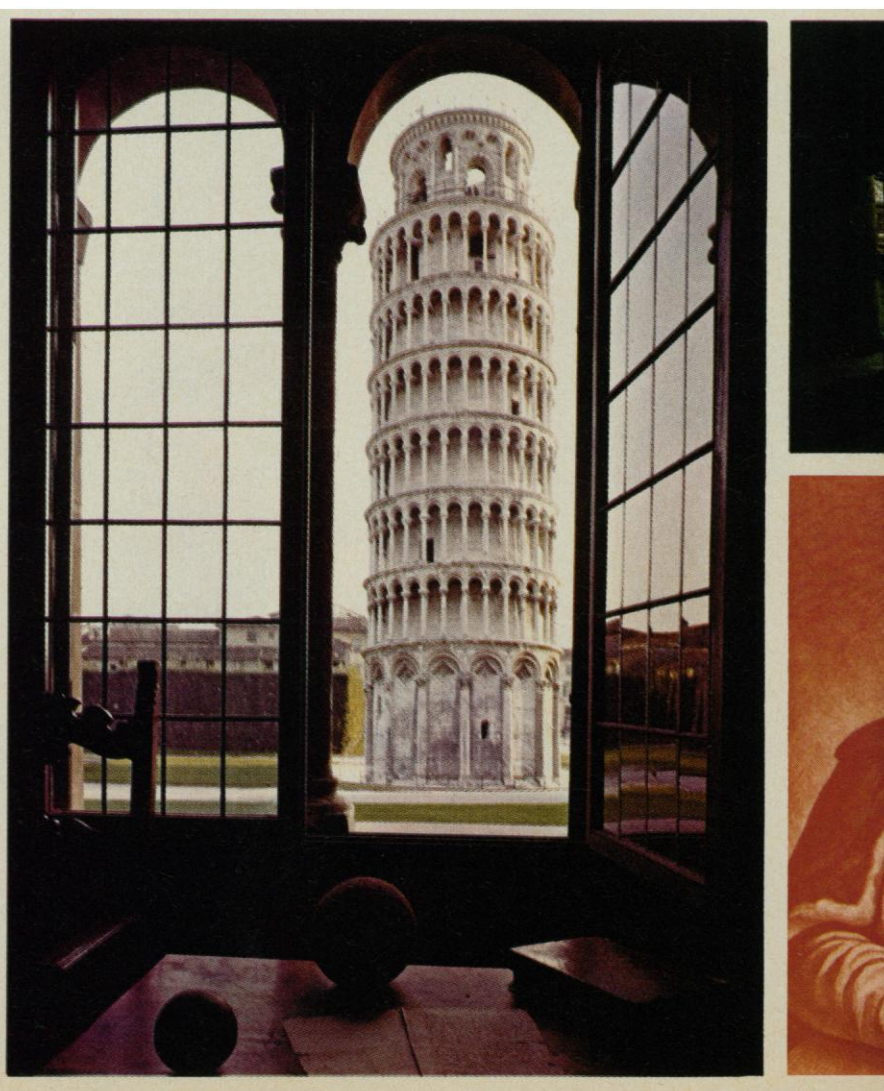
Marconi's wireless work is to be seen in our next stop, **39** Bologna.

Florence. **40** The Istituto Museo di Storia della Scienza. Galileo's telescopes. Next, a visit to **41** the house in which Galileo was imprisoned from 1633 to his death in 1642.

42 More Galileo in Pisa. The leaning tower was made to order for his earthshaking experiments on the nature of falling bodies.

43 Rome. The Accademia Nazionale de Lincei in the Palazzo Corsini.

44 The Academie Nationale de France.



45 The observatory of the Collegio Romano, where Jesuit astronomer Father Angelo Secchi (1818-1878) made the first spectroscopic survey of the heavens.

46 Museo Copernico ed Astronomico where Polish Astronomer Nicolas Copernicus did much of his early work.

47 Naples. The Zoological Station.

48 University of Padua. The anatomical theater was built in 1594 by Fabricius of Acquapendente, a pioneer of the comparative method of anatomical research and discoverer of valves in the veins.

Vienna. 49 The Pharmakognostisches Institute, which houses a museum of 10,000 items of scientific interest.

50 A reconstructed apothecary, laboratory and print shop in the Technisches Museum fur Industrie und Gewerbe.

Czechoslovakia. Gregor Mendel did his landmark work in genetics in a 51 monastery in Brno.

Still in Prague. 52 Charles University where you will visit the rooms in which Einstein, Ernst Mach and Philipp Frank taught and worked.

Germany. Munich. 53 The Deutsches Museum. Reconstruction of the laboratories of Lavoisier and Liebig.

54 The werner von Siemens institute, where electrical engineering and research are traced from 1850.

Heidelberg. 55 The Deutsches-Apotheken Museum, an ancient castle packed with apparatus and drugs, vessels and relics.

56 The Deutsches-Roentgen Museum in Remscheid preserves Roentgen's apparatus, including a 1905 X-ray lab.

57 The Deutsches Gesundheit-museum in Cologne.

Berlin. 58 Chemistry Institute, where Otto Hahn split the uranium atom in 1938.

East Berlin. 59 The Robert Koch Museum. Koch, co-father of modern bacteriology, used glass slides to grow cultures until his assistant, Julius Petri, invented the glassware that carries his name.

60 The home and garden of Alexander V. Humboldt.

61 The library of Max Planck.

62 Charité Hospital where Rudolph Virchow, founder of cellular pathology, first described leukemia.

Cracow, Poland. 63 Collegium Majus for a look at the telescopes of Copernicus.

A jet to Rumania and a drive to Cluj for a visit to 64 an 18th-century apothecary shop.

Greece. 65 The Lyceum, where Aristotle taught from 355 B.C. until just before his death. 66 Plato's Academy.

Istanbul. 67 Pergamon where Galen practiced medicine.

Bombay. 68 The Tata Institute of Fundamental Research, devoted to nuclear research, computer science, molecular biology, radioastronomy, and mathematics.

69 The Bhabha Atomic Research Center is India's national center of research for the peaceful use of atomic energy.

70 The Yoga Institute. Here you can learn Yoga culture, technique and scientific discipline.

Russia. 71 Academy of Sciences in Leningrad. Pavlov's lab.

72 The Anthropological and Ethnographical Museum.

73 The Mendeleyev Research Institute.

Moscow. 74 The National Economic Achievements Exhibition.

Tokyo. 75 The Kitasato Institute, founded by Baron Shibasaburo Kitasato who isolated the agents which cause bubonic plague and dysentery.

You're back on American soil when you visit 76 the Hawaii Volcano Observatory.

To wind up your trip we want to

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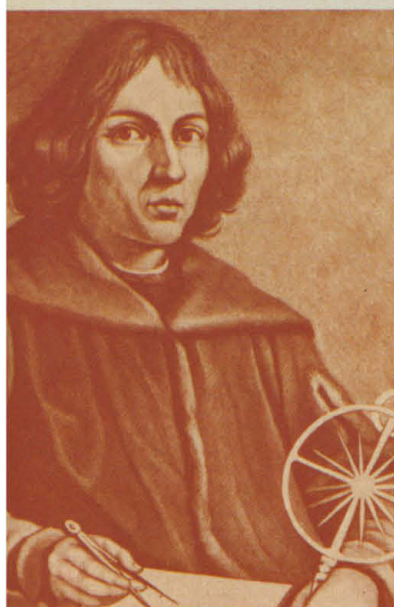
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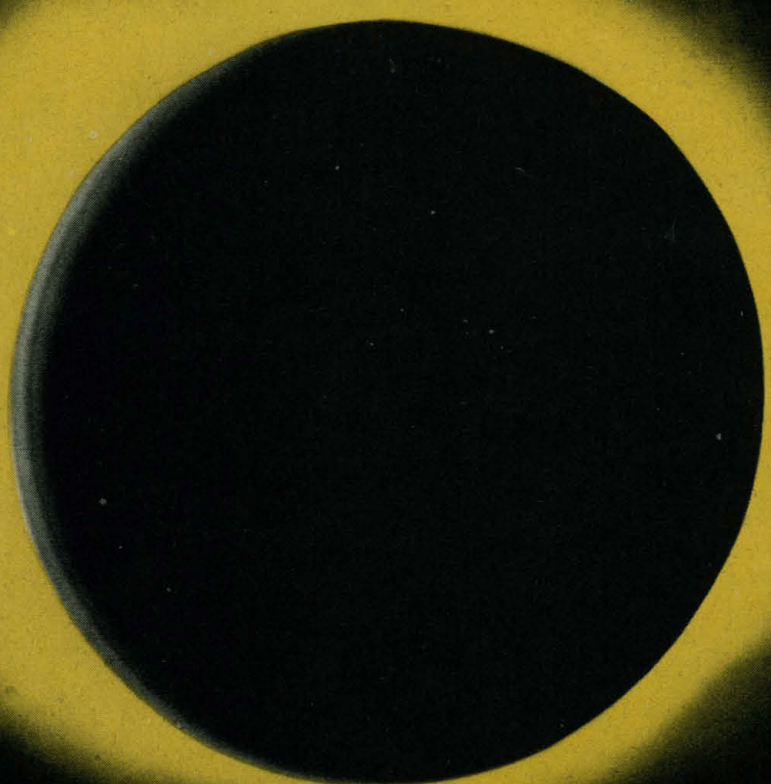
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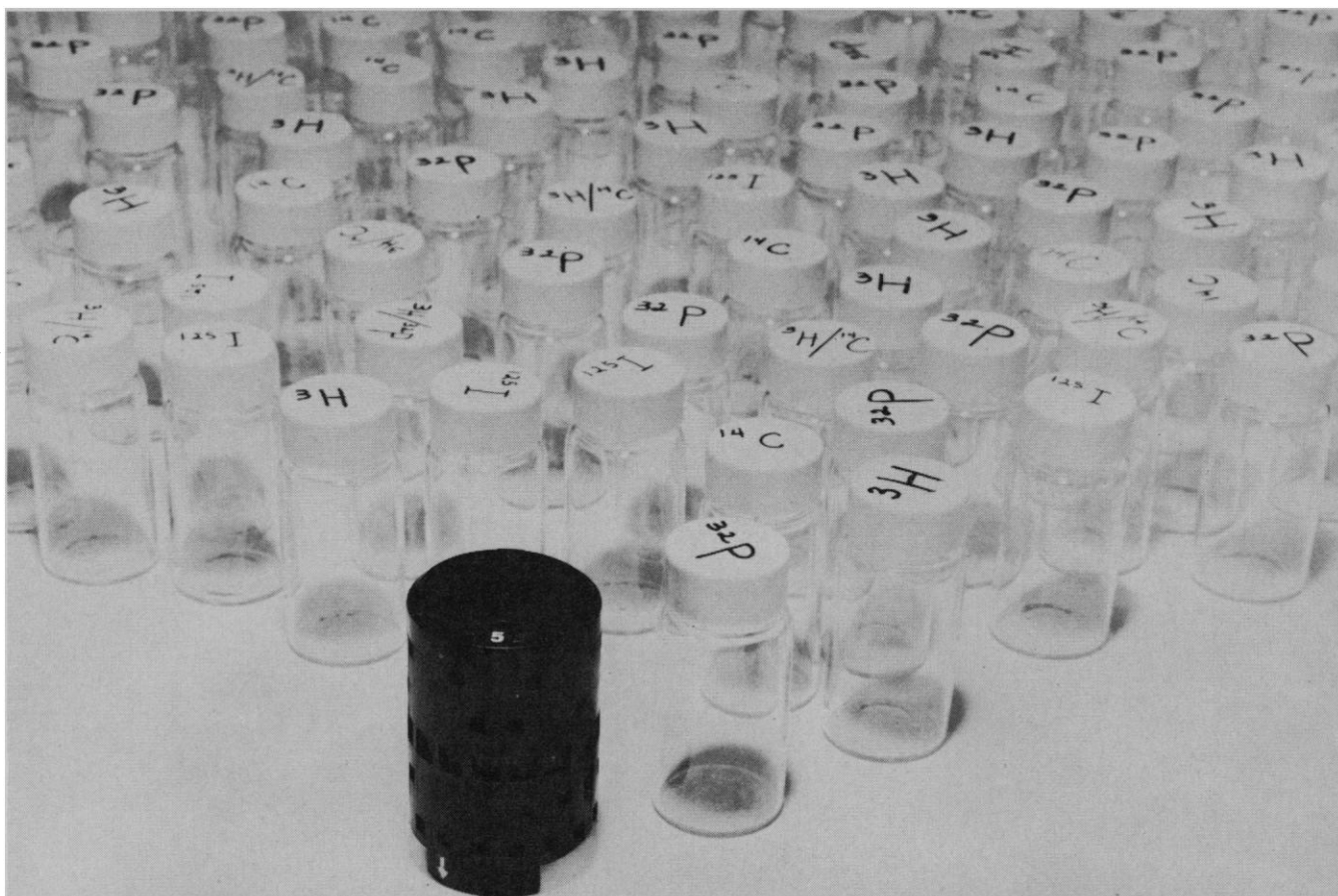


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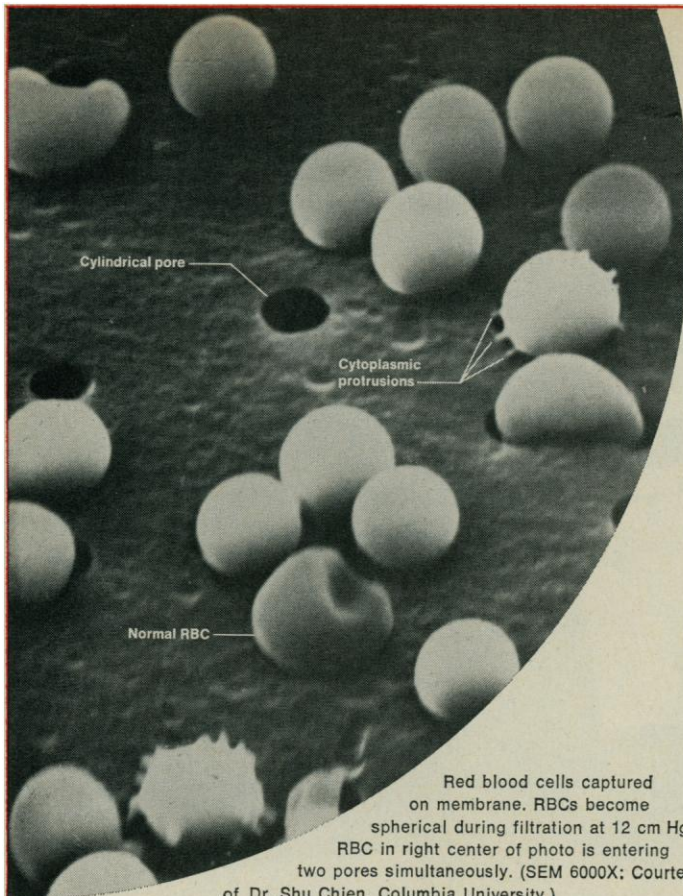
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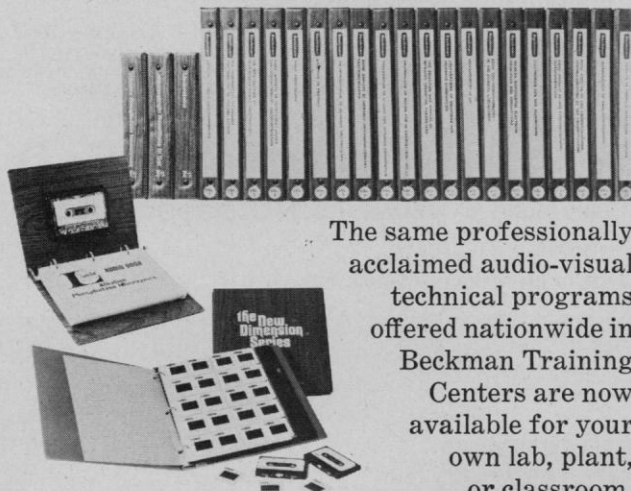
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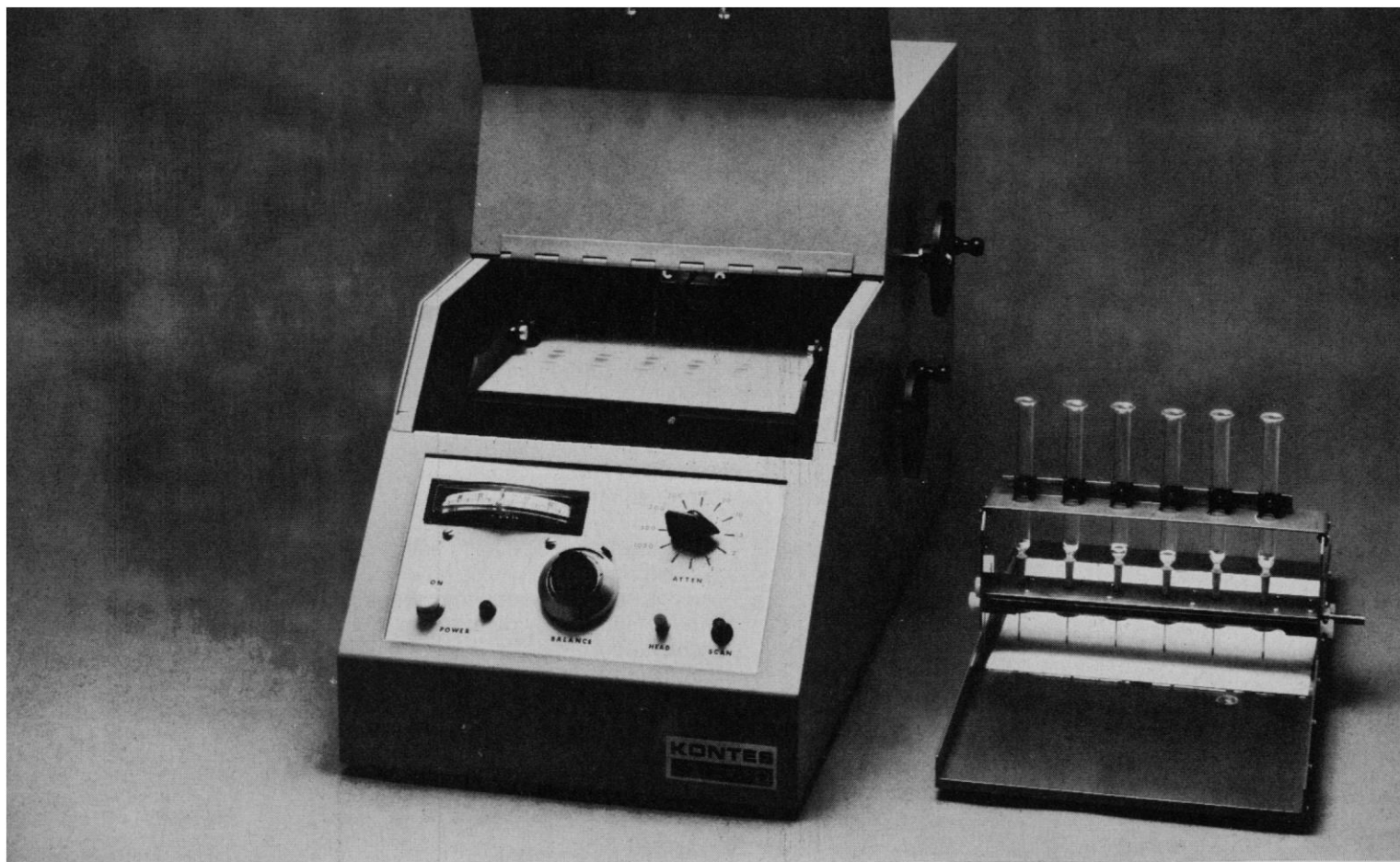
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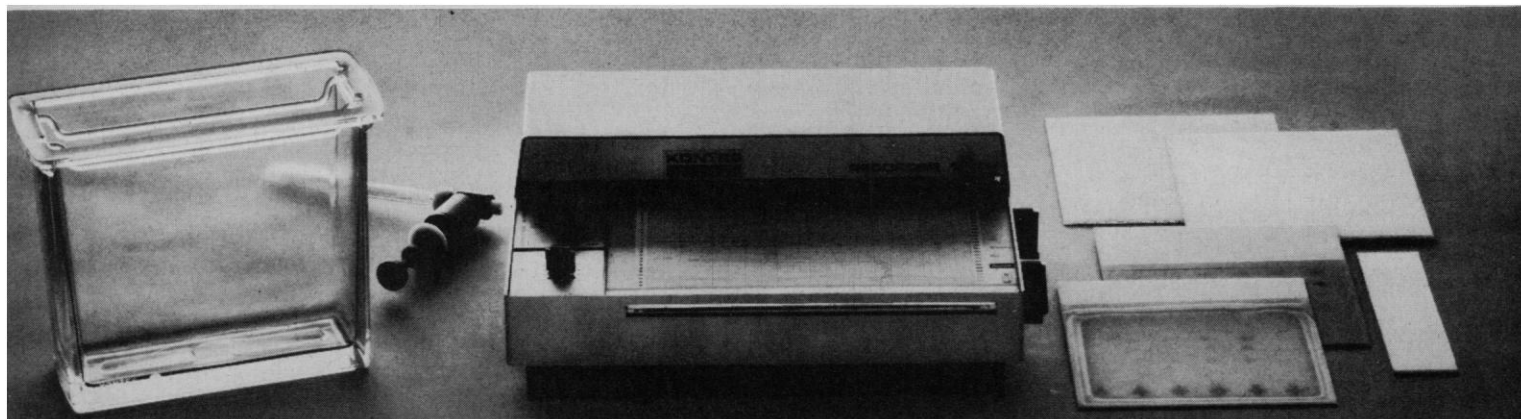
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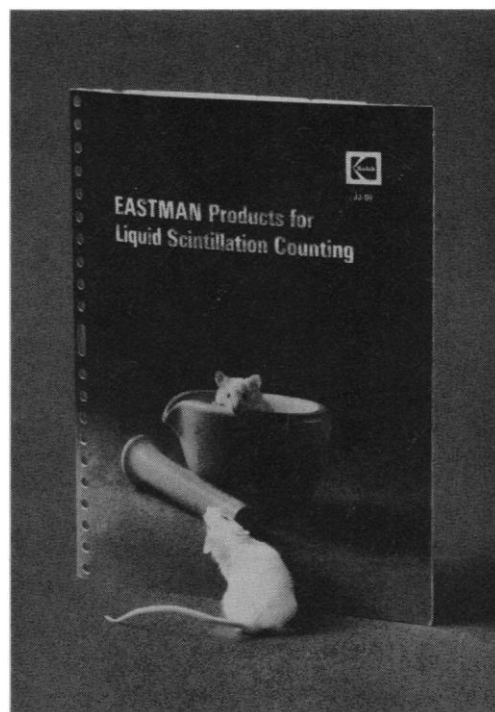
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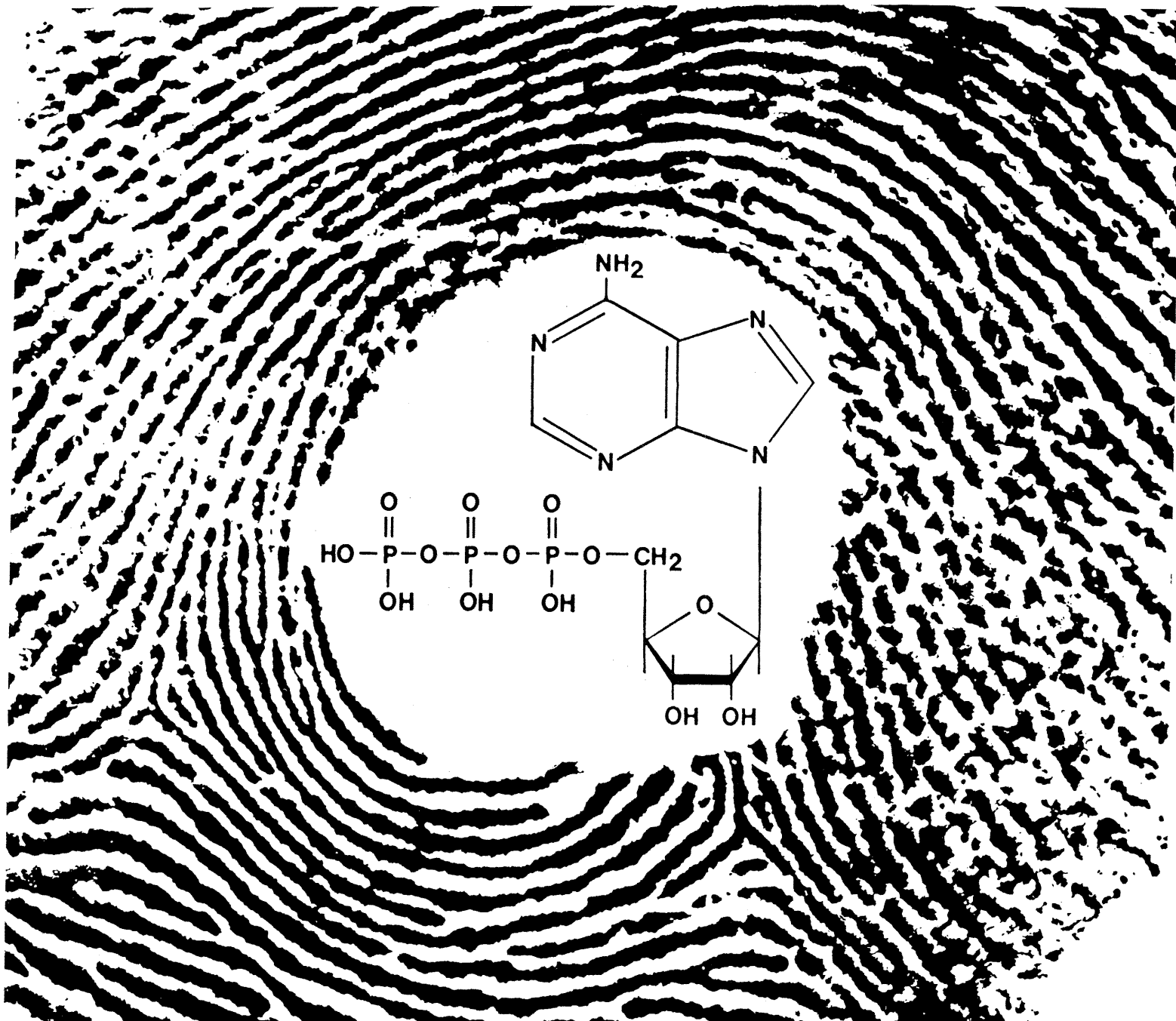
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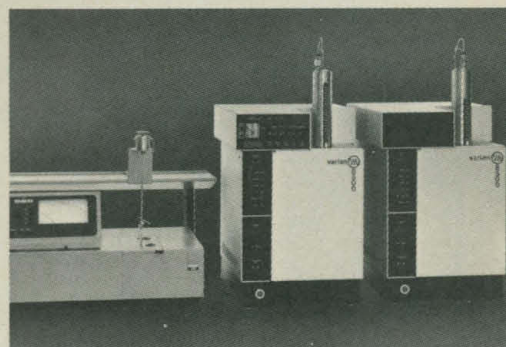
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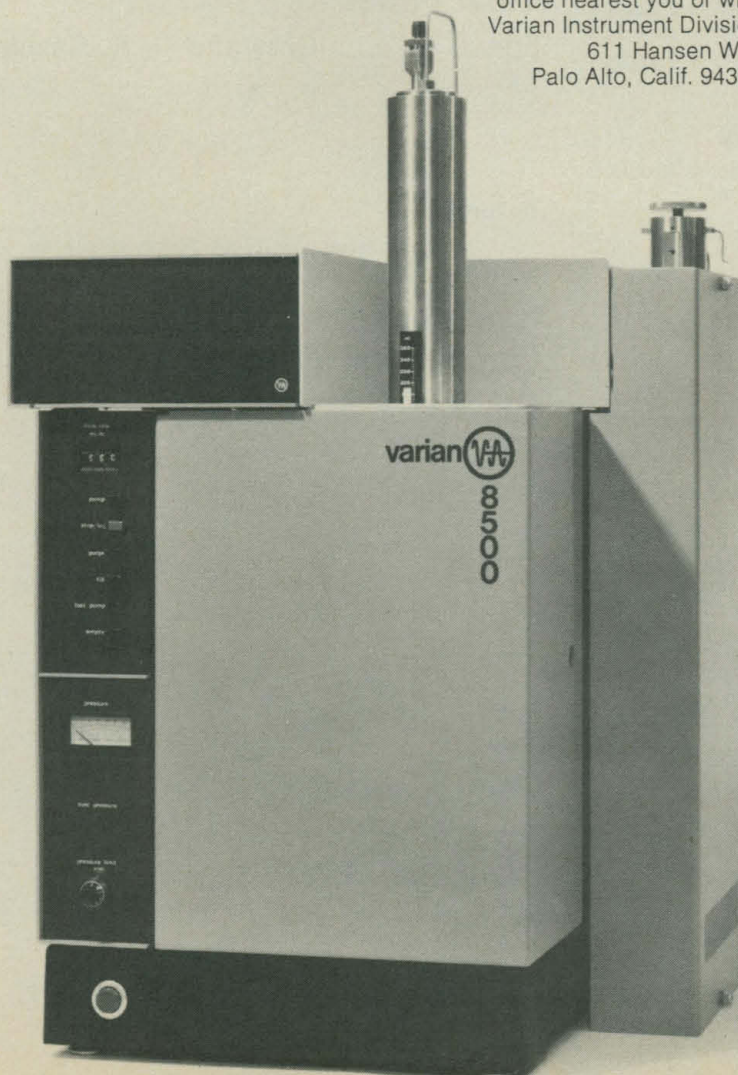
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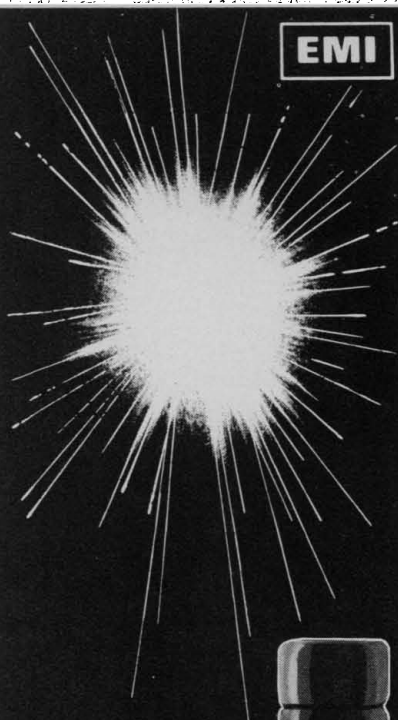
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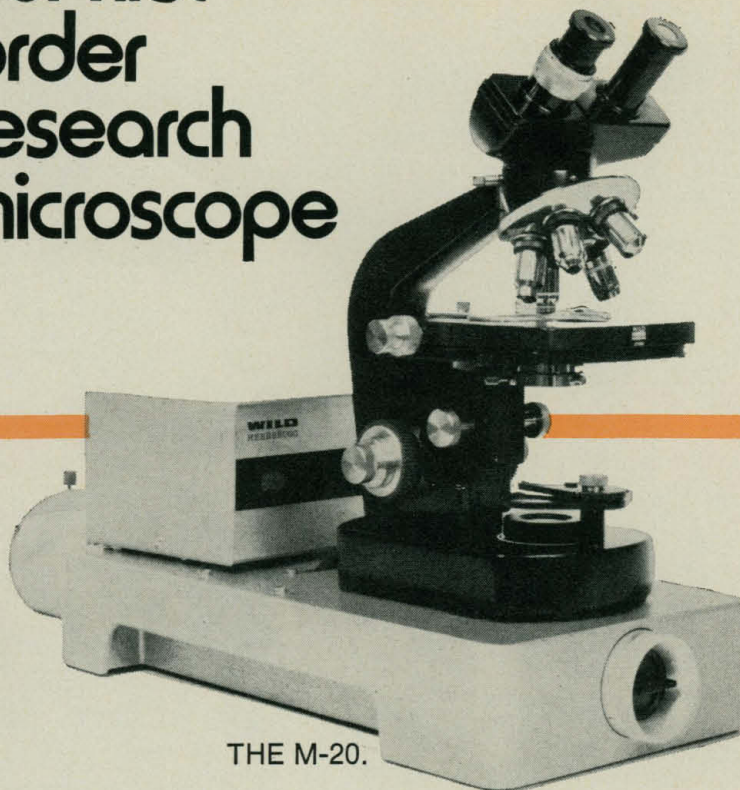
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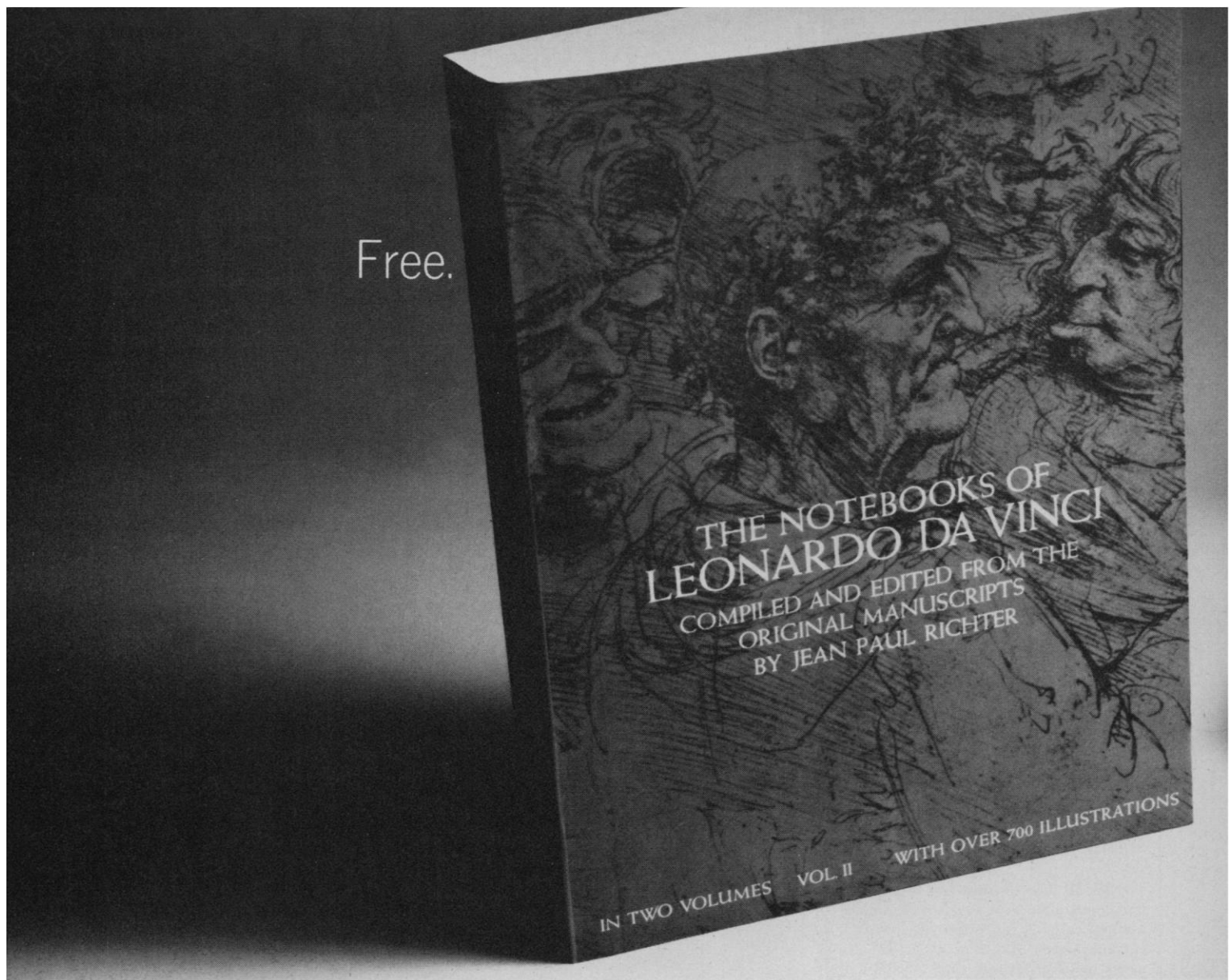
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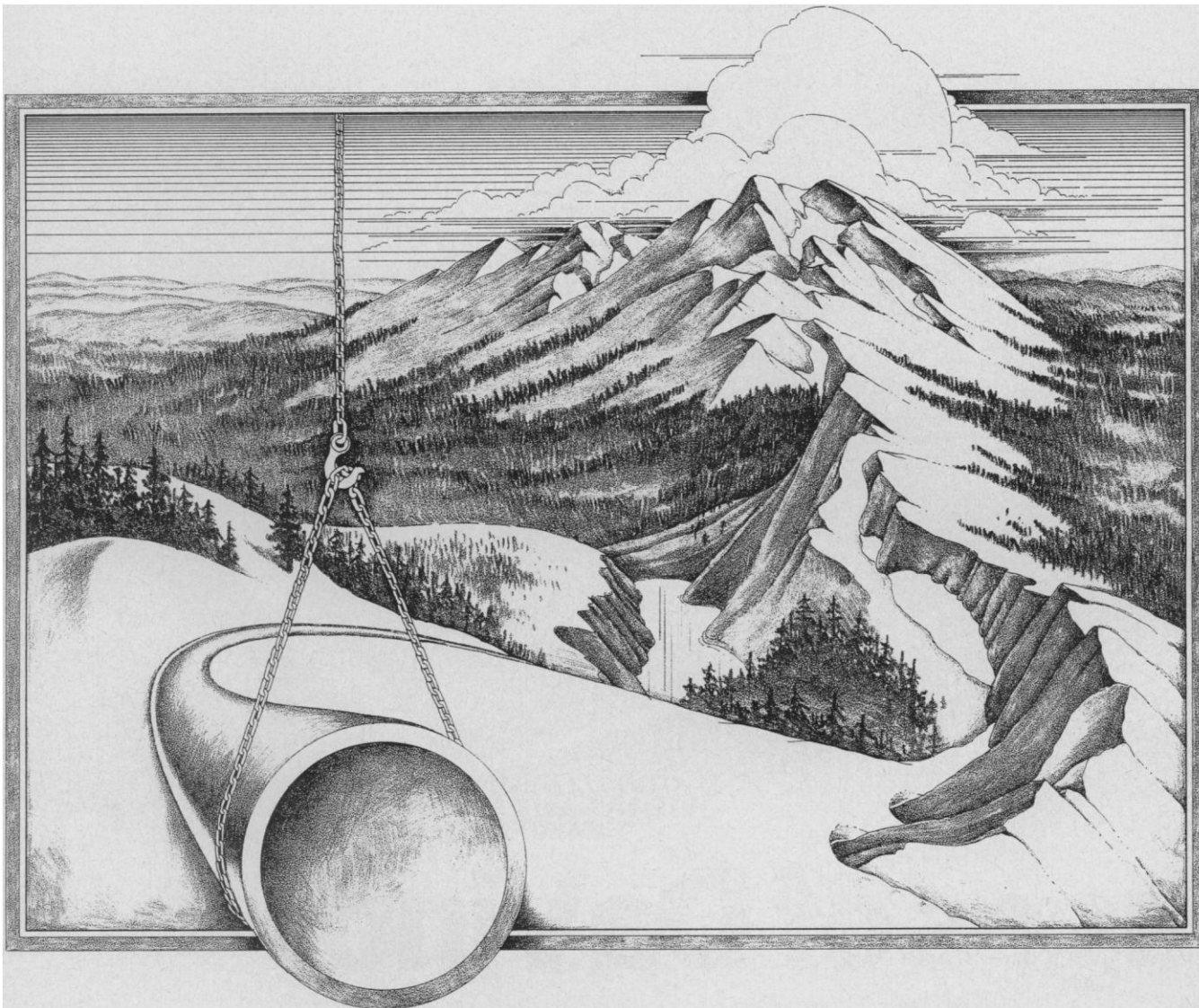
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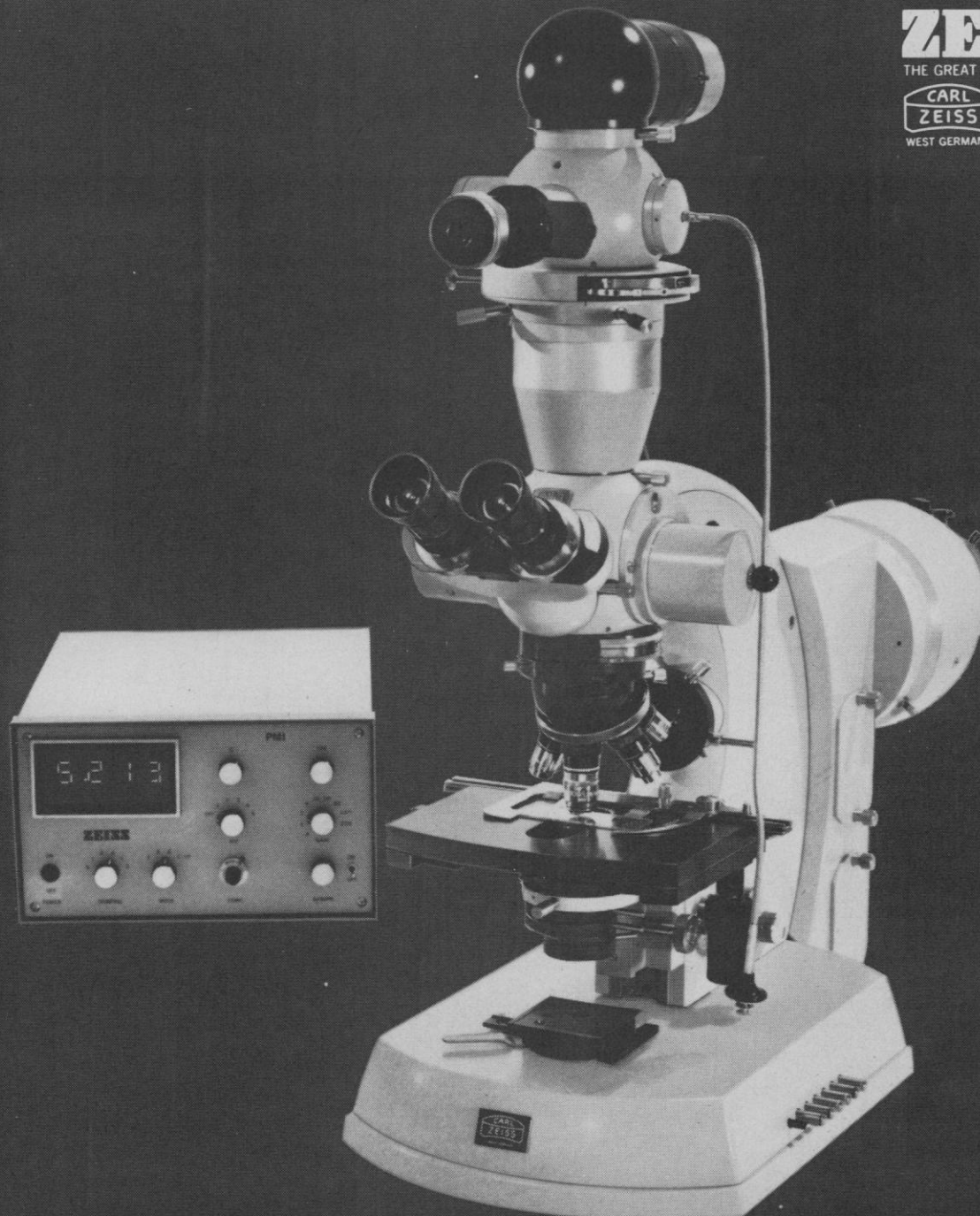
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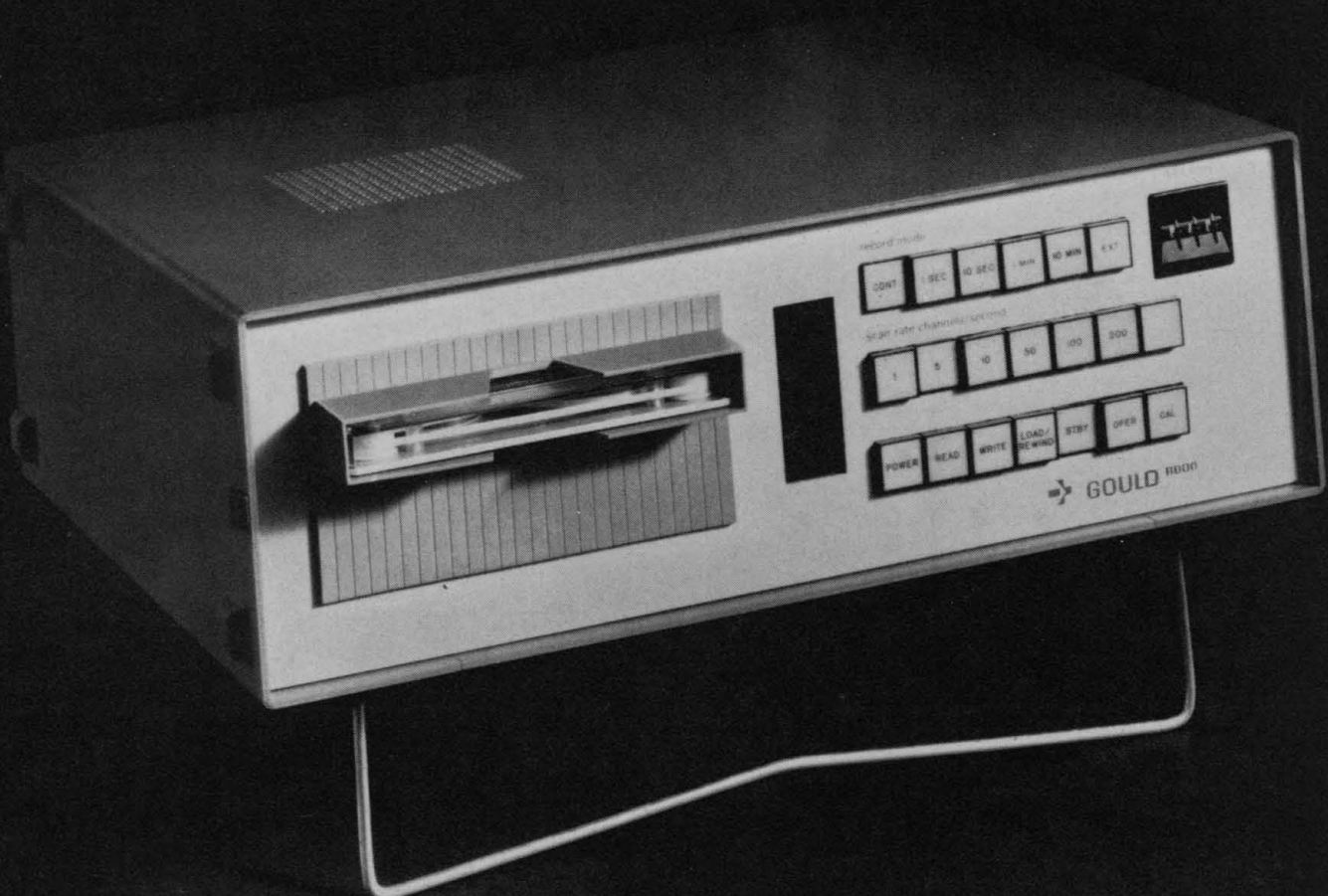
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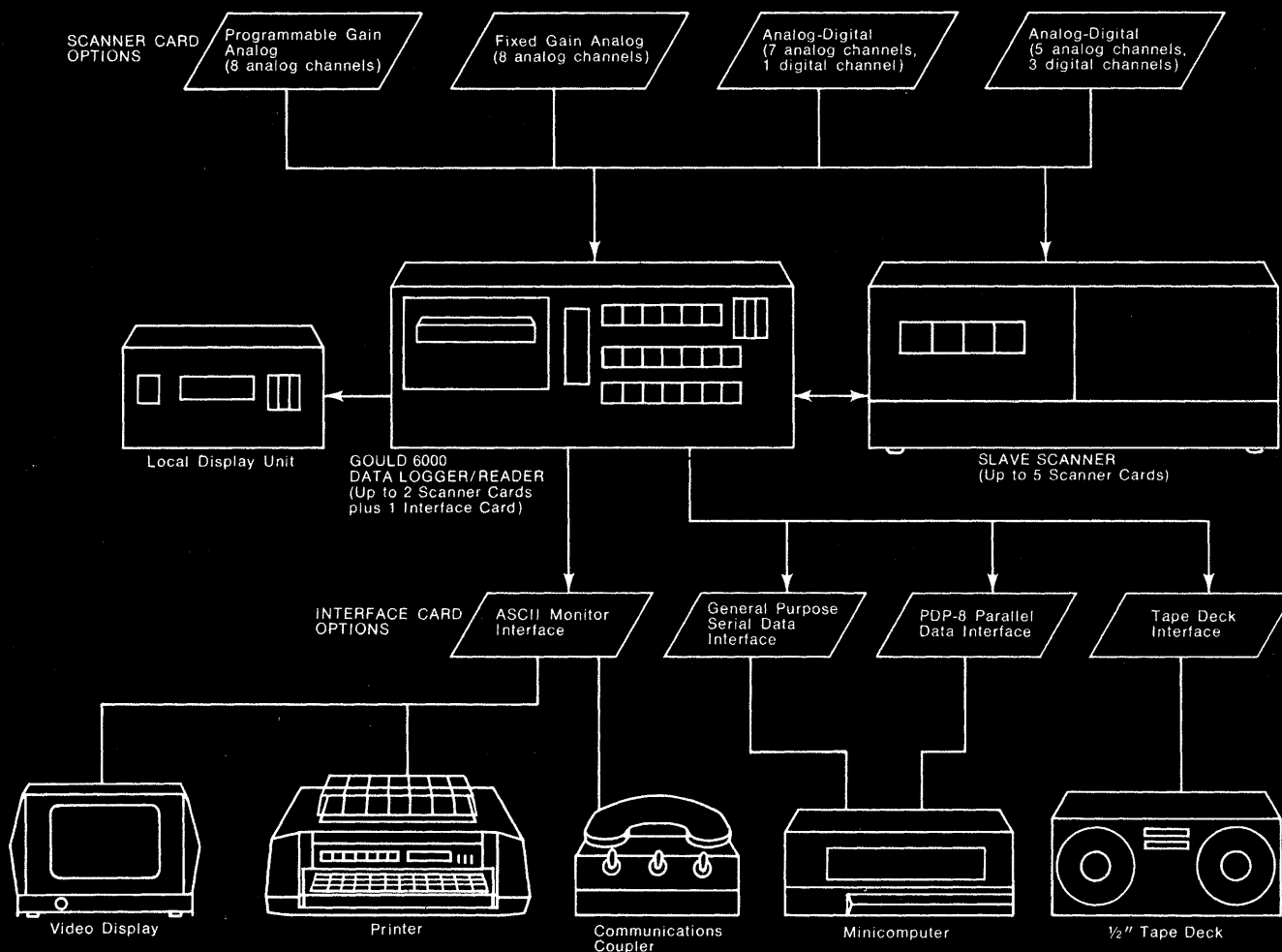
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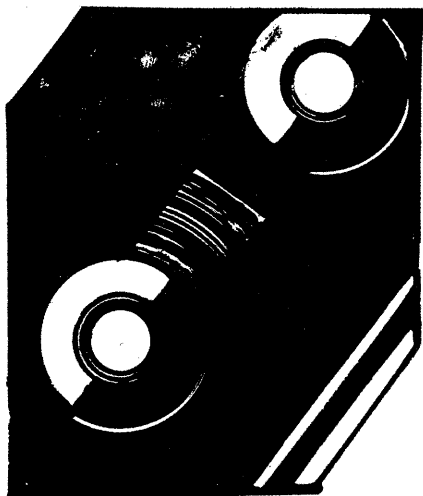
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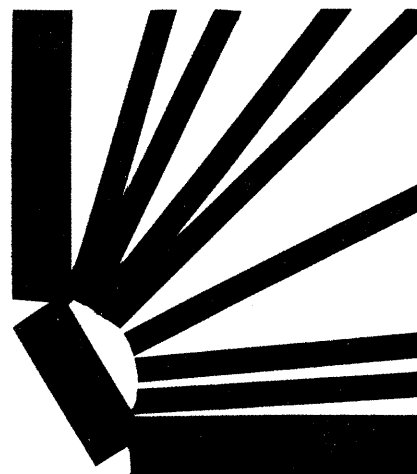
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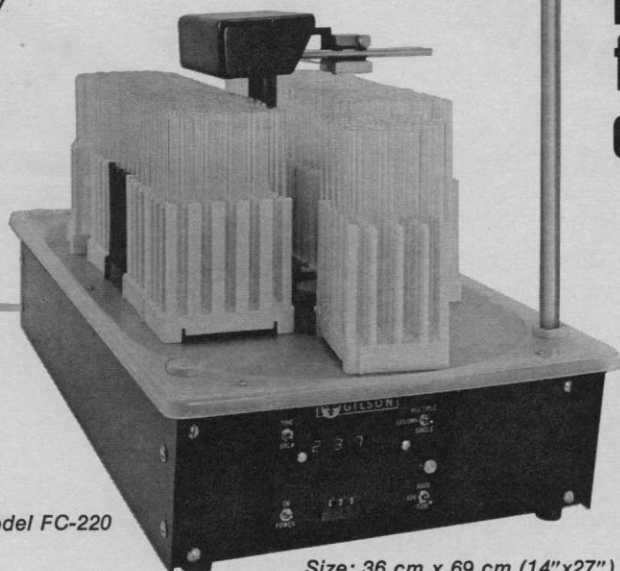
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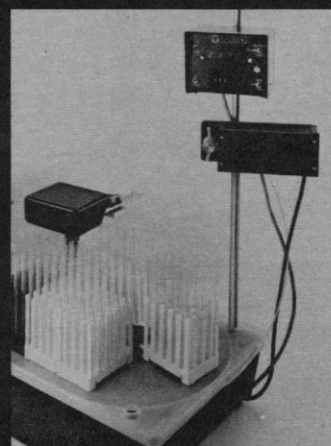
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Gasoline

Recently, Professor Marvin Paul of the City Colleges of Chicago suggested to *Science* that we devote an entire issue to energy. The idea was received with skepticism, but consultation with readers scattered across the United States caused us to proceed. The decision was taken February 4. Publication of the issue at this time was made possible by unusually good cooperation of both contributors and staff.

The content of this issue was chosen to present material relevant to important public decisions of the next few years. Some such topics have been recently treated in *Science** and repetition here was unwarranted. Other topics will be dealt with later.

One important matter not covered specifically in the following articles is gasoline and the automobile. Special notice seems desirable, for those long lines at the service stations are telling us something. When people are willing to appear at 5 a.m. at a station that is not scheduled to open until 8 a.m., they convey a message about the importance that many people attach to their automobiles. In part the attachment is economic. To many people, auto transportation is essential to their livelihood. In part the attachment is emotional, as Kenneth Boulding suggests in an article in this issue. Whatever the source of the demand, it would be politically impossible to force people this summer to get along on supplies as limited as those of February 1974. In future years as people adjust, as they change to vehicles consuming less gasoline, the acceptable level of supplies may drop. For this year and probably the next few years, a minimum acceptable daily consumption averaged over the whole year is about 6.2 million barrels a day or about 5 percent less than we consumed in 1973. Such a level would entail tension and grumbling.

With present-day refinery practice, a demand of 6.2 million barrels a day for gasoline fixes a minimum value for the input of crude oil. In typical instances, 48 percent of the crude petroleum is converted to gasoline. Thus to supply the minimum demand for gasoline, something like 13 million barrels of petroleum must be processed. Our total consumption of oil and its products has been averaging about 17 million barrels a day and our total production of crude oil and condensate has been about 11 million barrels a day. These figures indicate the central importance of gasoline consumption in dictating needs for crude oil. They also show that, in order merely to obtain enough gasoline, large quantities of gasoline or crude oil must be imported. There are, of course, other important uses of the gasoline chemicals in oil that will increase the lower limit on our need for oil.

Because of the central role of gasoline in energy problems, especial efforts should be made both to decrease demand and increase supply. Had we been driving smaller, less gas-consuming cars, there would have been no energy crisis. Some other forms of transportation consume less gasoline, and their use should be encouraged.

In principle, the oil companies could increase the yield of gasoline from crude oil. This would require changes in refineries. Today about 10 percent of the energy of crude oil is used in providing heat for the refining processes. In principle, this heat could be furnished by coal. Through more intense input of hydrogen in the cracking process, larger yields of gasoline could be obtained. One refinery expert has guessed that yields might be raised to as high as 75 percent from the present 48 percent. Such a shift would entail other shifts in the product patterns and in the consumption of hydrocarbons.

The barriers to increased yields are costs and time, but these can and should be overcome. Petroleum is too important to be used merely as a source of heat.—PHILIP H. ABELSON

* For a list of selected material related to energy that has appeared in *Science*, see page 386 of this issue.

The most sensible way to help solve the energy shortage is to generate more electricity.

More, not less. And from coal.

Ridiculous? Hardly.

It is, rather, a logical conclusion after cold analysis of America's plight, and energy resources.

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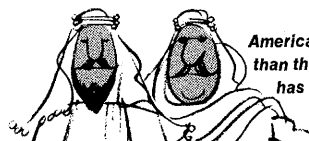
1. We do have an energy crisis. More specifically, we have an oil and natural gas crisis.
2. We need to take a hard look at all the fuels we have, then make it possible to use each wisely for its most critical use.
3. America has a vast amount of coal—about half the world's known supply, or enough to meet our energy needs for 500 years.
4. Coal should be used instead of oil to generate electricity wherever practical, thereby saving a staggering amount of oil.
5. Electricity generated by coal can be used instead of oil and gas for countless energy needs, with a few exceptions—such as some forms of transportation.
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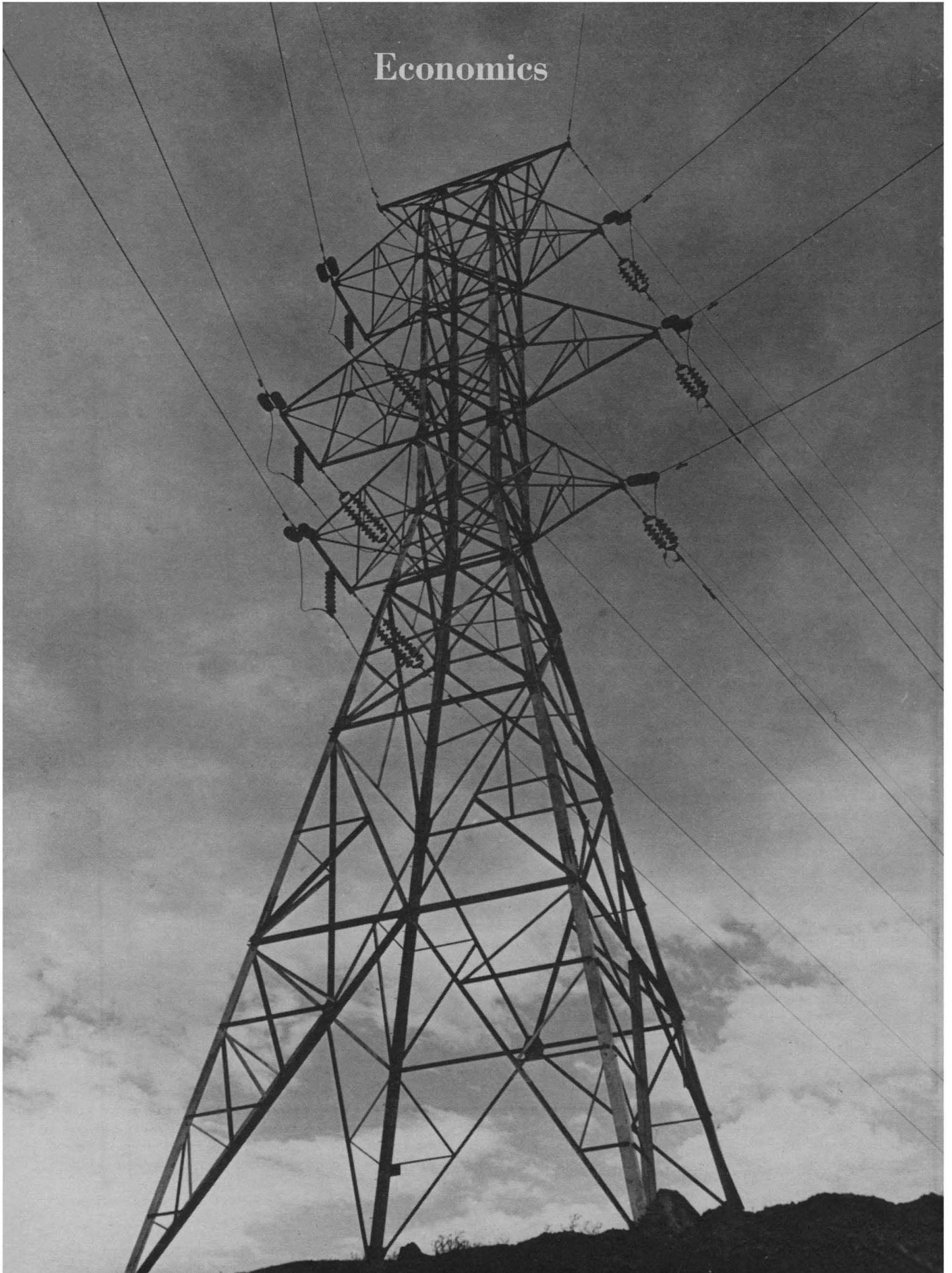
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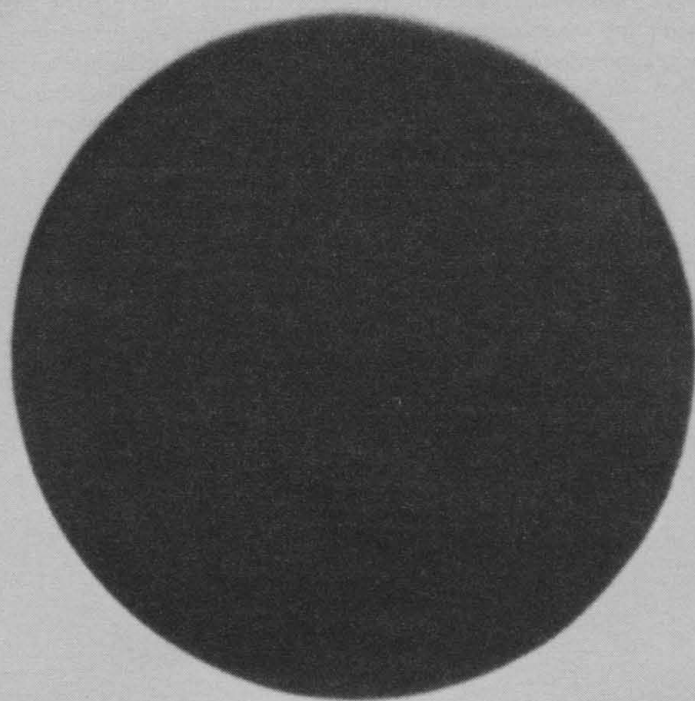


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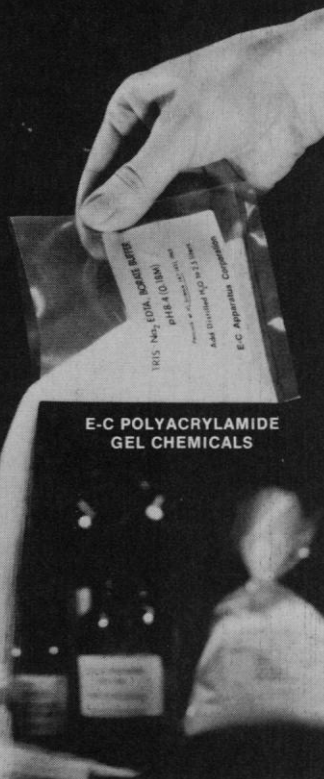


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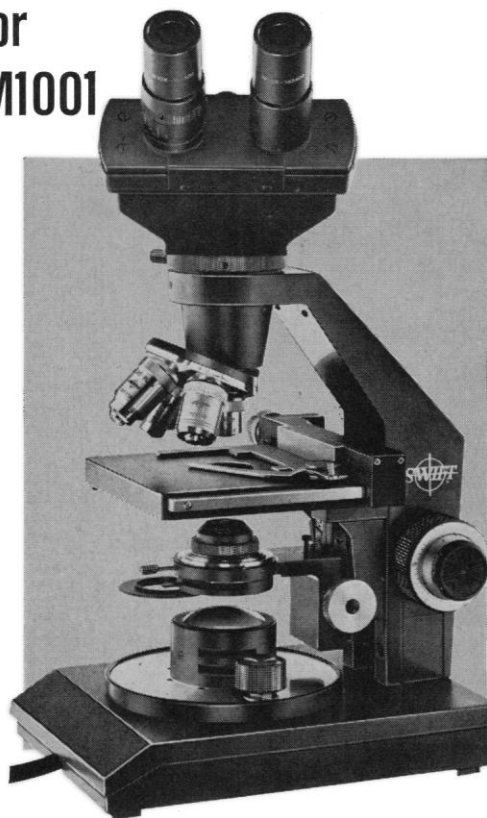
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Group III: Staff-Written Articles—

Research News

Energy and the Future, a AAAS book by Allen Hammond, William Metz, and Thomas Maugh II contains 22 articles that take a long-range look at energy. The book is based on a series of articles in *Science*, \$4.95 (\$4.45 members' price) paperbound. \$9.95 (\$8.95 members' price) casebound. Titles are as follows:

- "Energy from Fossil Fuels"
- "Gasification: A Rediscovered Source of Clean Fuels"
- "Power Gas and Combined Cycles: Clean Power from Fossil Fuels"
- "Magnetohydrodynamic Power: More Efficient Use of Coal"
- "Nuclear Energy"
- "Fission: The Pro's and Con's of Nuclear Power"
- "Breeder Reactors: The Future of Nuclear Power"
- "Alternative Energy Sources"
- "Geothermal Energy: An Emerging Major Resource"
- "Solar Energy: The Largest Resource"
- "Photovoltaic Cells: Direct Conversion of Solar Energy"
- "Fuel from Wastes: A Renewable Energy Source"
- "Magnetic Containment Fusion: What Are the Prospects?"
- "Laser Fusion: A New Approach to Thermonuclear Power"
- "Energy Transmission"
- "Transmission Lines: Three New Ways to Carry Electricity"
- "Fuel Cells: Dispersed Generation of Electricity"
- "Hydrogen: Synthetic Fuel of the Future"
- "Energy Conservation"
- "Conservation of Energy: The Potential for More Efficient Use"
- "Energy Needs: Projected Demands and How to Reduce Them"
- "Energy and the Future: Research Priorities and Energy Policy"

Additional Articles on Energy Topics

- A. L. Hammond, "Solar Energy: Proposal for a Major Research Program," **179**, 1116 (1973).
 W. D. Metz, "Ocean Temperature Gradients: Solar Power from the Sea," **180**, 1266 (1973).
 A. L. Hammond, "Dry Geothermal Wells: Promising Experimental Results," **182**, 43 (1973).

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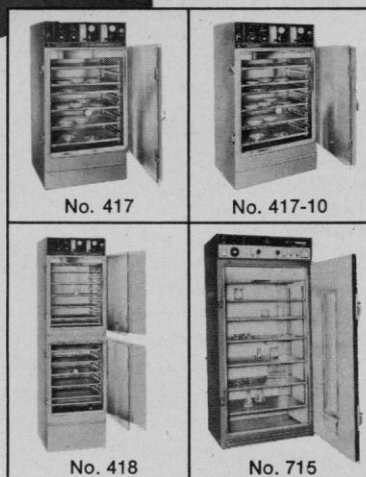
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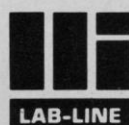
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