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SCIENCE

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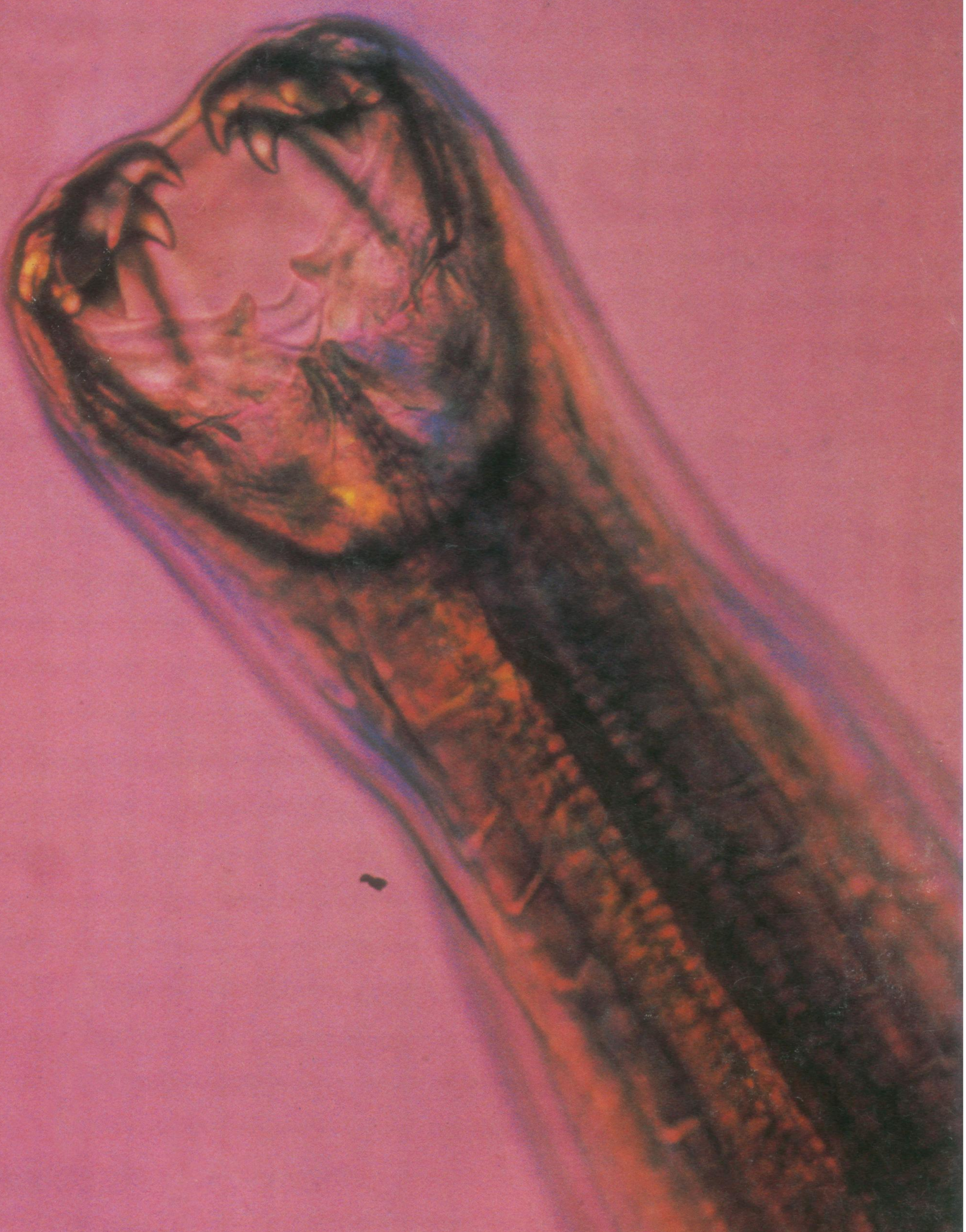

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SCIENCE

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11 Questions to ask before you buy an automated DNA synthesizer.

1 Do I really need an automated DNA synthesizer?

The answer depends on your requirements for custom oligonucleotides. If you need more than one oligomer per month, an automated DNA synthesizer will be a good investment. However, if you use less than one per month, you should consider ordering custom oligomers or synthesizing them manually.

2 What advantages will an automated synthesizer provide?

An automated DNA synthesizer will perform all of the time-consuming procedures necessary to synthesize an oligomer—without the error potential inherent in manual methods. You'll be able to synthesize more product in far less time, and you'll be freed to dedicate your energies to other important tasks.

Another advantage is around-the-clock synthesis operations. If you select a quality synthesizer—such as the Coder™ 280—you'll be able to run syntheses 24 hours a day. That can further enhance your productivity.

3 How much does an automated DNA synthesizer cost?

The purchase price of an automated DNA synthesizer will range from about $21,000 to $68,000.

But you should consider the reliability of the equipment and the manufacturer's dedication to service. Downtime or long waits for service can impede your productivity, costing you valuable time and expensive chemicals.

4 What are the differences among the DNA synthesizers currently available?

Every synthesizer on the market today does basically the same thing. The primary differences are in the modes of fluid movement (pump or pressure driven), the type of reaction chamber (flow-through column or agitated vessel), and the number of reagent reservoirs. All types have been proven effective.

Nevertheless, in evaluating synthesizers, be sure to consider the reputation of the manufacturer and the experience of the company's scientific personnel.

5 Will a synthesizer do all the work?

All synthesizers will do the work involved in the synthesis itself, and some systems also will cleave your product from the resin. However, your product will be in crude form at this point, requiring purification by HPLC, electrophoresis, or other methods.

6 What kind of results will an automated DNA synthesizer produce?

You can expect results equal to those produced by manual synthesis techniques. Yields will average around 95% per base coupling, provided that you use high-quality reagents and take care in handling these materials. But even the best reagents handled with the utmost care will occasionally generate yields lower than 95%, regardless of some manufacturers' claims.

7 Which chemistry is best?

There are basically two types of solid-phase chemistry being used: phosphate-triester and phosphite-triester. Each has its advantages and disadvantages, depending on the specific requirements of your synthesis operations, and each has been proven to produce quality results.

The best choice is a synthesizer that can perform all solid-phase chemistries, rather than a system that is limited to only one method.

8 How much will it cost to run a synthesizer?

Exact figures are difficult to project, given the wide range of costs for chemicals and other factors. However, you should be able to produce 5 O.D. units of a purified pentadecamer for less than $125 for all reagents and solvents.

9 What problems should I anticipate with an automated synthesizer?

Even the best laboratory equipment will experience some downtime, and lesser quality synthesizers may break down or malfunction frequently, especially if they are being used continuously.

As a consequence, you should choose a manufacturer who has a qualified, responsive field service department—one that can provide both on-site and over-the-phone technical assistance and support.

10 Can the synthesizer's microcomputer be used for other duties?

If the synthesizer has a stand-alone microcomputer as a controller, such as the Coder 280 with Apple //e™ the answer is yes. The controller can then provide your lab with additional computer capabilities such as statistical analysis, word processing, and other lab management functions.

11 Will an automated DNA synthesizer do peptide synthesis as well?

If your synthesizer is user programmable, it is possible to do solid-phase peptide chemistry. However, it is not very practical because peptide syntheses usually require a minimum of 1 g. of resin and DNA synthesizers are designed to accommodate not more than 200 mg. of resin.

Furthermore, most DNA synthesizers are not designed to handle corrosive reagents such as trifluoroacetic acid. Versatile peptide synthesizers are.

Vega Biotechnologies wants you to be fully informed about automated DNA synthesizers—before you make your decision.

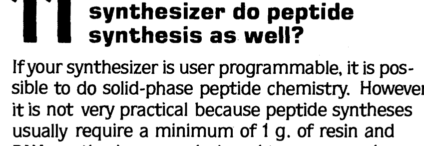
We invented the automated DNA synthesizer, and we offer the widest range of systems—including our Coder 280 with Apple //e microcomputer.

If you're in the process of evaluating synthesizers, or if you've simply been thinking about automating your DNA syntheses, call us toll-free at 800-528-4882. We'll send you more detailed information on our DNA synthesizers, answer any other questions you might have, and arrange a free demonstration.

The bottom line is this: Make sure you understand everything about automated DNA synthesizers before you invest in a system.

Vega Biotechnologies can help.

Call us, today.



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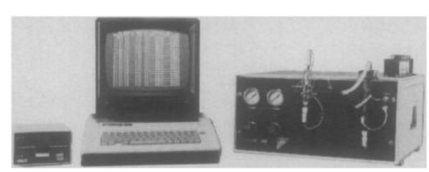

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LETTERS

Base SI Units

I read with interest the article "Using time to measure length" by Arthur L. Robinson (Research News, 24 June, p. 1367). I would like to point out that the seven base units of the International System of Units specify standards for time, distance, mass, temperature, current, amount of substance, and luminous intensity; the last two quantities were replaced by voltage and resistance in the article.

ALVIN WALD*
Department of Anesthesiology, Columbia-Presbyterian Medical Center, 630 West 168 Street New York 10032

*Chairman, Standards Committee, Engineering in Medicine and Biology Society, Institute of Electrical and Electronic Engineers.

Floating Accelerator

Reading "Neutrino exploration of the earth" by M. Mitchell Waldrop (Research News, 10 June, p. 1142) brought to mind the original tongue-in-cheek suggestion of a floating accelerator by William A. Shurcliff in *Science* (Letters, 5 November 1965, p. 685). Shurcliff's letter predates by 7 years the suggestion by Alvaro De Rújula, Georges Charpak, Sheldon Glashow, and Robert Wilson of a floating accelerator mentioned by Waldrop. Shurcliff's letter is uproariously funny and, in my opinion, deserves republication in view of its prophetic nature.

HERMAN WINICK
Stanford Synchrotron Radiation Laboratory, Stanford, California 94305

We reprint below the prophetic letter.—Eds.

Floating Accelerator: Progress at Last

It has been a pleasure to observe, during the last 6 weeks, increasing interest among policy makers in the proposal that the 200-Gev proton accelerator be located on a large, specially designed, floating platform. Long recognized as offering unique advantages of flexibility of use and economy of construction, the plan has been plagued by questions of safety. Happily, these have been solved, and, according to a report soon to be issued by the Conference of Eastern Coastal Universities (CECU), full-scale consideration of the plan is now warranted.

The report stresses two main design goals: (i) avoidance of extensive use on land and (ii) transferability of the accelerator from one harbor to another at approximately 6-month intervals. Preliminary engineering surveys show that the harbors of New York, Philadelphia, Baltimore, Boston, and Norfolk, Virginia, are almost ideal for the purpose, and West Coast harbors could be used after the widening of the Panama Canal is completed.

The accelerator, of strong focusing (alternating gradient) type, would be incorporated in four floating platforms, each about the length and width of a modern 100,000-ton oil tanker. Each would have the form of a quadrant of a circle, and the four units would be joined (by a precision key system and giant hydraulic clamps) to form a single rigid ring. Prior to the clamping operation, ballast tanks in each quadrant would be flooded with sea water to appropriate depth to bring the quadrants to the same level. Thanks to the slight elasticity in the integrated structure, fine-scale alignment of the quadrants of the synchrotron itself can be accomplished by fine adjustment of the water levels in these tanks.

The diameter of the accelerator is relatively small: 400 meters. Correspondingly more powerful magnetic guide fields are provided by 60-kilogauss superconducting magnets of low-inductance design in a multiple-pyramiding arrangement which provides especially tight control of betatron oscillations without significant increase in the period of the synchrotron oscillation (except at injection, when special pentapole magnets of diamagnetic ferrite are superimposed on interphased counterfields).

Plans for the linac injector are still tentative, but may call for a 1500-foot 1-Gev traveling-wave assembly mounted on two aligned concrete barges to be held by slender, prestressed-concrete equants in rigid tangential orientation.

The ring of 1024 magnets, located in a common circular tunnel running through all four platforms, will be situated 6 meters below the waterline, so that adequate shielding is provided, at no expense, by the surrounding water. A protective screen of nylon netting will probably be mounted some 10 or 20 meters from the quadrants to keep fish away and thus prevent radiation damage to them. The use of such a screen was suggested by the Izaak Walton League.

Although shielding, cooling, and electrical grounding present no problems (thanks to the unlimited amount of sea water available), the provision of adequate power poses problems. Because city electric power, supplied to the accelerator via submarine cables, may be in short supply during the daytime, the accelerator may have to be operated at night only. (If so, tourists could visit the accelerator during the day, and the entrance fees charged might pay a significant fraction of the operating cost.)

When repair work must be performed in the circular tunnel, which would soon become highly radioactive, accelerator engineers would fill the entire tunnel with sea water. Mechanics employing aqualungs or diving suits could then work in complete safety.

A separately constructed central area of the assembly would contain machine shops, special power supplies, a large control room, administrative headquarters, and also a kind of motel (with parking for helicopters rather than cars) for the crew of approximately 1000 engineers and technicians. Recreation facilities would include a movie theater, squash courts, swimming pools, and a specially stocked fishing pool.

The plan circumvents rivalry from groups in different parts of the country. (The possibil-

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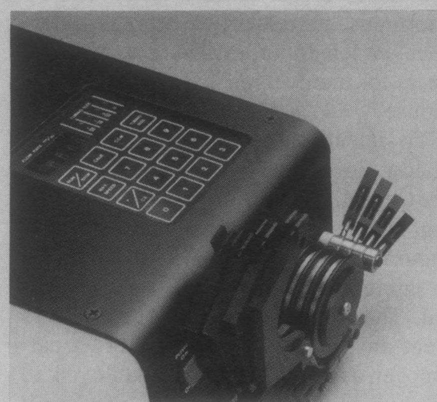

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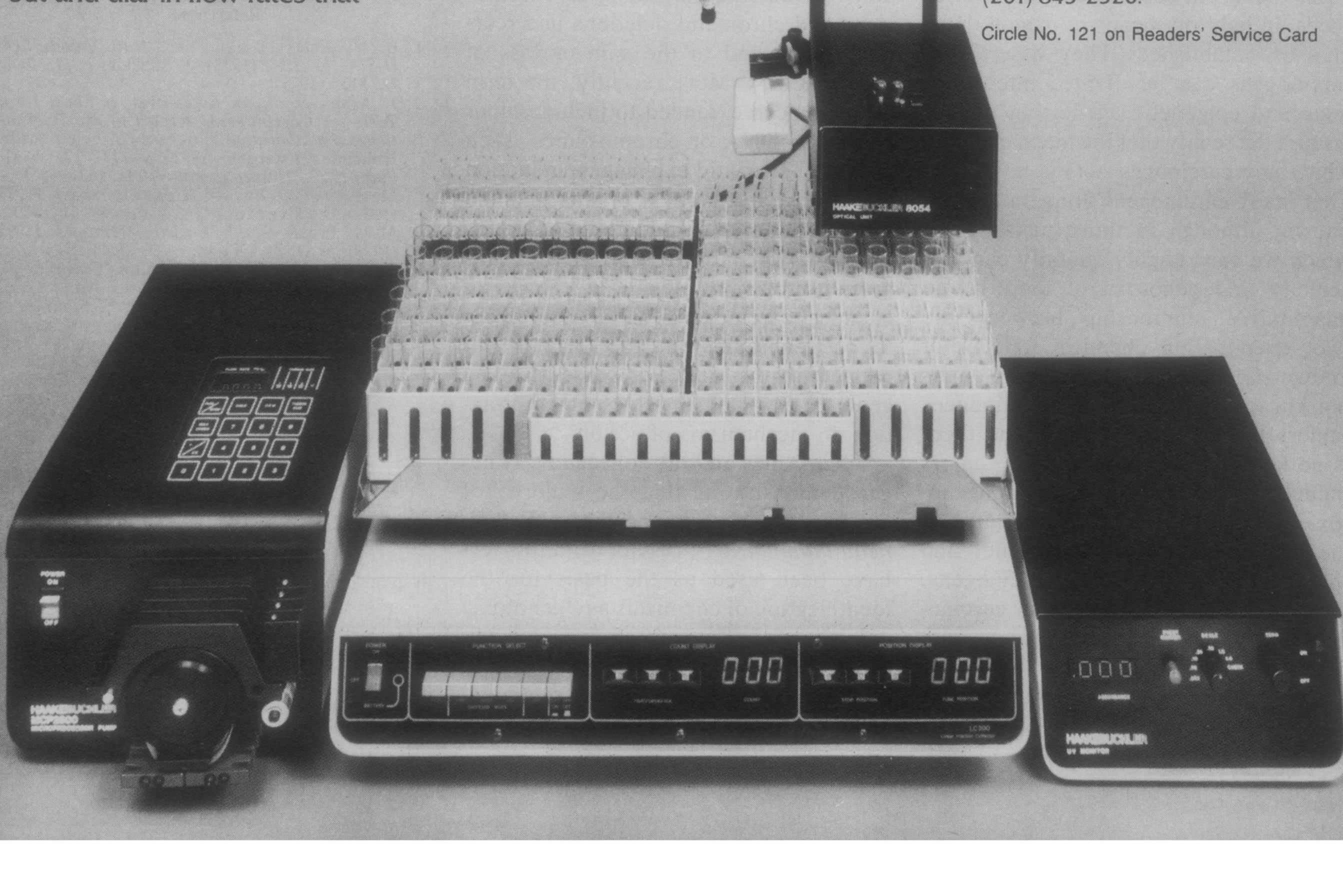

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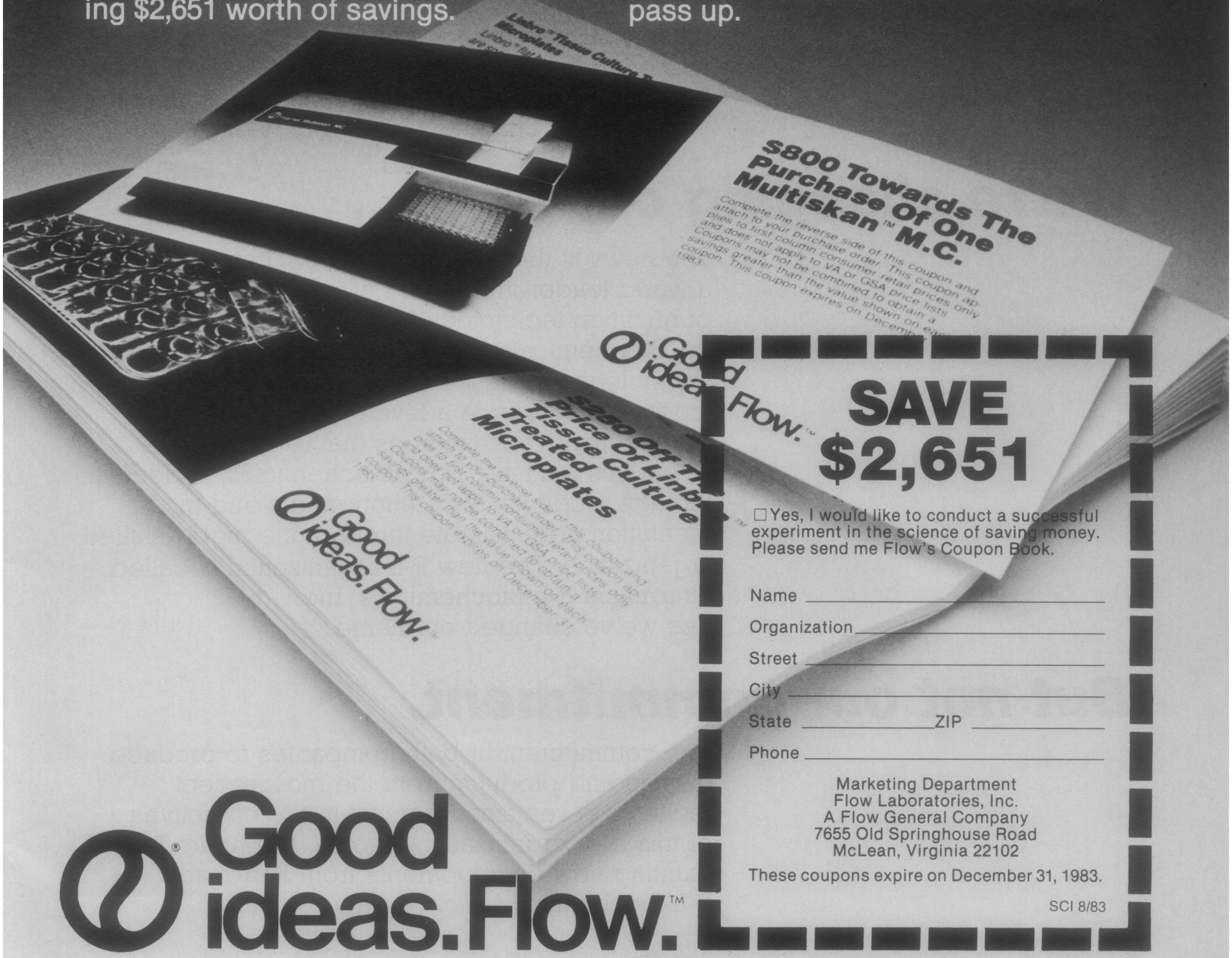

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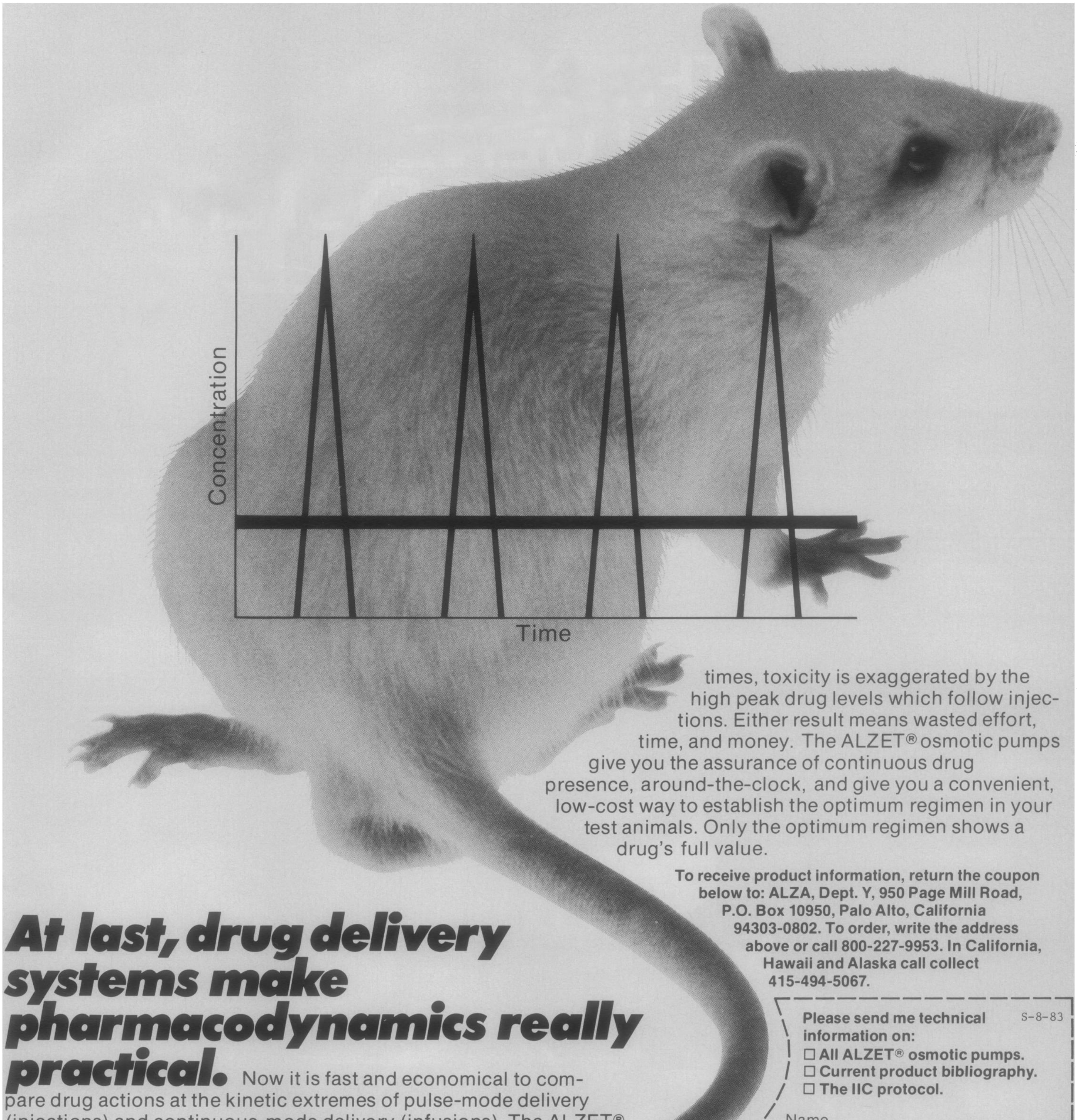
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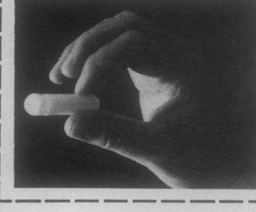


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SCIENCE

Oil Recovery with Supercritical CO_2

Supercritical fluids are being employed in a variety of applications in the food, pharmaceutical, and chemical industries, and additional uses are in sight. Supercritical carbon dioxide at temperatures around 40°C is being used to extract caffeine from coffee and undesirable substances from hops. Supercritical propane is used to extract hydrocarbons from heavy and residual oils. Supercritical toluene can extract the organic matter of coal, leaving the ash. Another interesting example is the use of supercritical CO_2 to enhance oil recovery. This application is likely to have large-scale economic and strategic consequences.

When liquids are heated in a closed space, the vapor pressure and the density of the vapor above the liquid phase increase. At the same time, the density of the liquid decreases. Ultimately, at the critical temperature, the density of the gas phase and that of the liquid phase become equal. Above that temperature, no liquid phase exists. The volume of the container is filled with a fluid whose density is dependent on pressure. Thus, above the critical temperature, one may have a fluid (not a liquid) that has a density greater than liquids below the critical temperature. The critical temperature of CO_2 is 31°C, and fluid CO_2 can be used above that temperature. Supercritical fluid CO_2 is an excellent solvent for fats and hydrocarbons.

The great target for use of CO_2 is enhanced oil recovery. In the United States, more than 300 billion barrels of oil have been left in known formations after production by earlier technology. With oil priced at $29 per barrel, the known oil in the ground is a most enticing target. This treasure is being tapped in a number of ways, including steam flooding and use of surfactants. In future, the method of choice is likely to involve CO_2. About 18 trillion cubic feet of the gas is available in geological formations in Colorado. Already the major oil companies are investing billions of dollars for pipelines and other facilities to bring the CO_2 to oil fields in the Permian basin of western Texas and New Mexico.

When CO_2 is injected into oil-bearing formations, the maximum pressure that can be attained is related to the weight of the overburden. In general, the CO_2 fluid can be made to have a density of 0.7 or more. Franklin M. Orr, Jr., has written,* "When the pressure is high enough that the CO_2 is a dense phase that extracts hydrocarbons efficiently from the oil, the CO_2 can displace nearly all the oil it contacts." The important proviso is "all the oil it contacts." Circumstances deep underground are complex. Large variations in porosity and permeability occur within short distances. On injection, the CO_2 will relatively easily reach part of the oil-bearing stratum and bypass the remainder. Ultimately, when production of oil is attempted, a limited yield will be attained. Production engineers are exploring substances that can be injected to clog the easy paths and ensure more uniform contact with the oil. Such efforts are only beginning to achieve results. Each oil field is different and requires its own special production scheme. Engineers are using very large computers in efforts to model the fields and their behavior. Samples of the oil-bearing rocks are subjected to laboratory measurements, and these are used in various studies of hypothesized field conditions. The hope is that results from major field tests in the near future will serve as ground truth.

With billions of dollars invested in CO_2 injection, it is clear that the major oil companies expect a good economic return on the ventures. Orr is sufficiently optimistic to suggest that CO_2 produced in power plants may ultimately be captured for use in oil recovery. In view of recent advances in separation techniques the concept might eventually prove practical. In the meantime, trillions of dollars worth of oil sits in the ground awaiting the arrival of displacing fluids.—PHILIP H. ABELSON

*F. M. Orr, Jr., *Journal of Petroleum Technology*, July 1983, p. 1285.