SCIENCE

17 March 1972

Vol. 175, No. 4027

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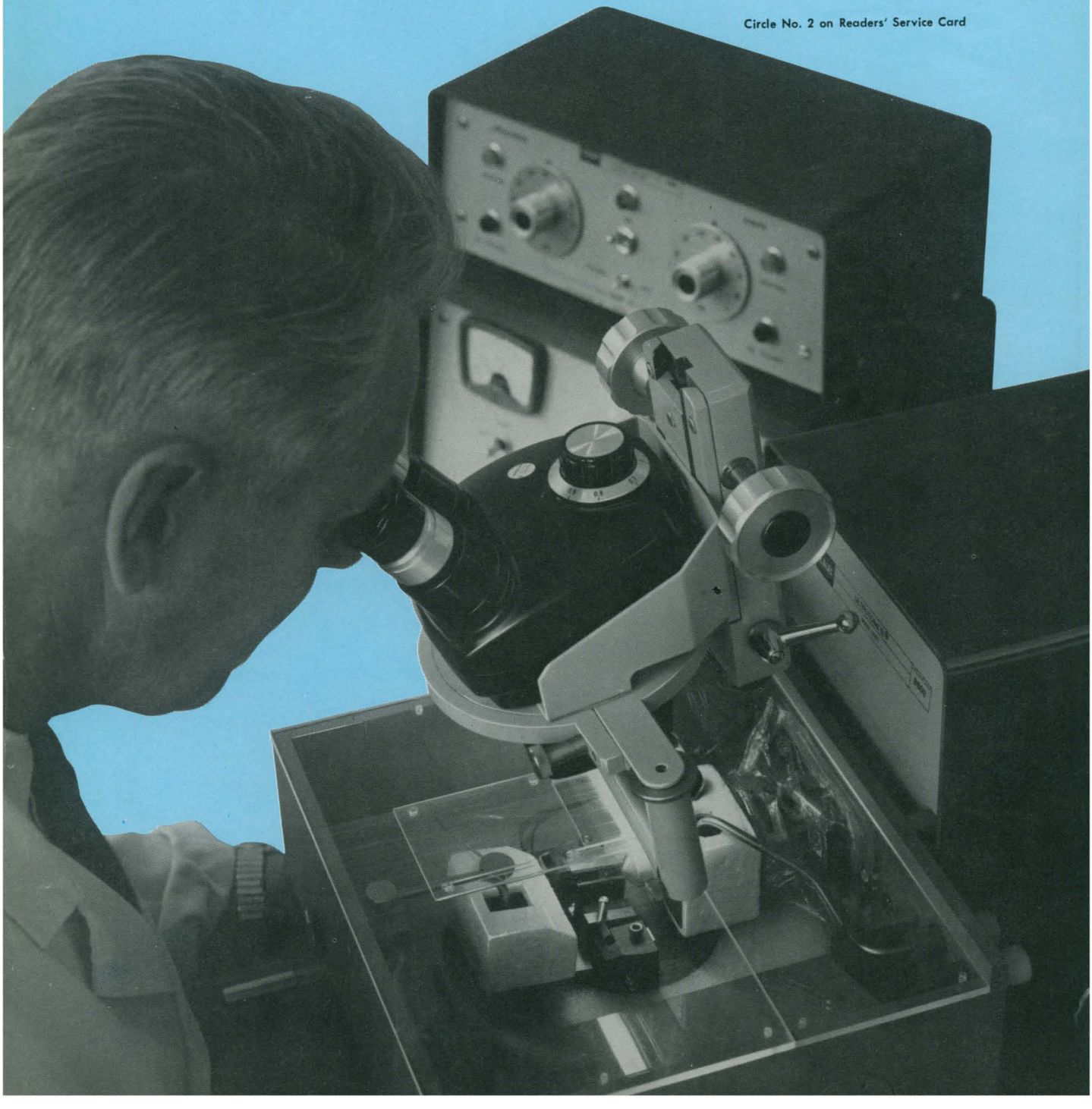

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SCIENCE

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COVER

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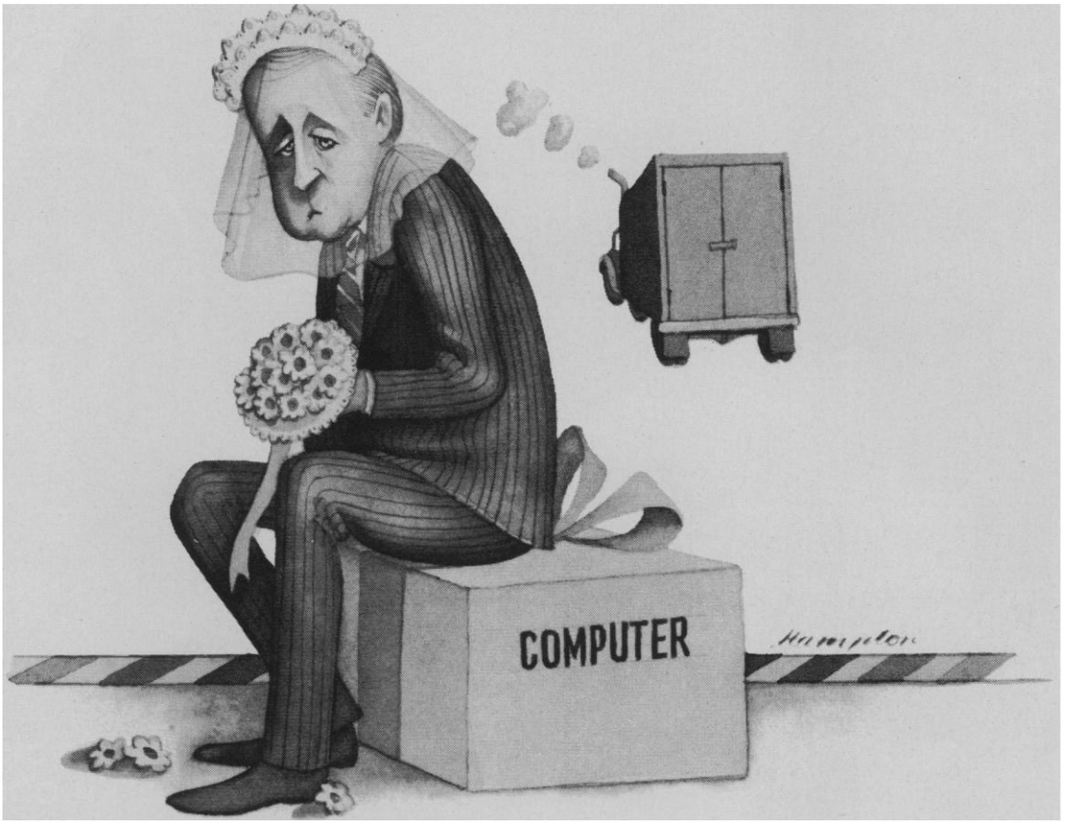

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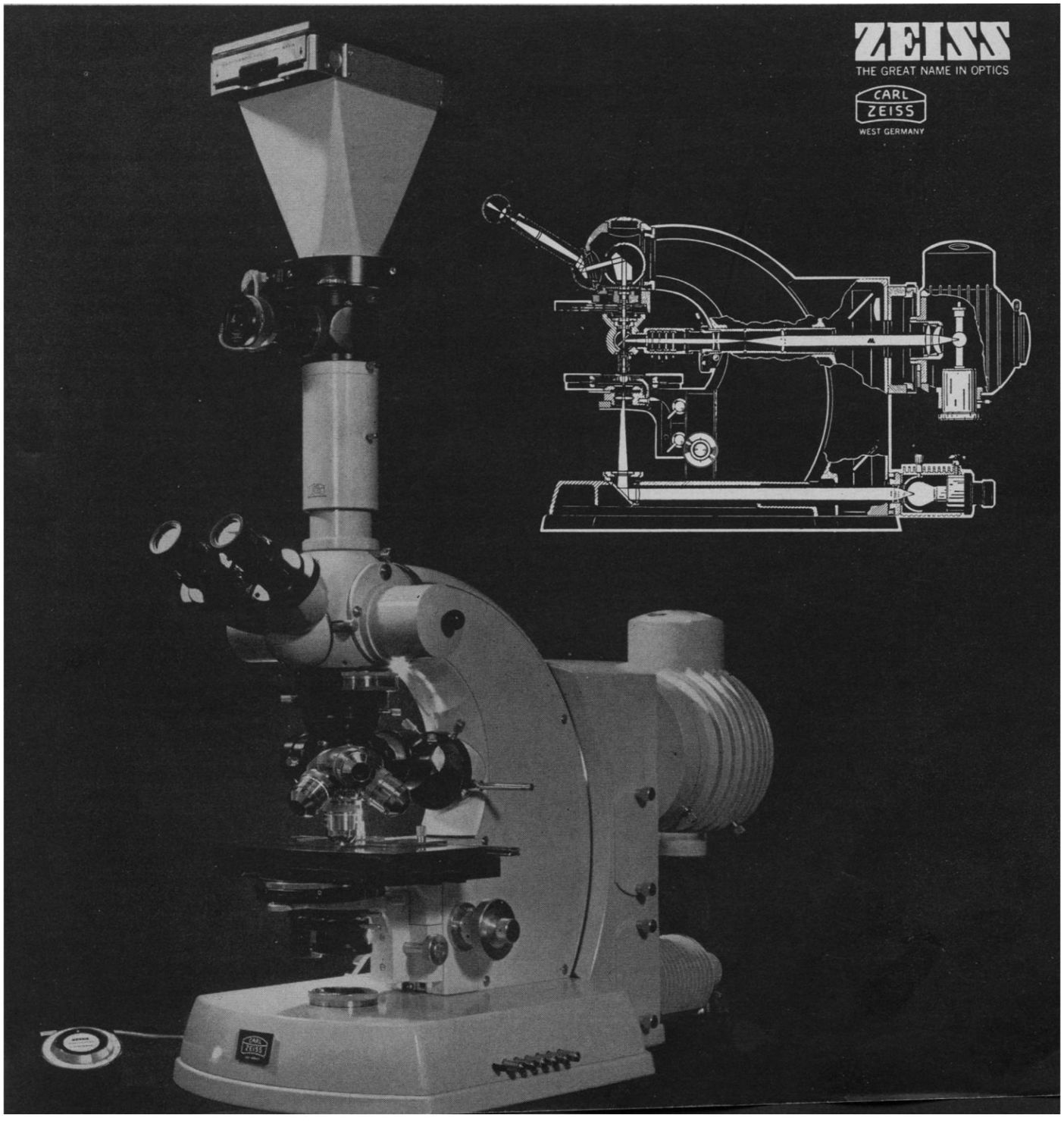

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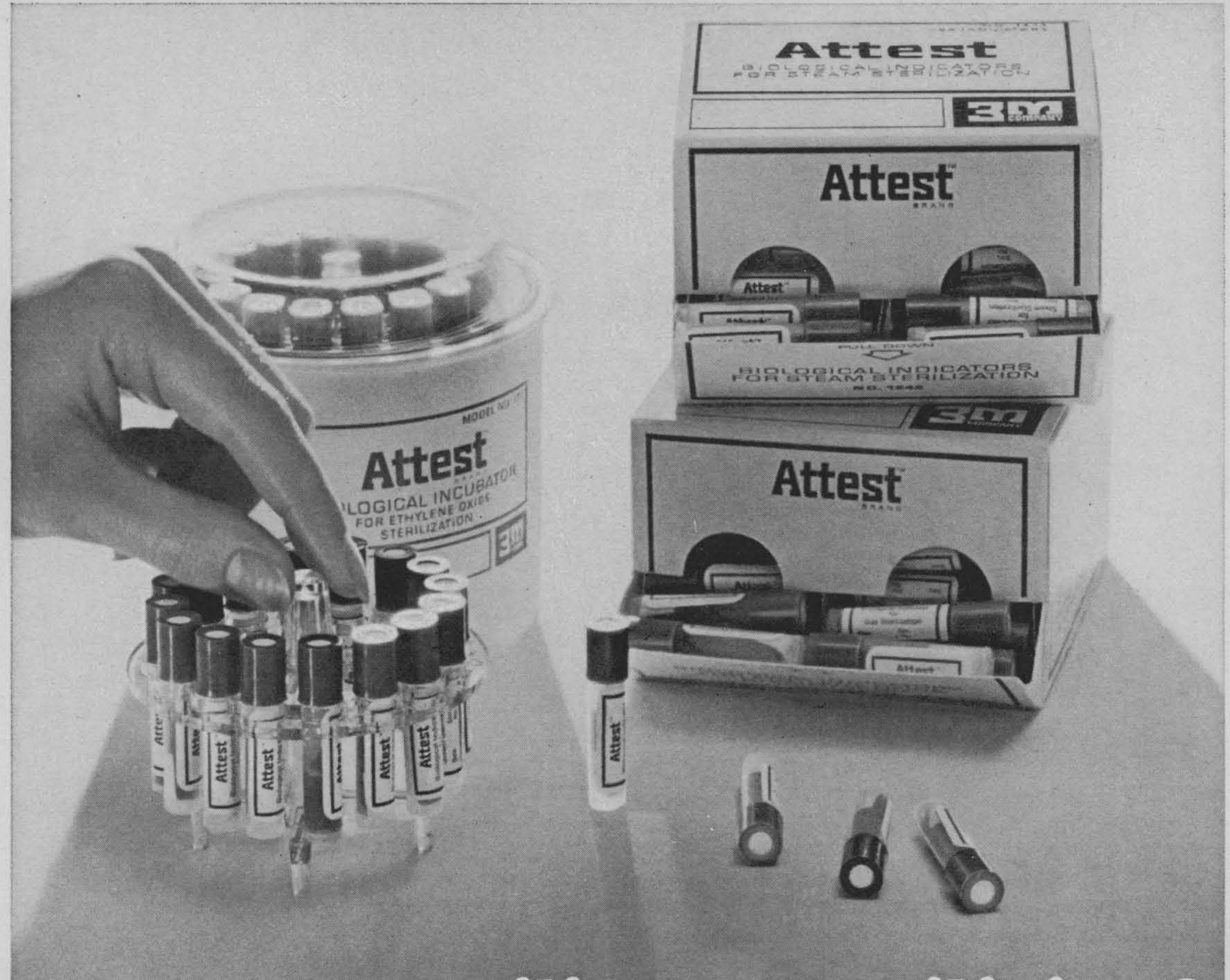

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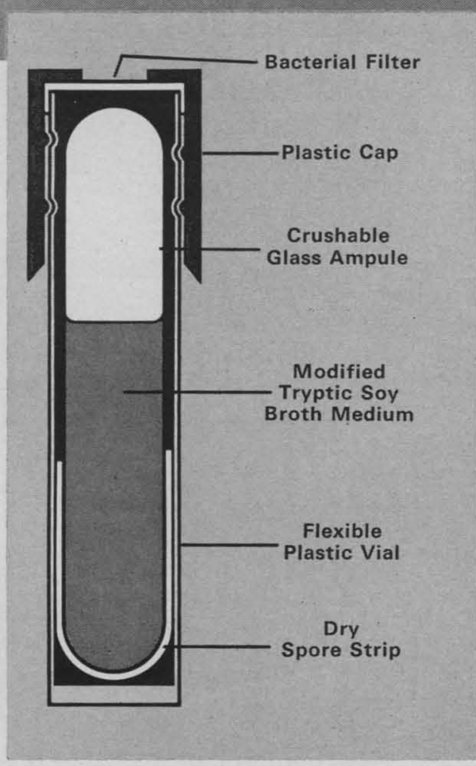

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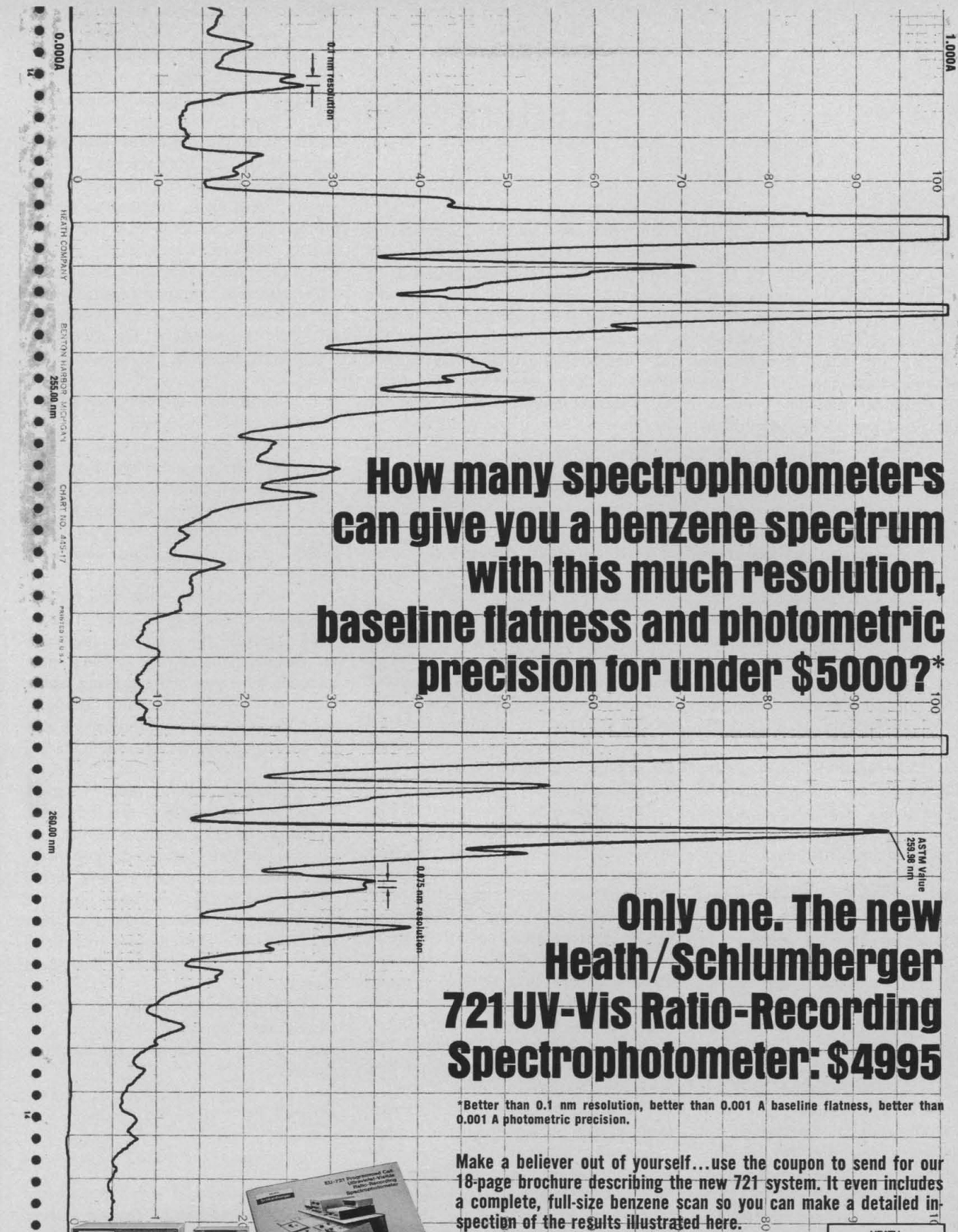

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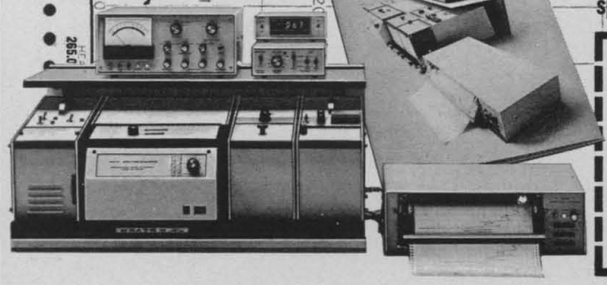

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ANATOL T. CHARI
400 Newport Center Drive,
Newport Beach, California 92660

Captive Audience

Nonsmokers are a captive audience at scientific meetings. They must tolerate the annoyance and unpleasantness of being soaked in polluted air for many hours. I propose a simple solution in which the rights of both nonsmokers and smokers are respected. Smokers should be permitted to sit in only one part of the lecture room. For example, if signs are posted and ashtrays are distributed to show that smoking is allowed on the left side only, a convention would soon be established. It might even spread to other public gatherings.

This suggested segregation of smokers from nonsmokers is already in effect on trains and some airplanes. It has been tried without objection at one meeting. Smokers must appreciate how extremely unpleasant their habit is to many people.

ARTHUR B. PARDEE
Department of Biochemical Sciences,
Princeton University,
Princeton, New Jersey 08540

Fusion by 1990?

The Creutz-Hosmer colloquy "How soon for fusion?" (News and Comment, 7 Jan., p. 43) exposes a fatuous rationale for accelerating the rate of controlled thermonuclear research; fusion by 1990 instead of 2000 would be "exciting" for the citizenry and would make plasma physicists "feel good."

There is, however, a truly compelling reason for increasing the fusion budget. Commercial fusion in 1990 would render the fast breeder (fission) reactor obsolete less than a decade after approximately $4 billion in public funds had made it feasible. If the fusion optimists are correct, then the development of breeders may and should be bypassed—a strategy with manifold environmental advantages.

According to Deborah Shapley (News and Comment, 9 Apr. 1971, p. 143), a power economy based on breeders would produce, by the year 2000, 720,000 kilograms of plutonium under civilian control, and a likely worldwide black market in plutonium. International security hazards aside, this would pose a public health problem of terrifying magnitude; the maximum permissible body burden of plutonium is less than a microgram. A quarter century of effort has still not yielded a safe, permanent storage method for the highly radioactive waste from fission reactors.

The most cogent argument *for* breeders is that continued deployment of current (nonbreeding) reactors will exhaust U.S. supplies of ^{235}U by the 1990's. Put this way, the argument suggests a moratorium on the deployment of nonbreeding reactors.

What kind of new power plants before 1990? One possibility is to redirect the funds for the breeder program to subsidization of pollution controls on fossil-fueled plants. U.S. coal reserves will be sufficient for centuries (*1*).

ROBERT C. AXTMANN
Center for Environmental Studies,
Princeton University,
Princeton, New Jersey 08540

Reference

1. H. H. Landsberg and S. H. Schura, *Energy in the United States* (Random House, New York, 1968), p. 82.

In "How soon for fusion?" my questioning of Edward C. Creutz of the National Science Foundation is characterized as that of a skeptic "who chided scientists for their proclivity to do what seems possible mainly because it seems possible." The unabridged record of this colloquy during Joint Committee on Atomic Energy hearings clearly indicates that my questions simply sought to elicit any compelling reasons for spending the extra resources required to implement Creutz's plea to accelerate the advent of electric power from controlled fusion by about 10 years, from 2000 to 1990. To do so would mean diversion of substantial sums from other scientific and nonscientific priorities. Its costs and benefits deserve the forthright

analysis that I was seeking but did not get.

The fact that this colloquy was presented in such a distorted and superficial context has caused me grief. Several readers of *Science* have written accusing me of such assorted sins as witness badgering. technical ignorance, and blasphemy in the Temple of Science. Everyone failed (as did Creutz) to spot my question about a moratorium on experimental CTR work pending further theoretical exploration as an allusion to the 1965 Allison Report, which took some U.S. programs to task for excessive "tin bending" at the expense of theoretical effort. My question invited but did not receive an answer describing the improved balance of today's programs.

There are all too few in the Congress who, like myself, labor long and hard to get compelling facts on the record of pertinent hearings to support generous public funding of scientific research. It is not a particularly commendable occasion when the editors of *Science* figuratively toss one such "Christian" to the anti-intellectual lions.

CRAIG HOSMER
U.S. House of Representatives, Washington, D.C. 20515

I have seen Congressman Hosmer in action on a number of occasions and know that he can take care of himself. The editors of *Science* had no intention of tossing Christian Hosmer to the anti-intellectual lions. If they have done so inadvertently it is the lions who are in need of sympathy.

—P.H.A.

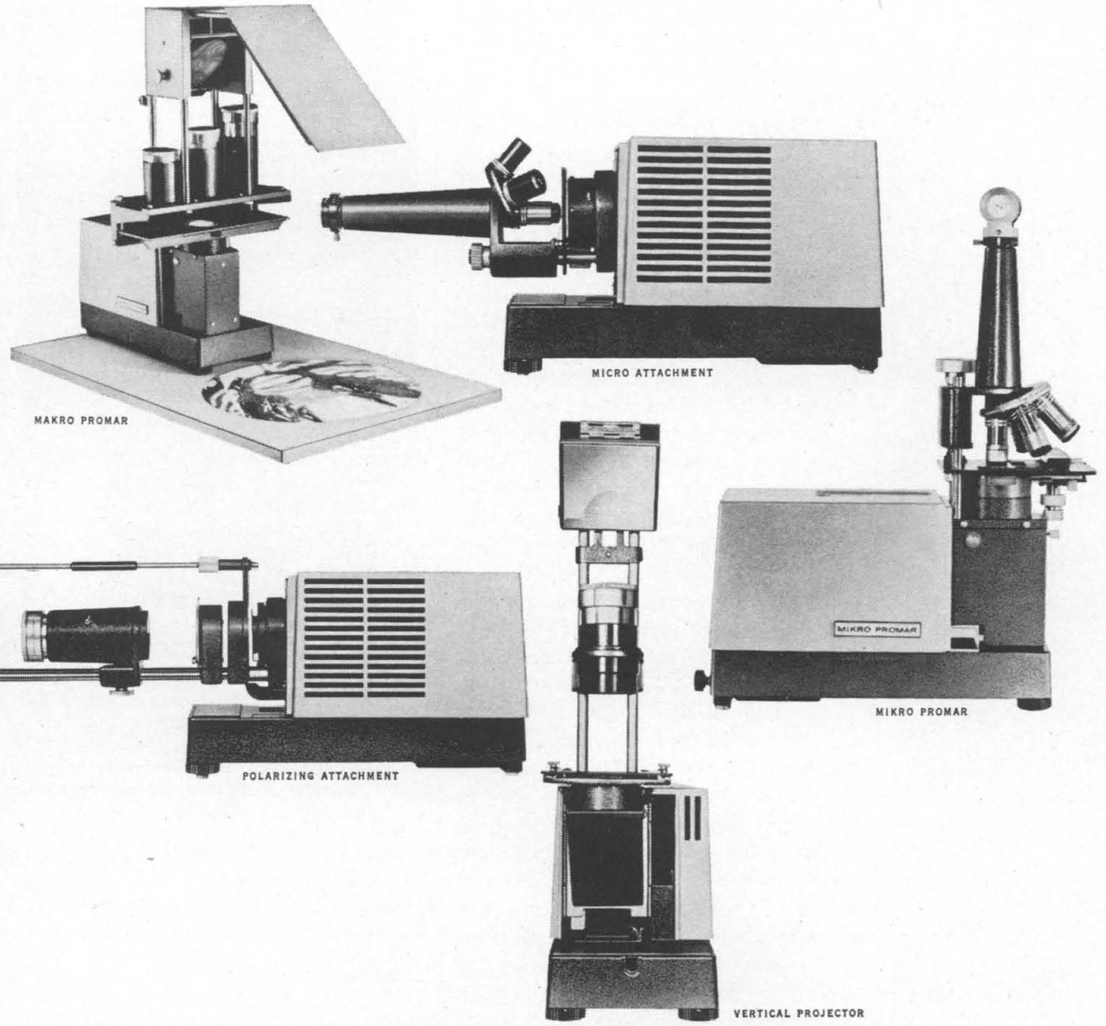
"Necessity or Chance"

Jacques Monod's fascinating book *Chance and Necessity* deserves both the lengthy review by Dobzhansky (7 Jan., p. 49) and serious consideration by readers, but Milton (*1*) said it all in two short lines: "Necessity or chance/ approach not me; and what I will is fate."

AUSTIN J. MACINNIS
Department of Zoology, University of California, Los Angeles 90024

Reference

1. J. Milton, in N. Webster, *New Twentieth Century Dictionary of the English Language* (unabridged) (World, New York, 1950), see "fate," p. 638.



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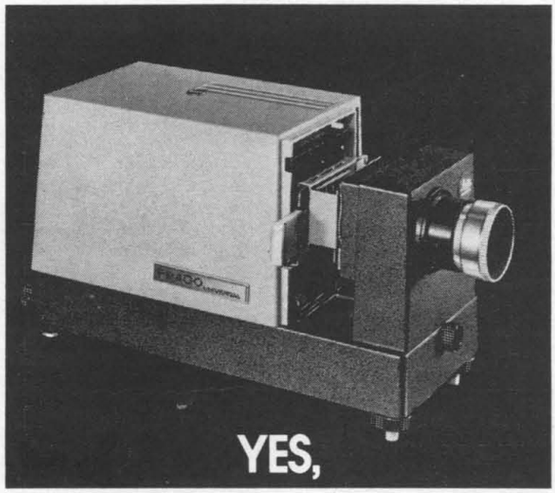

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17 March 1972, Volume 175, Number 4027 **SCIENCE**

Limits to Growth

The public and its leaders are now aware of and rightly concerned about the unpleasant potential consequences of overexuberant growth. Small wonder, then, that a 1-day symposium on the "Limits to Growth" held at the Woodrow Wilson Center in Washington on 2 March should draw an attentive audience that included senators, ambassadors, and a cabinet officer, as well as numerous representatives of the press, radio, and television.

The principal speaker was Dennis Meadows, who has headed a study group at Massachusetts Institute of Technology. This group has used high-speed computers in an attempt to examine the interacting consequences of continued exponential growth of population, food production, industrialization, pollution, and consumption of nonrenewable natural resources. Meadows' major conclusion is the perhaps obvious one that, if mankind continues to indulge at current rates in various forms of exponential growth, calamities will occur in about 50 years.

As a pioneering effort to evaluate a complex web of interactions the study, and a popular book* based on it, is likely to have considerable impact. The book is to be translated into half a dozen languages and distributed broadly. The approach, though, has defects.

Responding to the allure of tackling a truly big problem, the study group has attempted to treat the entire Earth as a single system. In order to limit the number of variables, they chose to aggregate variables on a global basis. Thus the population growth of all the world is taken as a single variable, although the growth rates in various countries and regions differ by a factor of 6 or greater. An even less defensible aggregation of variables is subsumed under pollution. Here an attempt is made to lump together the many components of solid, liquid, and gaseous pollution, even though each differs in nuisance or toxic characteristics.

Enthusiasts can easily lose sight of the limitations of computers. In this study, data from the past are used as a basis for predicting the future, but such data are far more relevant to the past than to the future. The computer is unaware of changing human behavior. Concern about the population explosion and such matters as pollution has already had profound effects. Recently released figures show that the rate of growth of population in this country has been slowing. The rate of increase of important polluting chemicals has been slowed, stopped, or is even decreasing. Important segments of the middle and upper-middle classes are talking of a future "no growth" society.

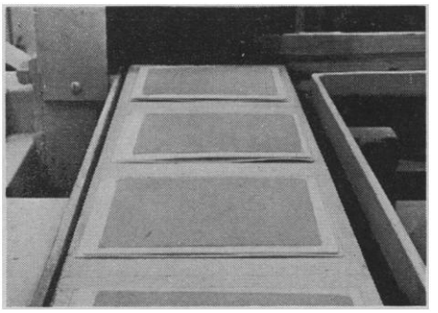
The study also does not adequately take into account ingenuity with respect to natural resources. Current technology is based on the availability of certain raw materials, such as copper and natural gas. As these resources become scarce, technology will change and, for example, aluminum will be used as a conductor, while methane will be obtained from coal.

The concept of Earth as a closed system is an appealing one, and in some respects it is valid. We all share the oxygen of the atmosphere and must be concerned with changes in its carbon dioxide content. However, much of pollution is local or regional in its effects. The same is true with respect to population. Growth of population exacerbated by concentration in urban centers is a bad enough problem in the United States. It is a far more serious and potentially catastrophic phenomenon in the so-called lesser developed countries.

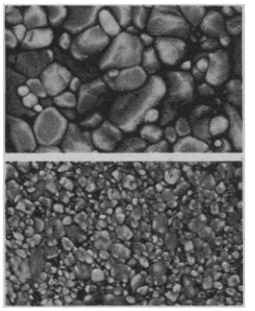
A member of the audience at the recent symposium privately reminded us that, although Meadows predicts hell in 50 years, hell is already present on Earth in places such as Calcutta.—PHILIP H. ABELSON

* D. H. Meadows, D. L. Meadows, J. Randers, W. W. Behrens III, *The Limits to Growth*, a report for the Club of Rome's Project on the Predicament of Mankind (Potomac Associates–Universe Books, New York, 1972).

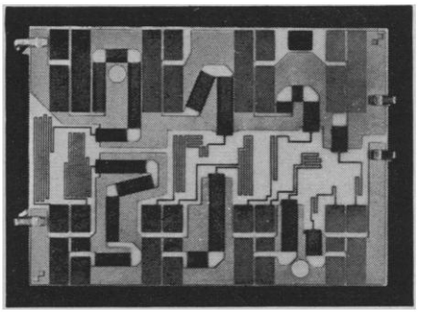
WESTERN ELECTRIC REPORTS



1500° C furnace was specially designed to fire these new substrates. The relatively low temperature results in smooth substrate surfaces for practically fault-free thin film bonding.



Electron micrographs show the great difference in grain size between new ceramic material (lower) and the previous material (upper).



Thin film integrated circuit shown here is part of a resistor network. It is one of many that benefit from the improved substrate. Metal leads on sides are bonded by thermocompression to tantalum nitride resistor film.

Smoothing the way for perfect thin film bonding.

Aluminum oxide, or alumina, is considered to have the best combination of properties for thin film circuit substrates. Until recently, however, the bonding of metal elements to gold-coated tantalum nitride resistor film on alumina was somewhat unpredictable.

Now, an advance at Western Electric has made it possible to get practically fault-free bonding of these materials.

This new perfection in bonding came through the development of finer grained alumina substrates.

The process has four basic steps: milling, casting, punching and firing.

During milling, alumina is combined with magnesium oxide, trichlorethylene, ethanol and a unique deflocculant. For 24 hours, this mixture is rotated in a ball mill. In a second 24-hour period, plasticizers and a binder are included.

The deflocculant plays a major role by dissipating the attraction forces that exist between the highly active alumina particles. This prevents thickening, which would ordinarily make an active alumina mixture unworkable.

The 48 hours of milling is followed by casting. When the material comes off the casting line, it is in the form of a flexible polymer/alumina tape, dry enough to be cut into easily handled sections.

After casting, a punch press cuts the material into the desired rectangles or other shapes. Holes can be punched at the same time.

Finally, because of the use of active alumina, the material is fired at an unusually low temperature which results in smooth substrate surfaces for reliable thin film bonding. The finished substrate is then ready for the various processes of thin film circuit production.

In developing this new process, engineers at Western Electric's Engineering Research Center worked together with engineers at the Allentown plant.

Conclusion: This new way to produce substrates is a truly significant contribution for thin film circuit production.

The ultimate gain from this smoother substrate is for communications itself. For through the achievement of nearly perfect bonding of metal leads to tantalum nitride, thin films can be produced with even greater reliability and economy.

Western Electric

We make things that bring people closer.

ing abortion by this route was generally less than 5 and 3 mg, respectively; that is, approximately 5 percent of that required by intravenous administration. The incidence of generalized side effects was low compared to that seen after intravenous administration. Apart from some nausea and pain associated with the contractions, no vomiting or diarrhea was reported. Although the disadvantage of an indwelling catheter was recognized, it was agreed that the apparent advantage of administering prostaglandins locally at the site of action encourages further exploration of this route of administration, especially in the second trimester as an alternative to treatment with hypertonic salt solution.

It had been established that prostaglandins are absorbed from the vagina both in monkeys and humans. S. Karim (Uganda) reported on the vaginal administration of prostaglandins. After being given intravaginally 20 and 50 mg of PGE_2 and $PGF_{2\alpha}$, respectively, every 4 hours, in a small volume for one or two consecutive days, 56 of 60 cases (6 to 23 weeks pregnant) were reported as "successes." Side effects similar to those occurring during systemic administration were reported in approximately 25 percent of the trials. There was a consensus of opinion that the prostaglandins administered vaginally exert their action after absorption into the systemic circulation. It is likely therefore that the efficacy and side effects of vaginally administered prostaglandins will be similar to those produced by similar concentrations in the plasma of intravenously infused prostaglandins.

In a limited number of cases prostaglandins were administered *intravaginally* or *intravenously* 3 to 7 days after the first missed period (S. Karim, N. Wiqvist, and M. Bygdeman). The efficiency of the method could not be assessed on the basis of these preliminary trials. In several cases pregnancy continued, and repeated administrations were required. The possibility of effects on fetal development makes it essential to follow each case closely.

The effect of prostaglandins in infrahuman primates was reviewed by G. Duncan (United States). Of special interest are the results of studies in which pregnancies in rhesus monkeys were successfully terminated with prostaglandins (PGE_2, $PGF_{2\alpha}$, and 15-methyl-$PGF_{2\alpha}$) given by the vaginal route. In contrast to the situation in humans, the conceptus is not expelled in the rhesus monkey after the administra-

tion of prostaglandins. Termination of pregnancy induced by prostaglandins in such animals is associated with heavy vaginal bleeding. Observable side effects are virtually nonexistent. There is a rapid decrease in circulating "progestin" in the plasma after administration of prostaglandin in early pregnancy. This seems to suggest a direct effect of prostaglandin on steroidogenic function of the corpus luteum in this species.

Recent progress in the metabolism and analysis of prostaglandins was described by B. Samuelsson (Sweden). This work provided information on the initial step in the biological inactivation of prostaglandins and on the time course of the appearance of metabolites in plasma. The results are of importance for more detailed pharmacokinetic studies, the design of analogs of prostaglandins and the development of methods for quantitation of plasma prostaglandins. A new method by which individual prostaglandins can be identified and determined quantitatively in extracts of body fluids in subnanogram quantities by means of a combination of gas chromatography and mass spectrometry with an isotope carrier technique was described.

The recent elucidation of the principal urinary metabolites of the primary prostaglandins has made it possible to obtain the first estimates of the amounts of prostaglandins formed in the human species. The figures reported for PGE_1 plus PGE_2 were 20 to 50 μg per 24 hours in women and 100 to 200 μg per 24 hours in men. Radioimmunoassays for prostaglandins have also been described; however, the specificity of these assay methods remains to be established. Cross reaction with various circulating metabolites appears to be a major problem. Such metabolites are formed very rapidly and occur in the plasma in larger amounts than the parent compounds.

The interactions between prostaglandins and steroid hormones are being studied by several investigators [Anderson and Vande Wiele (United States), Bygdeman and Wiqvist (Sweden)]. Under the experimental conditions used, the intravenous administration of prostaglandins did not affect the concentrations of estrogens, progesterone, or 17α-hydroxyprogesterone in the peripheral plasma.

However, it was reported by Vande Wiele that the infusion of prostaglandin resulted in a marked decrease in chorionic gonadotrophin in the plasma. This decrease occurred within a few

hours after the start of the infusion and was not accompanied by changes in concentrations of steroids. The mechanism of action by which prostaglandins diminish circulating HCG levels is incompletely understood at present.

While the potential of prostaglandins in fertility control is considerable it was obvious to all participants that present information on the properties and effects of the prostaglandins as fertility-regulating agents is still too limited to warrant indiscriminate clinical trials outside of carefully controlled studies in hospital facilities. The importance of fundamental research as a necessary prerequisite for later applied studies also emerged from the review of the current state of knowledge on prostaglandins for fertility control. It was agreed that exploration of the potential of the prostaglandins in the regulation of human fertility would be accelerated if a number of common clinical protocols including the administration of various prostaglandins in different ways, and the design of comparative trials with other fertility-regulating methods could be agreed upon internationally. Even such a fundamental question as the definition of a successful abortion (complete or incomplete) has not been uniform in all studies reported. Under a common protocol the results from different centers could be compared and a consensus based on a sufficient number of cases could be reached more quickly.

The participants of the conference indicated their willingness to participate in such collaborative studies.

It was also felt that international collaboration in the form of coordinated metabolic studies on various types of patients treated according to these protocols would be of great value. It was concluded that another, more specialized meeting was needed during the autumn of 1971 to discuss the various methodological problems and metabolic studies. The participants also agreed that the creation of an international task force would complement efforts now under way and would help to establish guidelines for clinical trials that may be expected to expand rapidly once prostaglandins become readily available.

The suggestion was made and approved that the World Health Organization Research and Training Centre on Human Reproduction at Karolinska Institutet should take the initiative in convening a task force for initiating such studies.

A second meeting of a smaller group