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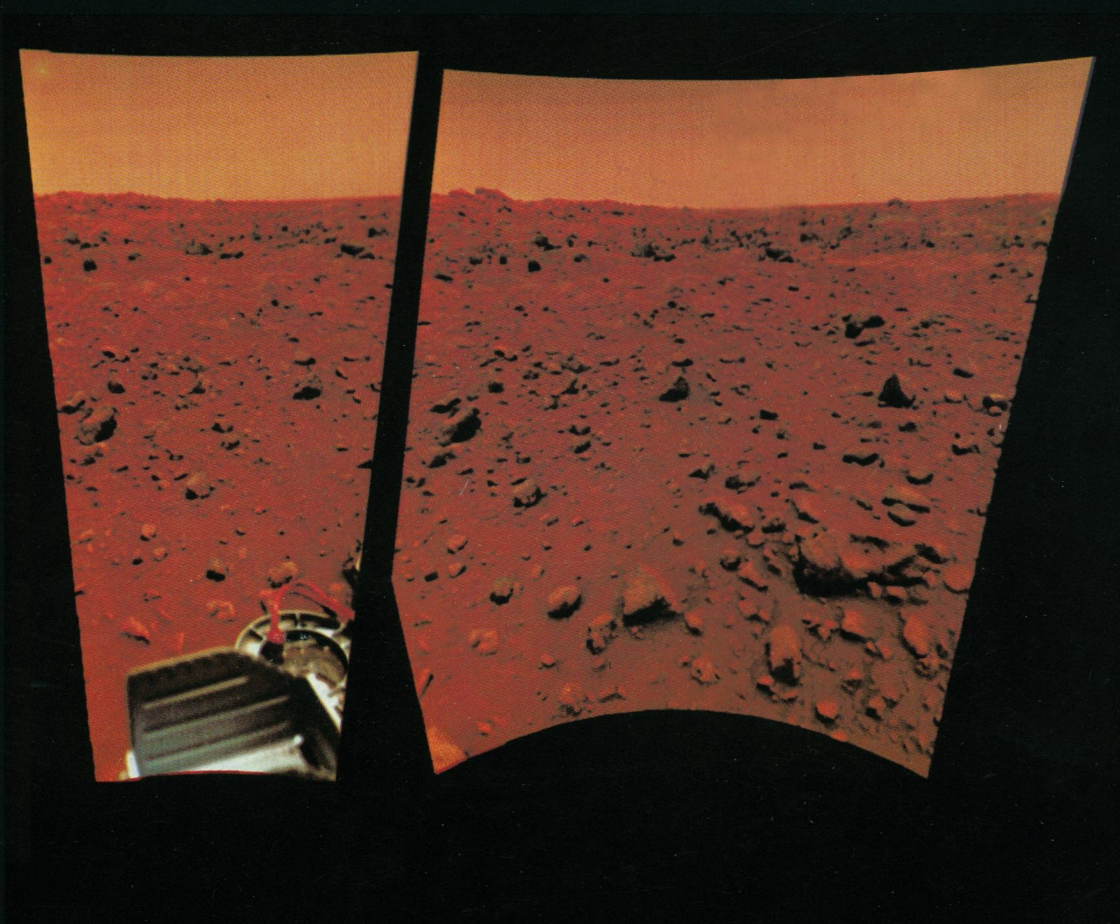
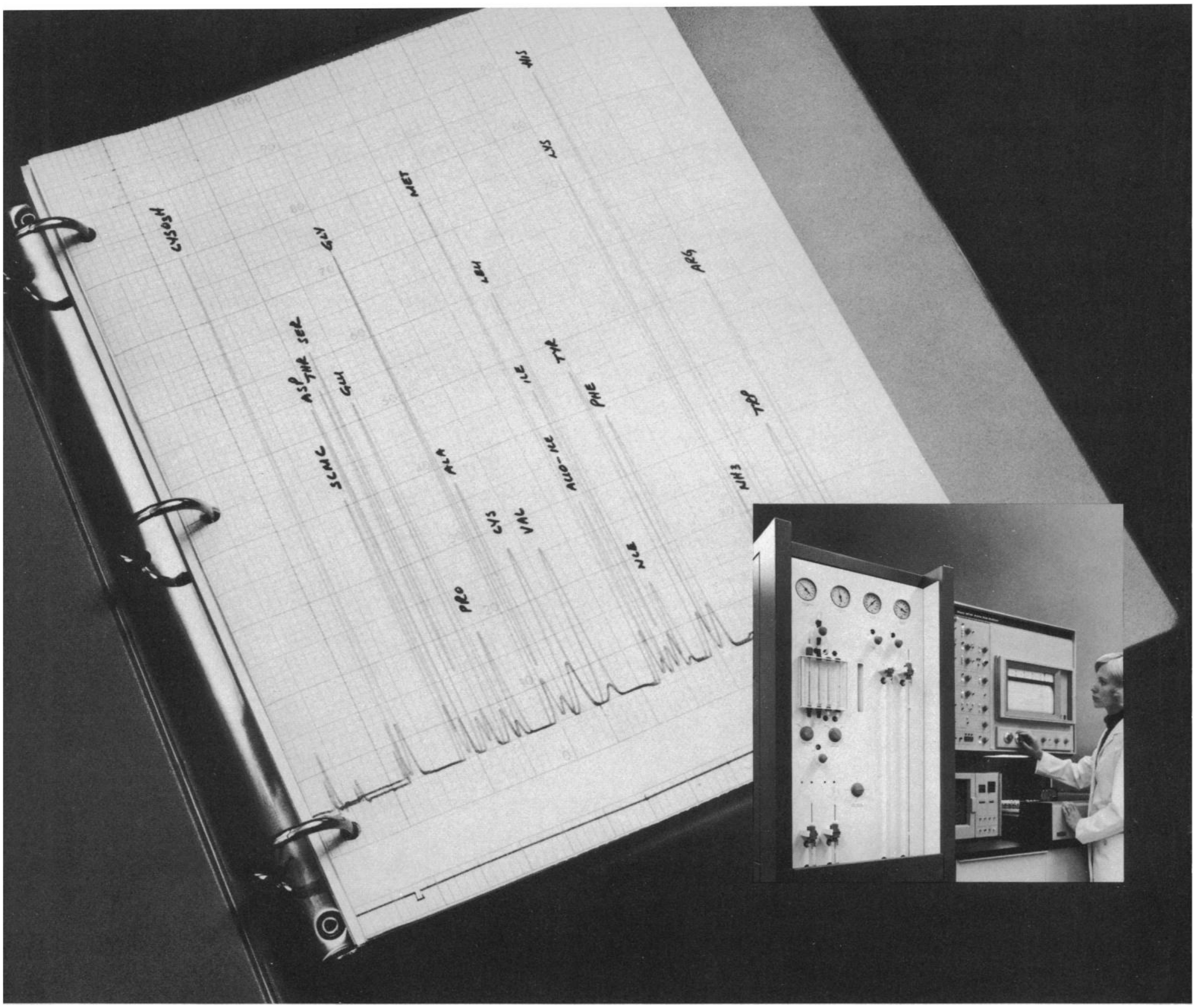
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

27 August 1976, Volume 193, No. 4255





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Volume 193, No. 4255

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COVER

Pictures, obtained by camera 1 (left) and camera 2 (right), 0.822 meter apart, provide stereo coverage of about 45 degrees in front of Viking 1 lander. The remainder of the camera 2 picture is included for its geological interest. Both images were computer-rectified to be equivalent to pictures obtained with conventional film-plane cameras. The stereo effect may be viewed by those with average interocular distances with any standard pocket stereo viewer. The apparent downward convexity toward the viewer in the foreground is a camera artifact. See page 791. [Jet Propulsion Laboratory, Pasadena, California]

TM: Meditation or Sleep?

R. R. Pagano *et al.* conducted their study, "Sleep during transcendental meditation" (Reports, 23 Jan., p. 308), with care; however, the authors unfortunately chose to give an overall emphasis to the report that tends to be quite misleading.

One of the main findings of their study, which was not sufficiently emphasized in earlier research, is that during the actual practice of the transcendental meditation (TM) technique the subjects may experience several "states of consciousness" including electroencephalogram (EEG) sleep stages 1, 2, 3, and 4. In addition, the authors further document the fact that the subjects' experiences during meditation as judged by both subjective reports and objective measurements may vary both from meditation to meditation and from subject to subject. However, even though a subject may experience more than one state of consciousness, and in fact may fall asleep during the TM technique, this in no way alters the previous well-documented finding that at other times during the practice of this technique the subject may be experiencing a unique "wakeful hypometabolic physiologic state." Considerable research has shown that such periods do exist during TM and that they are characterized by a number of physiological changes, including a lowering of breath rate and oxygen consumption and an increase of alpha and theta wave activity in which there appears to be a high degree of synchronous electroencephalograph activity quite distinct from that of EEG sleep stages (*1*).

Individuals who start the TM technique are informed that they may experience occasional periods of sleep if they are tired before starting the meditation period. These periods of sleep are considered to be both necessary and useful to normalize any fatigue in the body, thereby allowing the individual to maintain mental alertness while the body goes into a state of deep physical relaxation. The extent to which subjects may fall asleep during experimental periods will of course vary considerably with many factors, such as the overall health of the individual, physical activity before the experiment, the setting, and the type of equipment used. However, because of the limited number of subjects used in the study by Pagano *et al.*, no generalization can be made concerning how frequently sleep occurs during the practice of TM. The fact that there was a high degree of correlation between the subjective experience and the EEG measurements of sleep during the meditation period merely indicates that the subjects themselves are good judges of whether they are asleep or awake during the meditation period.

The important conclusion gained from the study by Pagano *et al.* is that if researchers are interested in studying sleep, they can probably find much more convenient settings, and that if they are interested in studying the "unique state of consciousness" produced by the TM technique, they should confine themselves to those periods when subjects report they are not sleeping.

ROBERT KEITH WALLACE
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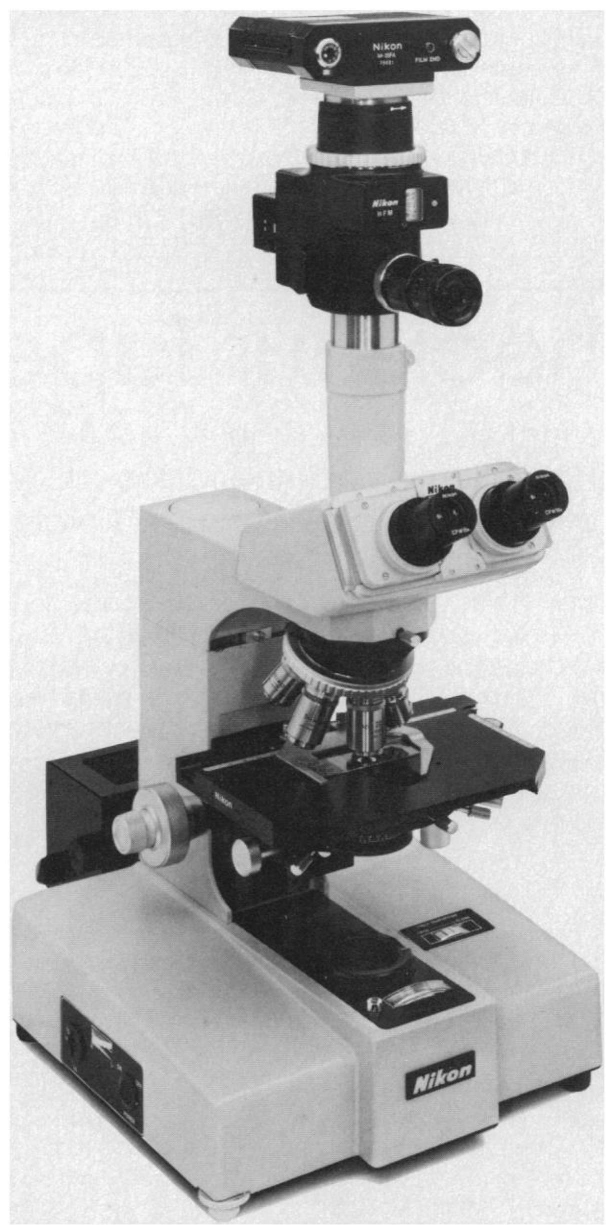
1. R. K. Wallace, *Science* **167**, 1751 (1970); ——, H. Benson, A. F. Wilson, *Am. J. Physiol.* **221**, 795 (1971); P. Levine, *Proc. San Diego Biomed. Symp.* **15**, 237 (1976); D. W. Orme-Johnson, *Psychosom. Med.* **35**, 341 (1973); J.-P. Banquet, *Electroencephalogr. Clin. Neurophysiol.* **35**, 143 (1973); B. C. Glueck and C. F. Stroebel, *Compr. Psychiatry* **16**, 303 (1975); R. Jevning, R. Smith, A. F. Wilson, M. Martin, *J. Clin. Res.* **24**, 1139 (1976); R. Jevning, A. F. Wilson, E. VanderLaan, S. Levine, in *Proceedings of the Endocrine Society. Abstracts* (Endocrine Society, Bethesda, Md., 1975); D. W. Orme-Johnson, L. H. Domash, J. T. Farrow, Eds., *Scientific Research on Transcendental Meditation: Collected Papers* (Maharishi European Research Univ. Publications, Weggis, Switzerland, in press), vol. 1.

Wallace agrees with two of the main findings of our study. These findings are (i) that during the practice of transcendental meditation (TM) subjects may experience several "states of consciousness" including sleep stages 1, 2, 3, and 4; and (ii) that there may be considerable variability from meditation to meditation and from meditator to meditator in the states of consciousness experienced. Since we feel these are important points which help more accurately portray what occurs during TM, we wish to thank Wallace for his candor in setting the record straight.

Wallace raises another important point. He argues that our results "in no way alter the previous well-documented finding that at other times during the practice of this technique the subject may be experiencing a unique 'wakeful hypometabolic physiologic state.' " Wallace is absolutely correct in the contention that our data do not *refute* the possibility that some part of the meditation period *may* be spent in a "unique wakeful hypometabolic physiologic state."

Our data showed that the meditators we studied spent an average of 40 percent of the meditation period asleep. It is, of course, possible that at other



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times during the meditation period a "unique wakeful hypometabolic physiologic state" was present. We do, however, question the use of the word "unique" in describing this state. Unique with respect to what? Based on Wallace's previous publications, the answer is, "with respect to ordinary wakefulness, sleeping and dreaming." However, ordinary wakefulness is itself composed of many different states, such as anger, joy, intense mental concentration, or simple relaxation, to name a few. It is obviously premature to claim that the wakeful hypometabolic state often achieved during TM is uniquely different from these states, particularly from the states produced by other forms of relaxation. TM may result in a unique state of consciousness, but there is no controlled research supporting that contention. The studies cited by Wallace do help to establish that a wakeful hypometabolic state does often exist during some part of the meditation period, but they are woefully inadequate for establishing a claim of uniqueness. In addition to our *Science* report, a recent report by R. R. Michaels *et al.* (18 June, p. 1242) offers evidence to the contrary. It is clear that, before the uniqueness of TM can be determined, much more research needs to be done, particularly comparing TM to other techniques such as progressive relaxation, autogenic training, or ordinary relaxation.

Finally, Wallace implies that the beneficial effects of TM are due to changes that occur during the awake portion of meditation. In seven of the 13 sessions in which we observed sleep, our subjects rated their meditations as "typical." Thus, as we concluded in our report, the following question is still an open one to be resolved by future research: Are the beneficial effects reported for TM due to the sleep that occurs during the meditation period or to some other feature of the process? In addition, in light of the above discussion, there is a second and related question which awaits resolution: Are the beneficial effects reported for TM due to the ordinary rest that occurs during the meditation period in both the sleeping and awake periods or to some *unique* feature of the process?

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Doomsday Expectations

During the past 2 years I have been conducting an informal poll on the doomsday expectations of persons with whom I work. I have asked students and faculty to record, by secret ballot, their response to the following question: "How long do you think our civilization will continue to exist in the developed state before it is vastly diminished or destroyed?" I ask respondents to record their intuitive hunches. Virtually everyone polled was able to record a numerical answer within a minute.

The estimates varied among groups but were surprisingly low overall. Twelve graduate students in a class in environmental planning had a modal expectation of 100 years in 1975, which increased to 150 years (16 students) in 1976. A sample of 35 graduate students in planning as a whole gave civilization a 50-50 chance of lasting 200 years, and 16 architecture graduate students gave it 100 years (*1*). Faculty members had substantially more optimistic expectations. Eight who responded from the planning faculty gave civilization a 50-50 chance of lasting 700 years, and four members of the architecture faculty gave it 500 years. Perhaps the most provocative result came from an upper undergraduate class in environmental biology for nonmajors that had a modal expectation of 25 years (26 out of 94 students gave answers of from 20 to 30 years).

Regardless of who ultimately may prove to have guessed "best," it is significant that those who teach planning have quite different implicit planning horizons from those of their students and that a sample of undergraduates gave their society a life expectancy not as long as their own. The number of "indefinitely" or "forever" answers was very few (3 out of 122). Changing attitudes toward the apocalypse might be an interesting social indicator, although its interpretation in terms of causal factors is undoubtedly not simple.

I invite interested *Science* readers to poll their own associates similarly (*2*).

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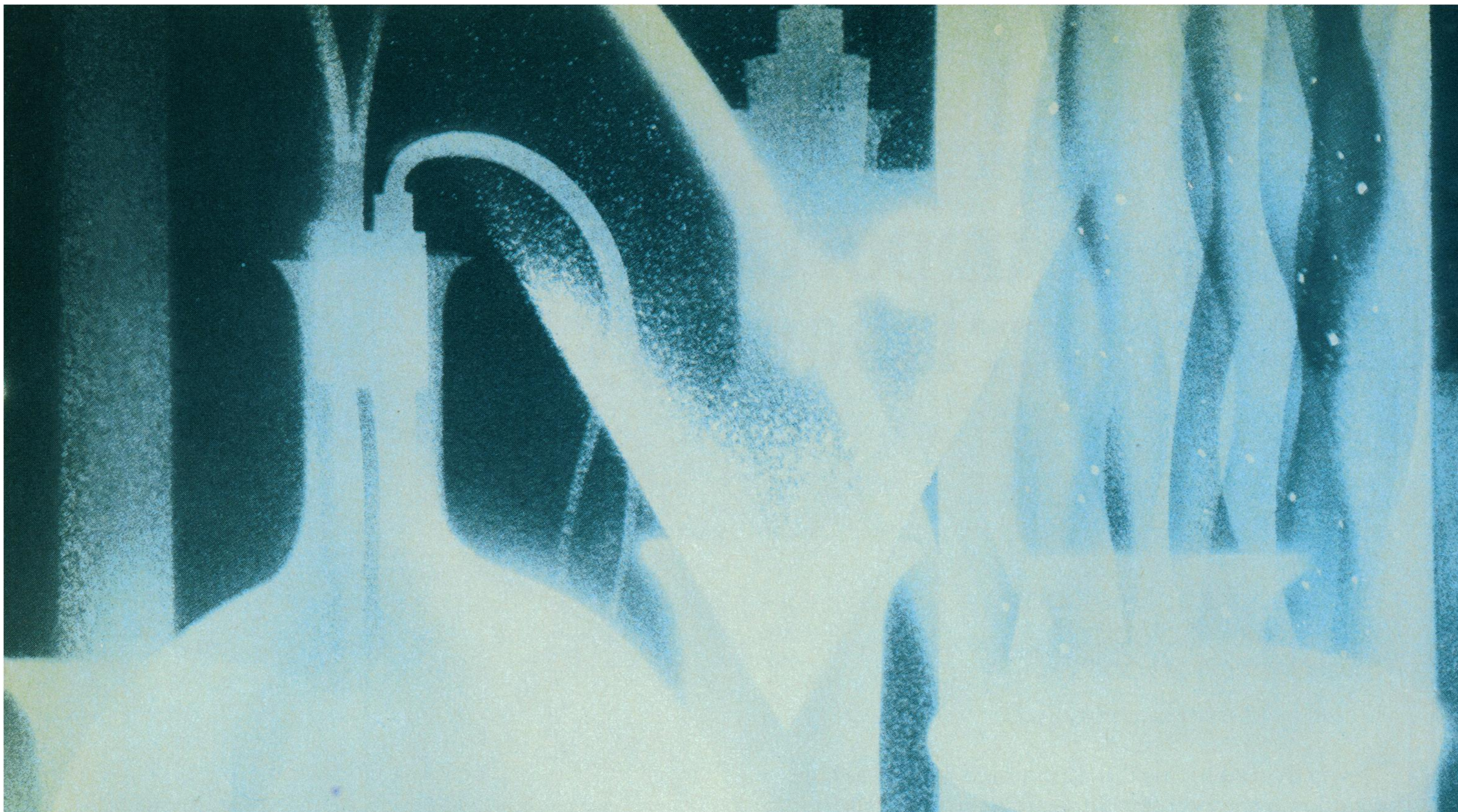
Notes

1. For the poll of students and faculty in architecture and planning as a whole, the technique was modified by my colleague John Friedmann, such that respondents recorded the percentage probability of survival for given periods in deciles. C. E. Weaver tabulated the results.
2. I would be interested in learning the results of such polls, including approximate ages, occupations, and sizes of groups, from readers willing to communicate them to me.



27 August 1976, Volume 193, Number 4255 SCIENCE

Viking 1

In the relatively short period in which Viking 1 has been in the vicinity of Mars much information has been gathered. This issue contains 13 reports arising from the mission.

A notable aspect of the venture has been the overall success of the engineers in preparing a relatively reliable spacecraft and in placing the lander on a smooth area of Mars. A related engineering triumph is the high quality of the pictures of Mars' surface. Results of scientific measurements on the martian atmosphere and surface are particularly interesting.

The total weight of the Viking lander at separation was 1185 kilograms. This had to suffice to provide space, power, and computer controls for 14 different experiments, as well as to provide for communications with the orbiter and Earth and the gentle placing of the lander on a chosen area of Mars. In a spacecraft with about 1,450,000 parts operating in a hostile environment, it was essential to build in the capability of meeting many contingencies and to provide a large number of redundancies to cope with unpredictable failures. A major contingency arose when close examination revealed that the original landing site was too rough and hazardous, but the Viking system had the capability of identifying and moving to a more suitable site.

The pictures transmitted to Earth in black and white and in color are much more rich in detail than those of Mariner 9. As more of them are received they will provide a basis for tackling the complex history of the evolution of the planet. Mars has experienced innumerable meteorite impacts that have left their mark. The interior of Mars has been molten! There has been volcanism with lava flows. There has been flowing water that left deeply incised channels.

On Mars, as on Earth, melting of the interior led to the evolution of volatiles. Part of these volatiles remain on Mars, and the Viking experiments have provided measurements of them. At present the total atmospheric pressure at the landing site is about 7 millibars. The principal constituents are carbon dioxide, 95 percent; nitrogen, 2 to 3 percent; argon, 1 to 2 percent; and oxygen, 0.3 to 0.4 percent. The composition of the atmosphere is influenced by condensation on cold surfaces near the poles, where temperatures as low as 134°K were observed. Under such conditions the vapor pressure of H_2O is very small (about 0 to 3 precipitable micrometers) and that of carbon dioxide is also limited.

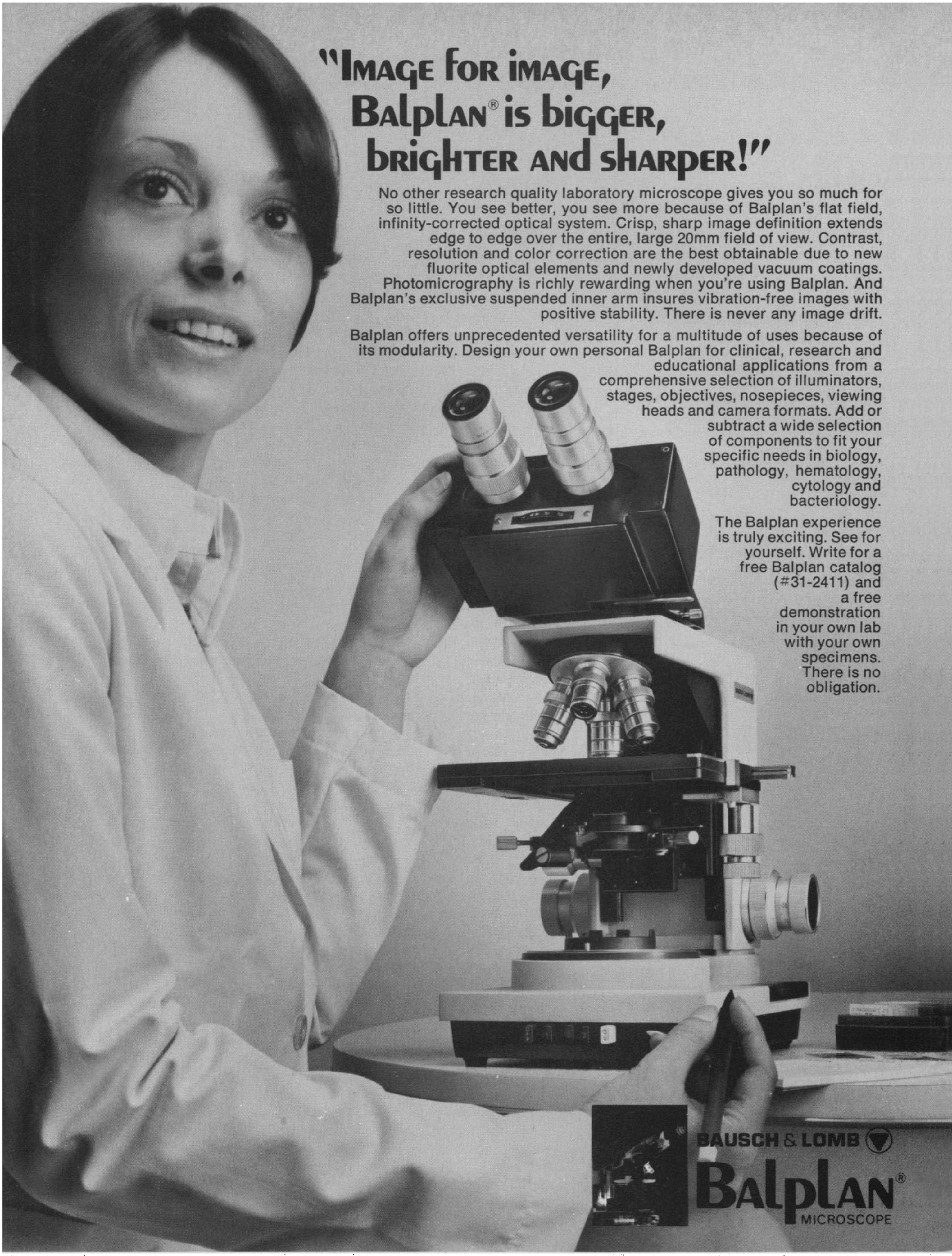
A crucial observation is the abundance of argon. This element does not react or condense and presumably does not escape from Mars. Most of it is argon-40 derived from decay of potassium-40. On the likely assumption that the potassium abundances of the earth and Mars are roughly equal, the observations indicate that the outgassing of Mars has been only about 1/100 as complete as that of Earth.

One of the important experiments was a determination of the composition of the atmosphere as a function of height through observations made by the lander on its way from the orbiter to the surface. At an altitude of 130 kilometers, O_2^+ is the major constituent. Carbon dioxide, CO_2^+, is less abundant by a factor of 9. Recombination of O_2^+ with an electron can provide an important source of atomic oxygen, some of which might escape the planet.

It seems certain that atomic oxygen is also produced by action of short ultraviolet light on carbon dioxide throughout the atmosphere. This oxidant is extremely reactive and it combines rapidly with organic matter at temperatures comparable to the lowest seen on Mars.

The history of Mars has many parallels to that of Earth, but it is clear that there are differences. Through examination and interpretation of the similarities and differences between Earth, Mars, Venus, and the moon we will eventually better comprehend the early history and evolution of the solar system and our knowledge of Earth will be enriched.

—PHILIP H. ABELSON



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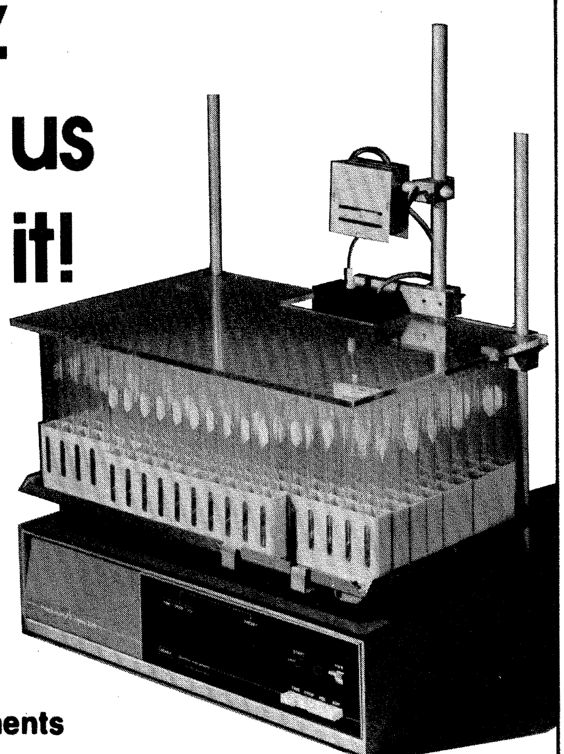

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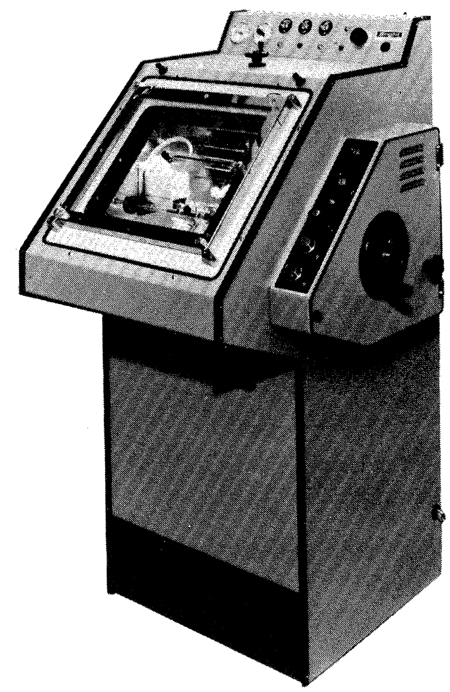

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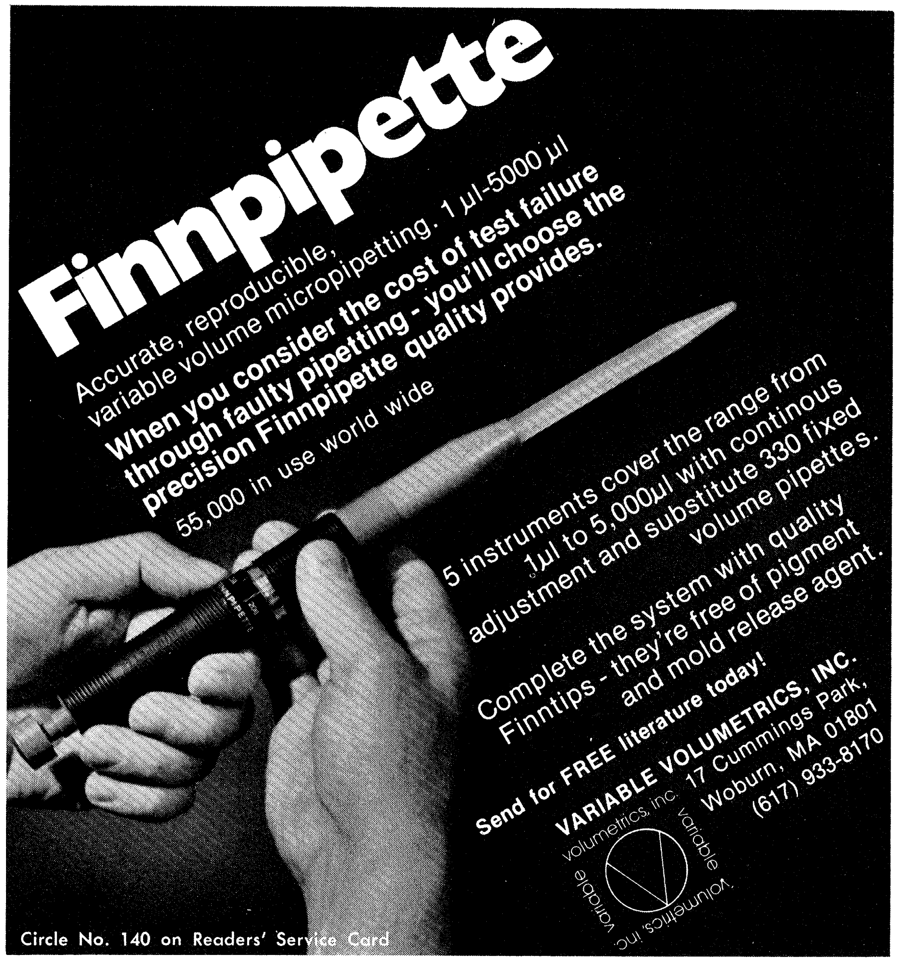

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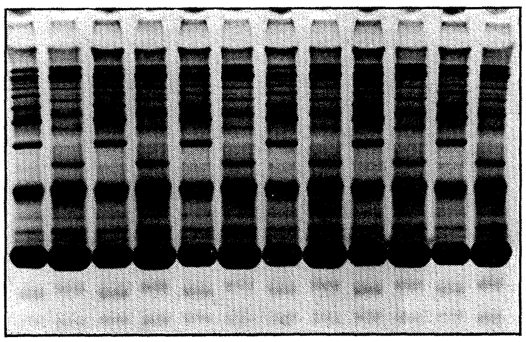

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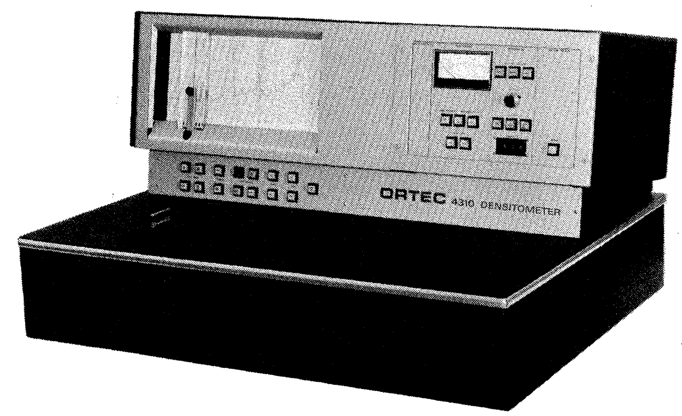

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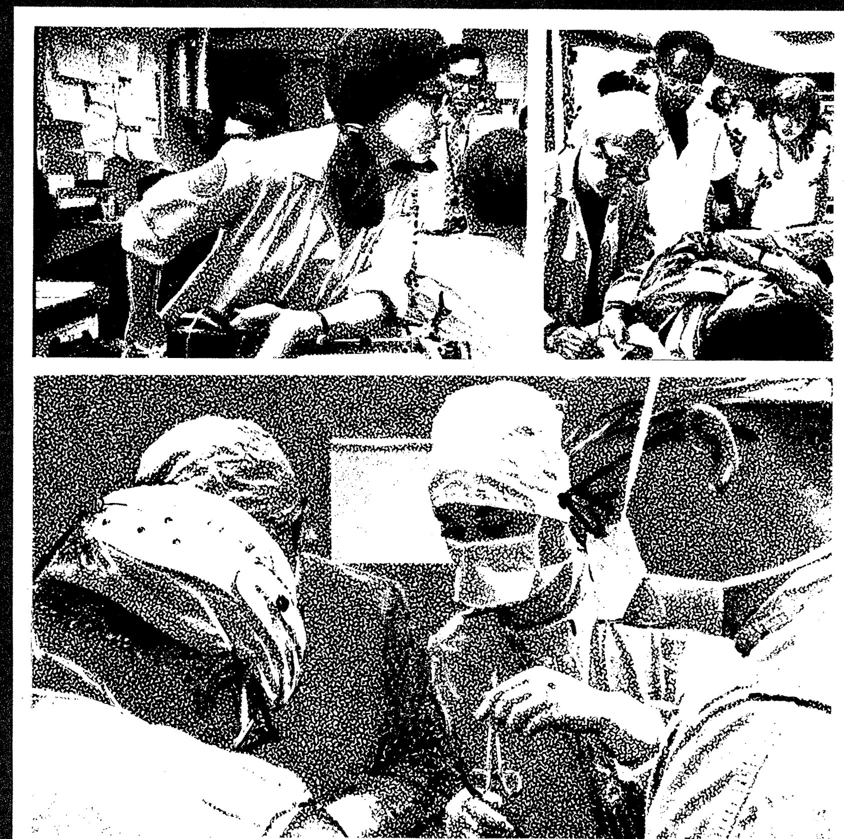

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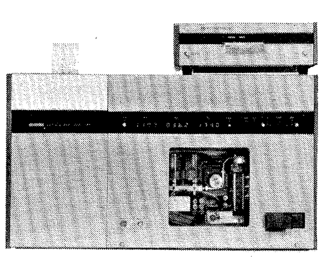

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—RICHARD G. SOMMER

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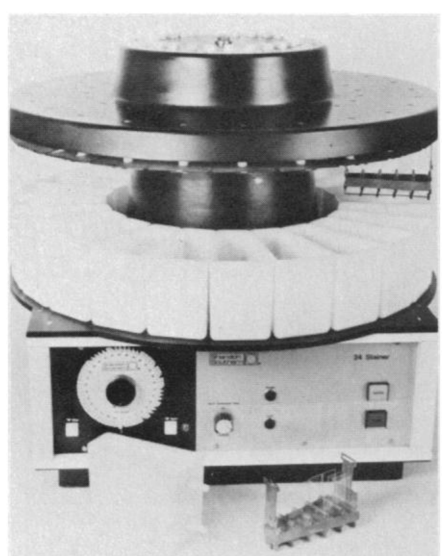

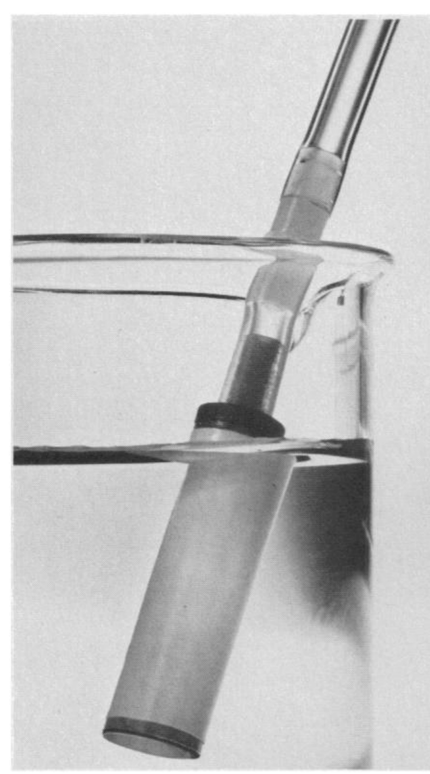

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Literature

Aflatoxin Standards is the topic of the May-June issue of *Gas-Chrom Newsletter*. All four major aflatoxins are included in a new kit. Applied Science Laboratories. Circle 819.

Polytron Homogenizers is devoted to applications of these instruments that combine ultrasonic energy with mechanical shearing. Brinkmann Instruments. Circle 820.

Quality Control Program comprises reports sent to participating laboratories to evaluate their analyses of blind control sera. Wellcome Reagents Division, Burroughs Wellcome. Circle 821.

Finnpipette describes a line of liquid transfer devices for a variety of laboratory procedures. Variable Volumetrics. Circle 829.

Clinical Products is an annual catalog that includes kits for many routine analyses and for other special chemistries. Amersham/Searle. Circle 830.

Carbon Dioxide Incubators are described in a catalog that is fully illustrated and includes design specifications. Hotpack. Circle 822.

Radioimmunoassay of Drugs of Abuse is the topic of Clinical Brief CB-31. The brief surveys procedures, components, and kits currently available for both detection and quantification. Beckman Instruments. Circle 823.

Substitute for Benzidine in the Detection of Blood is described in a product brochure. The product, 3,3′,5,5′-tetramethylbenzidine is safe and specific. Tridom Chemical. Circle 824.

Ultrapure Water for the Laboratory lists a variety of methods and instrumentation for the production of water that is free of impurities, organisms, and contaminants. Culligan USA. Circle 825.

Immuno-Fluor is devoted to rapid quantitative assay of immunoglobulins G, A, and M. Bio-Rad Laboratories. Circle 826.

Deconex is a laboratory detergent. It is described in a product pamphlet. Atomergic Chemetals. Circle 827.

Human Anatomical Models includes osteologic preparations, plastic models, slides, and charts. Ambiomed International. Circle 828.

Analytical Instruments gives an overview of a line of data systems, spectrometers, electron microscopes, and x-ray diffractometers. AEI Scientific Apparatus. Circle 803.

Logic Analyzers includes features of a line of digital apparatus with explanations of potential applications. Biomation. Circle 806.

NEWS AND COMMENT

(Continued from page 749)

APPOINTMENTS

Wernher von Braun, president, National Space Institute, to chairman of the board at the institute and **Hugh Downs**, vice president at the institute, to president. . . . **George M. Low**, deputy administrator, National Aeronautics and Space Administration, to president, Rensselaer Polytechnic Institute. . . . **William H. Knisely**, vice president for academic affairs, Medical University of South Carolina, to president of the university. . . . **William M. Birenbaum**, president, Staten Island Community College, to president, Antioch College. . . . **Arlan Burmeister**, acting president, Austin Community College, to president. . . . **D. Ralph Campbell**, principal, Scarborough College, University of Toronto, to president, University of Manitoba. . . . **Peter Clifford**, associate dean, School of Education, St. John's University, to president, St. Mary's College, Minnesota. . . . **John A. Coughlan**, executive vice president, Merrimack College, to president of the college. . . . **Myron L. Coulter**, vice president for administration, Western Michigan University, to president, Idaho State University. . . . **Samuel E. Curl**, associate vice president for academic affairs, Texas Tech University, to president, Phillips University. . . . **Robert A. Davis**, president, Brevard College, to president, Florida Southern College. . . . **John B. Duff**, provost, Seaton Hall University, to president, University of Lowell. . . . **J. Wade Gilley**, president, J. Sargeant Reynolds Community College, to president, Bluefield State College. . . . **Richard F. Gottier**, vice president and provost, Western New England College, to president. . . . **Peter W. Likins**, associate dean, School of Engineering and Applied Science, University of California, Los Angeles, to dean, School of Engineering and Applied Science, Columbia University. . . . **Clifford G. Grulee, Jr.**, vice chancellor, Louisiana State University Medical Center, to dean, Rockford School of Medicine, University of Illinois. . . . **Robert L. Tuttle**, acting dean, Medical School, University of Texas, Houston, to dean of the school. . . . **Joshua N. Goldberg**, professor of physics, Syracuse University, to chairman, physics department at the university. . . . **M. Brian Bayly**, professor of geology, Rensselaer Polytechnic Institute, to chairman, geology department at the institute.