SCIENCE

30 January 1970

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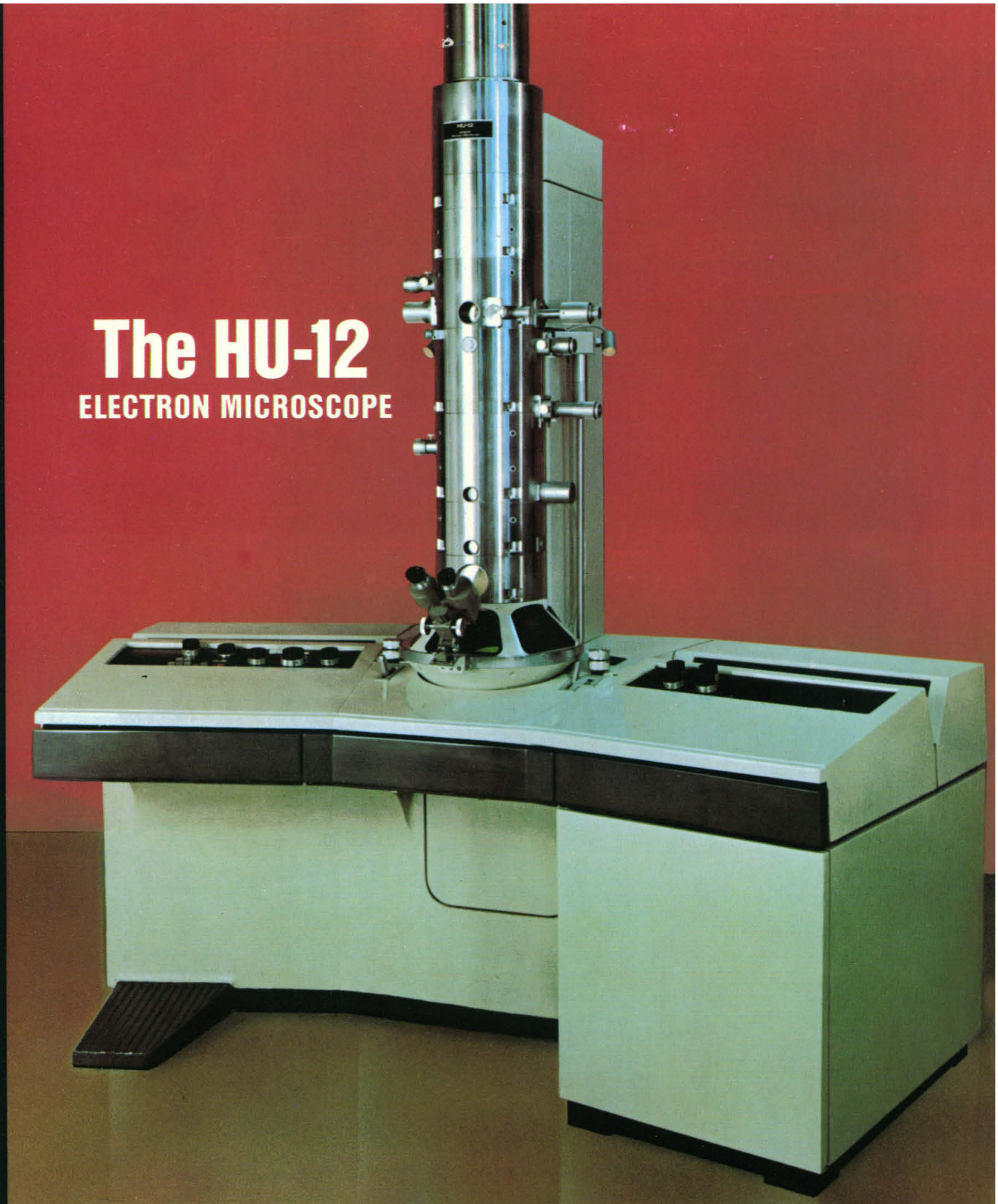

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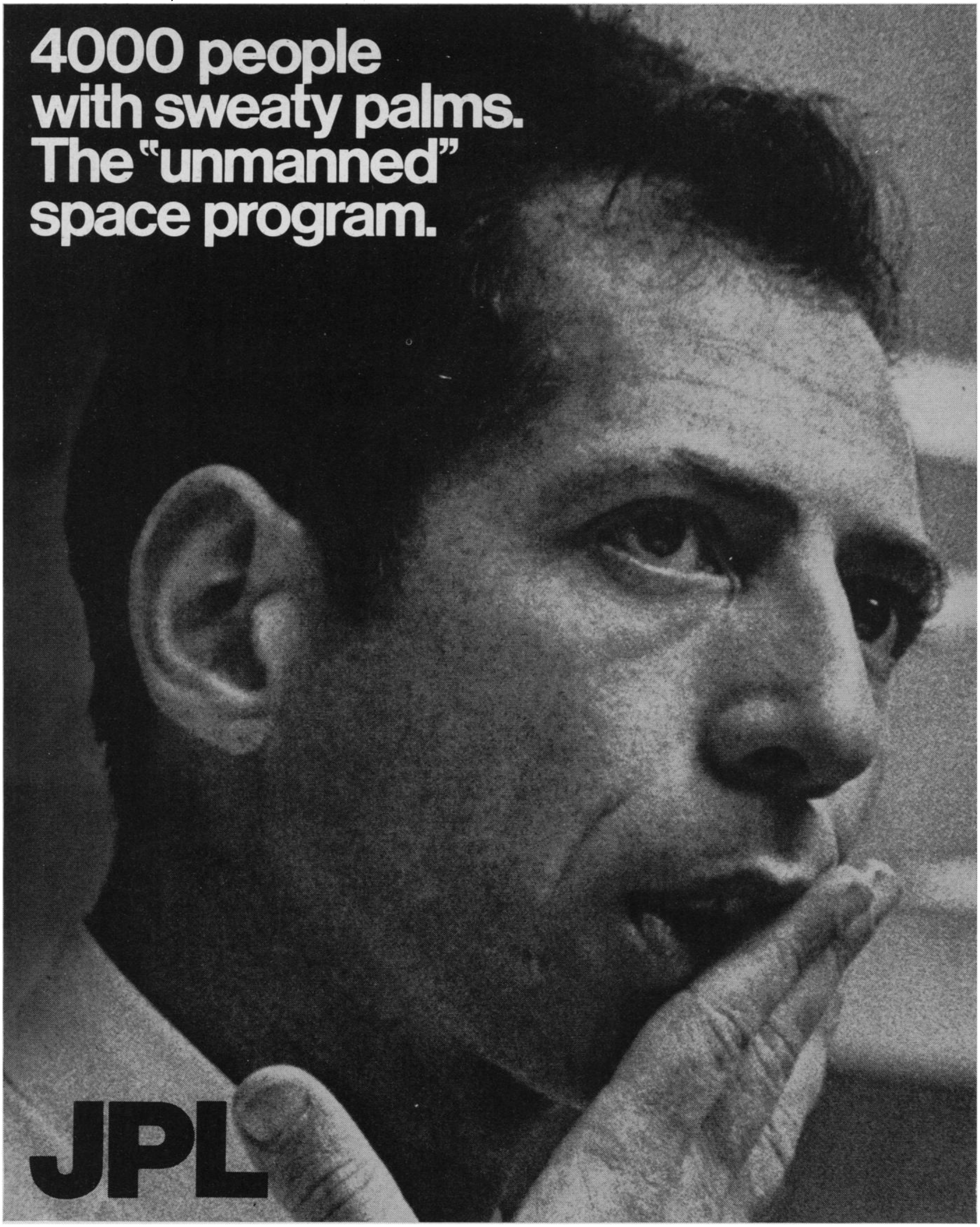
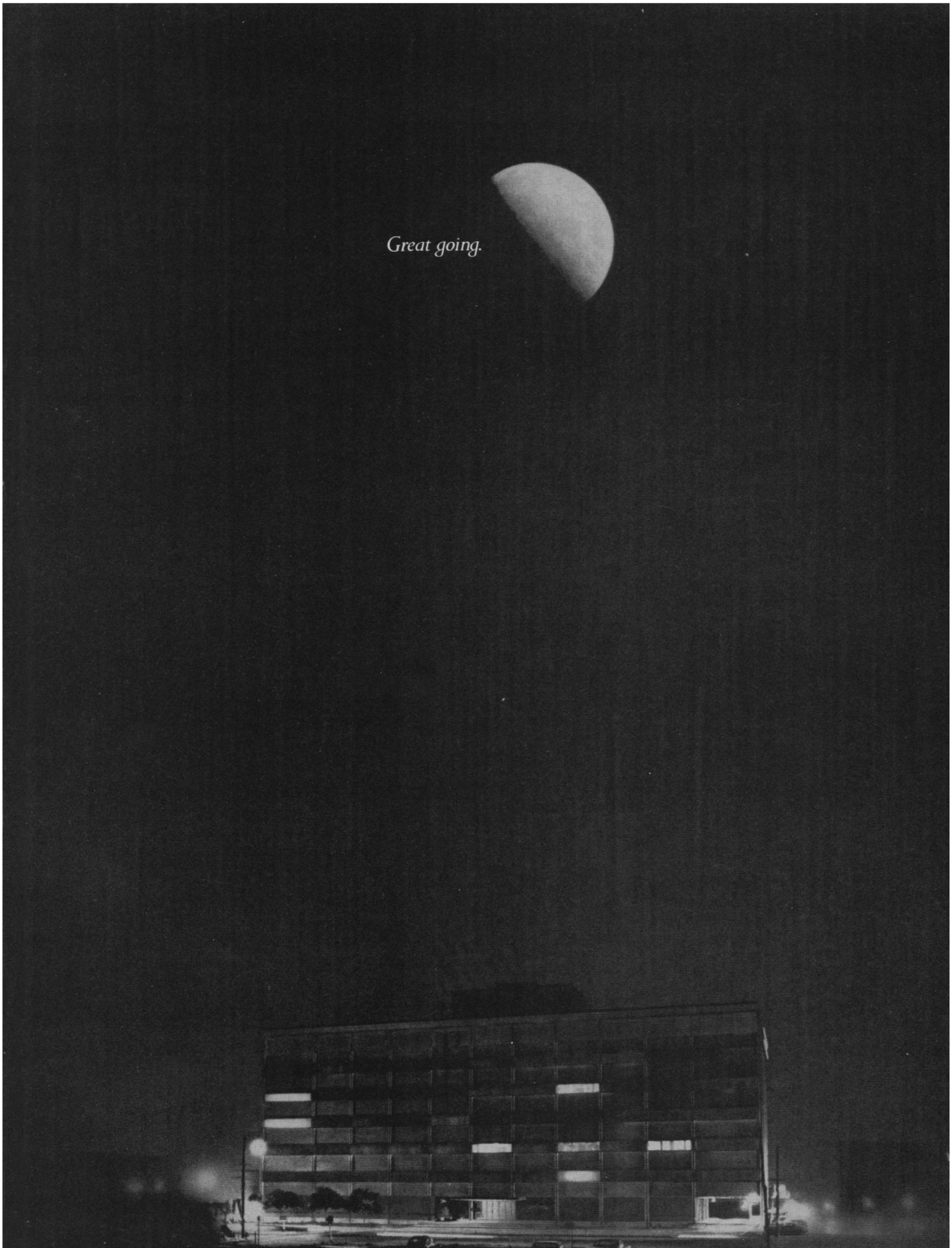
COVER

Meteoritic body (4 millimeters in diameter), composed of Ni-Fe and FeS, mimics man's image of the moon. This fragment crashed on the moon. The event produced a liquid drop, which collapsed as it cooled in the lunar gravitational field. The upper side of the fragment was abraded by lunar dust and struck by splashed lunar fragments traveling at crater-forming speeds. See page 664. [V. E. Krantz, Smithsonian Institution]


4000 people
with sweaty palms.
The "unmanned"
space program.
JPL


Great going.

back on earth the big name in specialty gases is matheson

MIGHTY JUPITER is eleven times larger than earth. When we look at it, we see a vast, turbulent ocean, not of water but of gas—hydrogen and helium with smaller quantities of methane and ammonia.

Our universe is serving the scientific community with specialty gases and gas systems. We market more than 130 different gases for laboratory and plant. Anything you can find around Jupiter, you can find at Matheson. Our universe also extends to gas handling equipment—an exclusive line of equipment for controlling, measuring, testing, producing, mixing, transporting, detecting and analyzing compressed gases.

By Jupiter, now wouldn't you say that we're big in specialty gases? By Matheson, we'd have to agree with you!

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13-69G

What did we learn from building the moon camera?

We learned what a good camera we already had on earth.

Because the moon Hasselblad is basically our electrically-driven Hasselblad 500 EL.

We also learned that NASA's photographic needs were much the same as the needs of serious photographers anywhere.

NASA needed to bring back high-resolution photographs. (Don't *you?*) The Hasselblad 500 EL offered the superb optics of Carl Zeiss lenses, plus the large 2¼" square format.

NASA needed great shooting capacity. (Haven't *you* been in spots where you wish you'd had more film in your camera? Or could switch from black and white to color in mid-roll?) The 500 EL, with its interchangeable backs, offered a large capacity magazine. Which meant that no film would have to be loaded by the astronauts during the entire moon flight. A fresh, preloaded back could be snapped on as needed. In a matter of seconds.

NASA needed simplicity of operation. (Aren't there times when you, too, want to concentrate on your subject, not your equipment?) The 500 EL offered electrically-driven automatic film advance and cocking of shutter.

Most of all NASA needed fail-safe reliability. (After all, if *you* were going on a long trip and didn't know when you'd get there again, you'd want insurance, too.) Since Hasselblad had been the space camera since 1962, there was no doubt that it would perform reliably on the moon.

There are, of course, some differences between the moon and earth Hasselblads.

For one thing, the moon Hasselblad has wings on the diaphragm and shutter speed rings so they can be operated with bulky gloves on.

It has an oversized shutter release button for the same reason.

It has a longer handle on the film magazine slide for the same reason again.

And it has a hinge to keep the film back from floating off into space during weightlessness.

The earth Hasselblad doesn't have any of these things because it doesn't need them.

On the other hand the earth Hasselblad has things the moon Hasselblad doesn't have. Or need. Like interchangeable film transport mechanisms and interchangeable viewers.

In its own way, the earth Hasselblad, with its reflex viewing system, is just as sophisticated as the moon Hasselblad. So rather than stand in awe of the astronauts' Hasselblad, it would be equally appropriate for the astronauts to stand in awe of *your* Hasselblad.

If you don't require an electrically-driven film advance, there are other Hasselblad bodies. All part of the Hasselblad system which includes three basic cameras, eight interchangeable Carl Zeiss lenses ranging from 40 to 500mm, five interchangeable magazines from 12 to 70 exposures, interchangeable viewfinders plus a large number of specialized accessories.

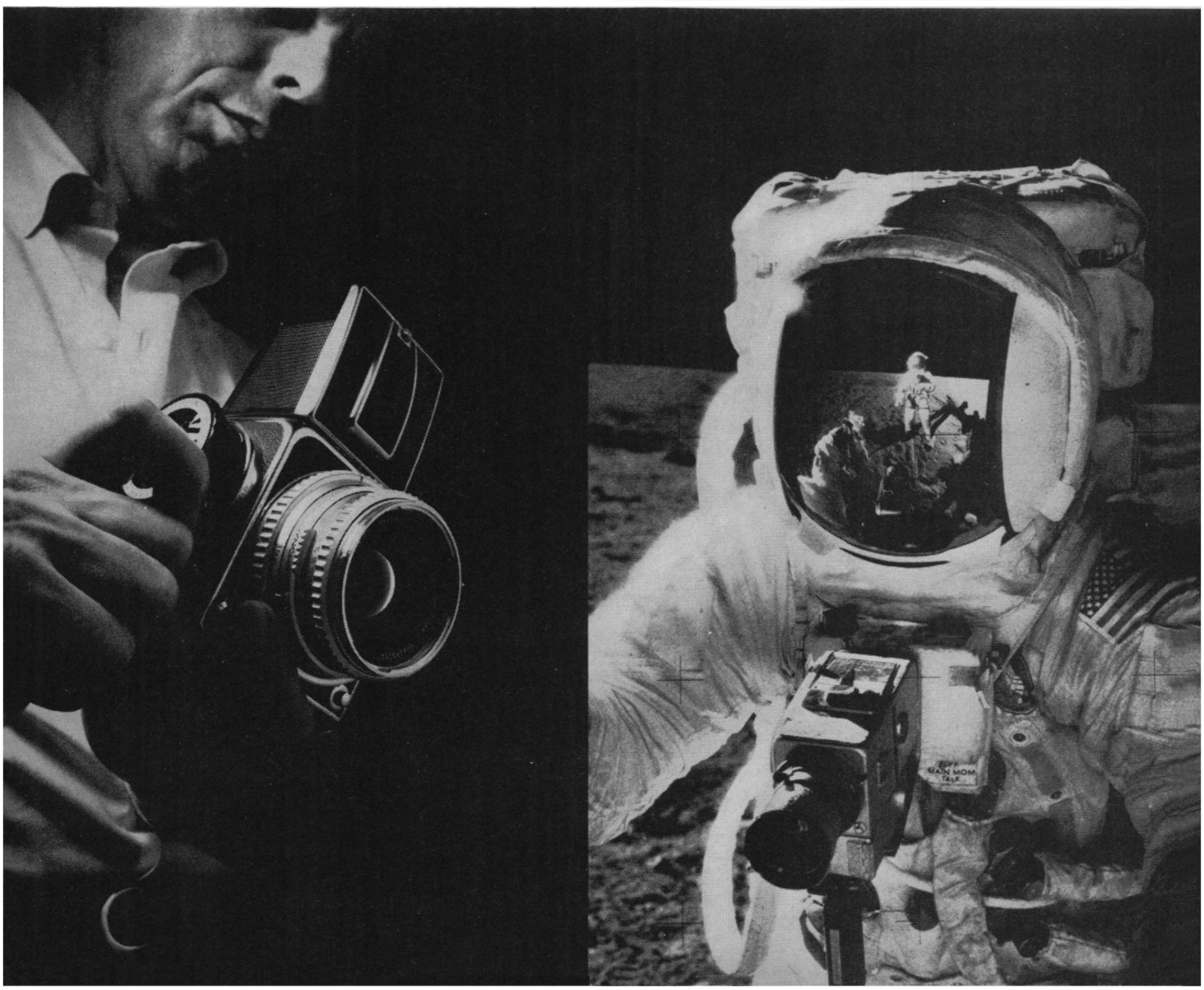
We didn't have to push technology to fantastic new limits to come up with the moon camera. We had been making such a product all along.

Which only goes to show that when you constantly shoot for the moon, you stand a good chance of making it.

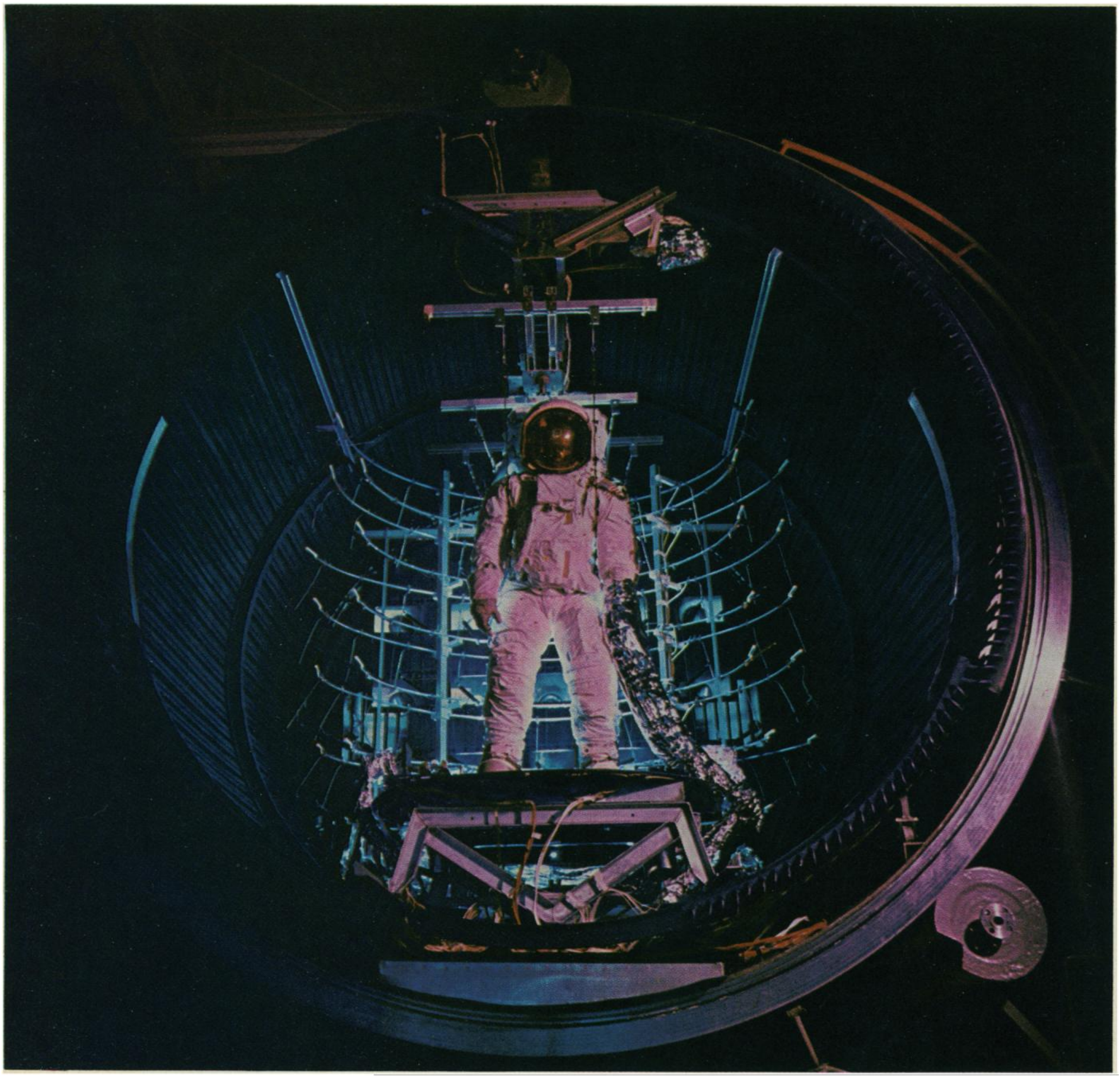
For more information, see your Hasselblad dealer. For your free 48-page catalog on The Hasselblad System, write Paillard Inc., 1900 Lower Road, Linden, N.J. 07036.

HASSELBLAD

Paillard Incorporated: Bolex.Hasselblad.Hermes.



Spacesuit for moonwear and portable life support system being tested in LTV Aerospace's space environment simulator.



WHY DO ANYTHING?

Why sail Westward out of Renaissance Europe, at ruinous cost, and risk falling off the edge of the world?

To see what's over there.

And to find a new world, green and virgin, rich and full of gold. And full of hope.

Why poke about under 19th-Century microscopes, facing ridicule and hunger and the waste of a lifetime?

To see what's down there.

And to find new microworlds, full of cures and knowledge of ourselves. And full of hope.

Why do anything? Why go to the moon, the planets, and the stars?

To see what's out there.

Somehow inevitably to make us more than we are. To push back the edges as long as there are edges to push back. To find unimaginable new answers, inexpressible new excitements, ineffable new hope.

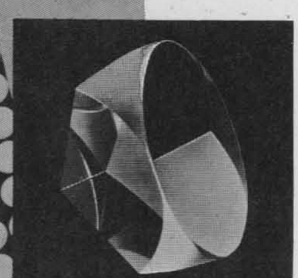
For whenever and wherever man has gone looking before, to see what was there, he has been right to do so. And he has never gone unrewarded.

LTV AEROSPACE CORPORATION

A quality company of Ling-Temco-Vought, Inc. LTV


What on Earth do we do next?
Landing men on the moon is only a beginning. TRW is proud of its part in this great achievement. But now the nation will look ahead to other goals on other planets. On Earth, for instance.
It is right here on Earth that we will set some of the major goals of the next decade...goals to improve communication and navigation, to fight hunger and to end the pollution of our environment. And the sustained technological drive that took us to the moon has given us a good start.
For example, TRW's Intelsat III communications satellites are already bringing live TV and telephone service to millions around the world. Our successful OGO spacecraft are readily adaptable as Earth Resources Technology Satellites to help increase the world's food supply and locate new natural resources.
TRW is already proving that many of these same scientific and engineering advances are directly applicable to critical everyday problems. We are actively working on air and ground transportation and traffic control systems, air and water pollution control, city planning and development, hospital and medical systems and public safety programs.
But even as we seek solutions to our problems on Earth, exploration of space goes on. Project Viking is already underway to probe Mars. And TRW is prepared to help.
These are but a few examples of how more than 80,000 TRW employees around the world are applying advanced technology to products, systems and services for commercial, industrial and government markets.
TRW®
On the historic APOLLO missions, TRW contributes in many ways, including the Lunar Descent Engines and Abort Guidance Systems, the S-4B Attitude Control Engines, and a variety of mission planning and software activities.

Suprasil® is making the moon shine brighter



The Laser Ranging Retro Reflector Package, placed on the Lunar Surface by our Apollo 11 crew, is vastly enhancing our knowledge of the Solar System.

The heart of this experimental package is an array of 100 Suprasil (Fused Silica) Corner Cube Prisms, the material for which was supplied by Amersil.

Suprasil, already established as an optically superior material, was still further improved to meet NASA's necessarily exacting requirements. An isotropic homogeneity of better than 1×10^{-6} per cm of pathlength was achieved with our Suprasil material, in order to facilitate the difficult task of finishing the corner cubes to the extreme accuracies required.

The entire NASA-University of Maryland project is representative of Amersil's interest in cooperative development with firms such as Perkin Elmer, A. D. Little, Bendix, and Boxton Beel, each of whom participated in this important and highly successful experiment.

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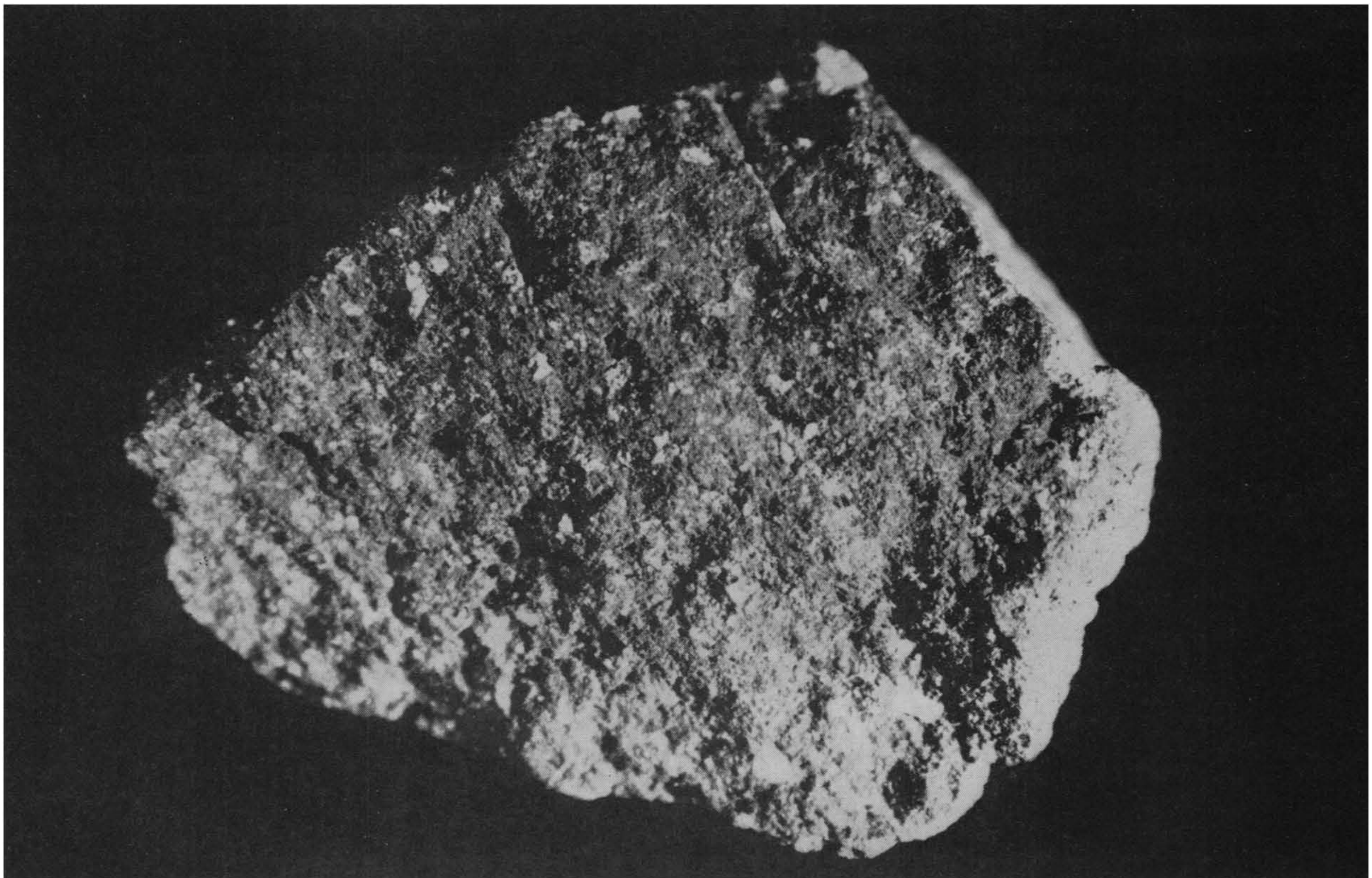


How to evaluate Sigma 5, 360/44 and SYSTEMS 86 real-time computers.

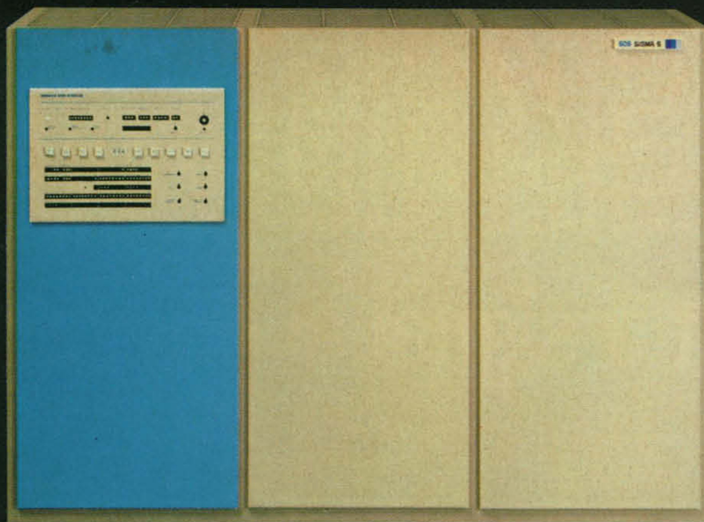
Take a close look at price-performance.

Not just the words, but a detailed comparison—using actual computer kernels—of the real-time response and throughput rates of each computer operating in a multiplexed I/O mode. With a hard-nosed dollar-to-dollar cost comparison.

It shows one of these machines is not only 15% faster, but more than 15% less in price.

It's the one you helped design. Because it grew out of our experience in meeting your real-time hardware requirements. Satisfying your custom software needs. Solving your front-end application problems.

We'd be happy to share the specific results with you. Just send us the coupons.

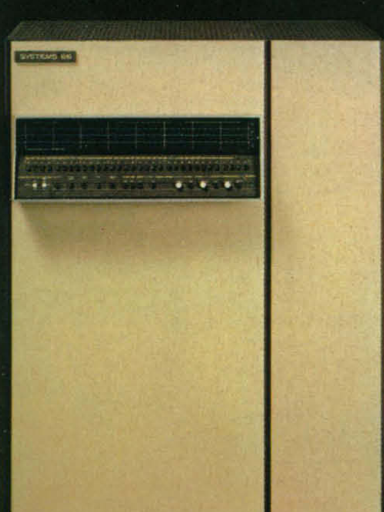


Sigma 5

32-bit real-time computer
Memory cycle time—850 nanoseconds
Typical batch configuration—$435,000

360/44

32-bit real-time computer
Memory cycle time—1000 nanoseconds
Typical batch configuration—$475,000



SYSTEMS 86

32-bit real-time computer
Memory cycle time—600 nanoseconds
Typical batch configuration—$360,000

SYSTEMS Engineering Laboratories
6901 W. Sunrise Boulevard
Ft. Lauderdale, Florida 33310

I'd like to see the actual test results that show why the Sigma 5 came in second in your price-performance comparison.

Name ____________________

Company ____________________

Address ____________________

City __________ State ____ Zip ____

SYSTEMS Engineering Laboratories
6901 W. Sunrise Boulevard
Ft. Lauderdale, Florida 33310

I'd like to see the actual test results that show why the 360/44 came in third in your price-performance comparison.

Name ____________________

Company ____________________

Address ____________________

City __________ State ____ Zip ____

SYSTEMS Engineering Laboratories
6901 W. Sunrise Boulevard
Ft. Lauderdale, Florida 33310

I'd like to know more about SYSTEMS 86. And about how the new SYSTEMS 88 can give me true multi-processing capability in a real-time application.

Name ____________________

Company ____________________

Address ____________________

City __________ State ____ Zip ____

Sangamo's expanding recorder/reproducer capabilities provide faster tracks to knowledge

For this mind-expanding age, Sangamo has developed a far-out family of extremely sophisticated recorders/reproducers. Each type, from the lightweight portable (which outperforms most heavyweights) to towering laboratory models, is programmed for flexibility.

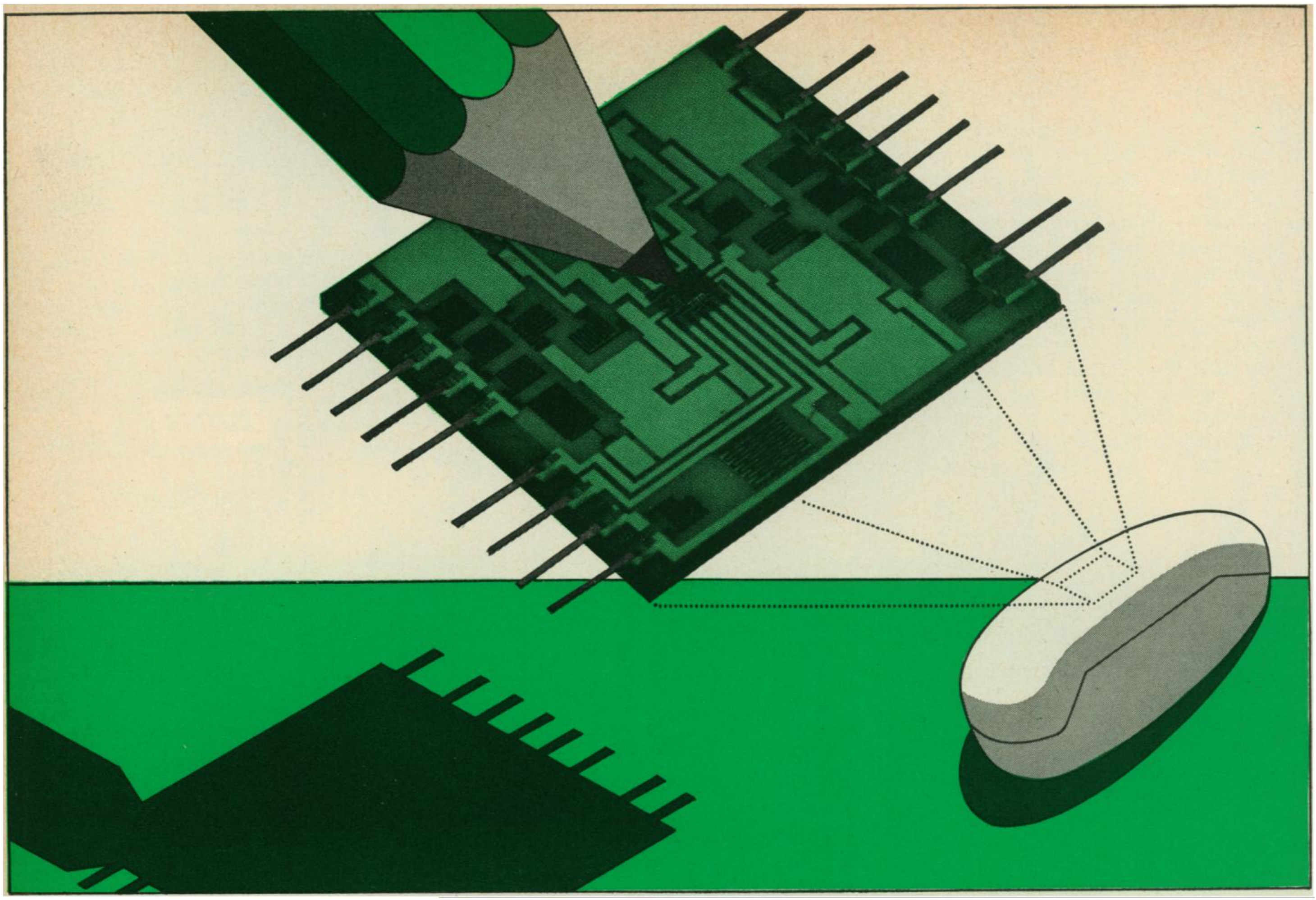
Interchangeable circuit modules permit switching from intermediate band to wide-band to whatever-band you want. And one set of electronics prevents family squabbles between laboratory and portable models.

Whatever your field—industrial, medical, military, or educational—Sangamo tapeabilities help improve your capabilities.

SANGAMO
Information Systems
Springfield, Illinois 62708

The innovators in tape instrumentation

DS70-01



Big future for little circuits

Bell Laboratories engineers have developed a special TOUCH-TONE Trimline® handset that suggests great possibilities for designers of future telephones. In this one, the musical tones you hear when you push the buttons are generated by two oscillators in a "hybrid" integrated circuit (one combining tantalum and silicon technology).

Such tiny, inexpensive circuits free designers from limits imposed by bulky, costly to assemble, discrete components—which restricted the type and complexity of circuit functions that could be designed into a telephone handset. Now, designers can think of people first—of what is easy to use—knowing that the electronics can be made to fit. The postage-stamp size, rugged integrated circuit above, for instance, contains 14 transistors, a diode, and 16 resistors in the silicon chip (under the pencil point), and 19 resistors and 8 capacitors made with tantalum film on the substrate.

Much of Bell Laboratories' integrated circuit work combines tantalum thin-film circuits (for precision passive components) and silicon integrated circuits (for active devices). To unite the two, we invented beam leads—small gold conductors which are formed as an integral part of the silicon circuit. They allow us to bond the silicon to the tantalum circuit in a simple one-shot operation. We've also developed a chemical-metallurgical system which fully seals off and protects the vulnerable parts of the circuit from environmental damage. So, we don't need costly vacuum-tight enclosures.

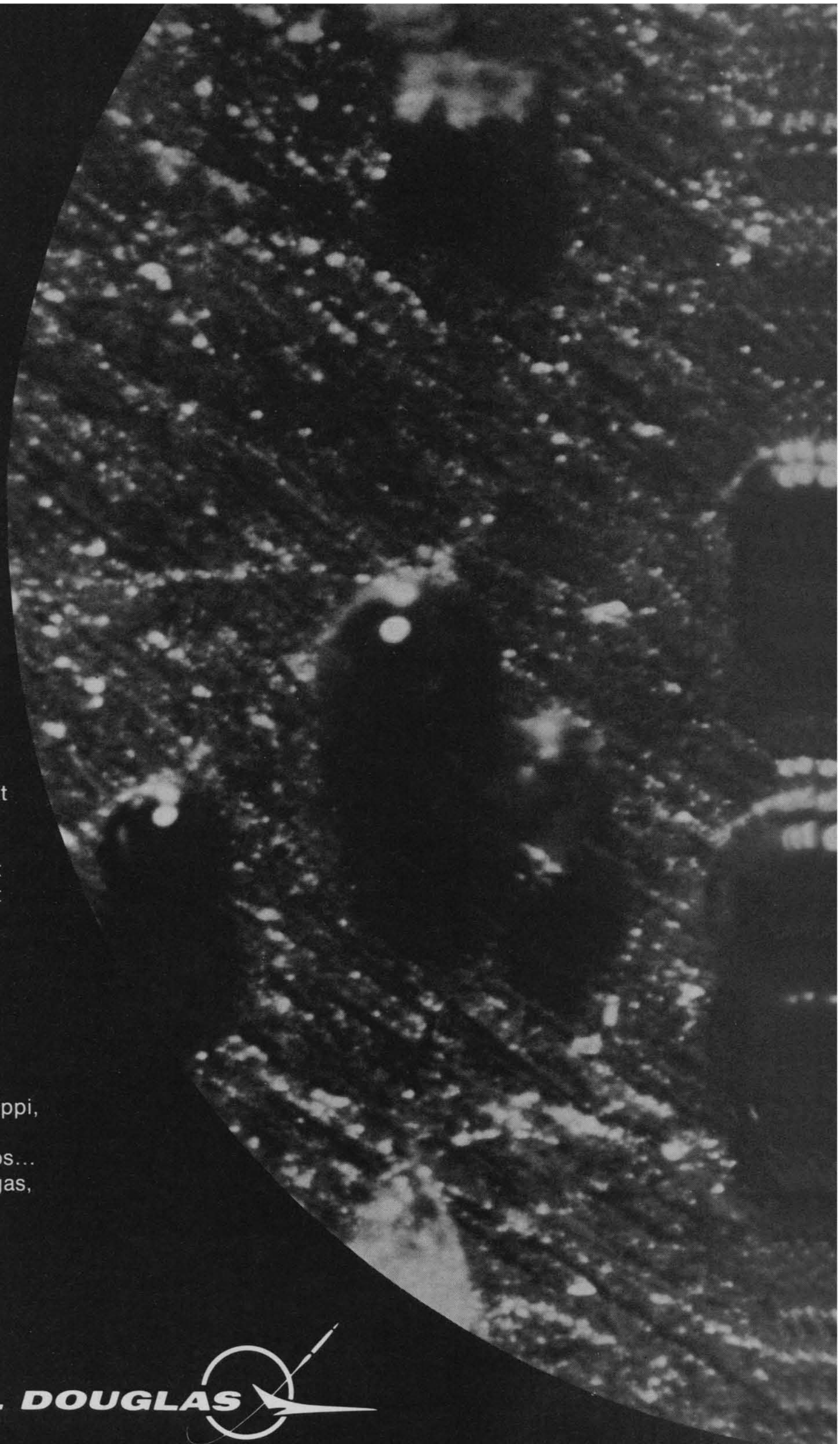
The extreme operational and environmental conditions of telephone use gave us some problems: Tailoring the resistance of thin-film resistors so that the resistance-capacitance product remains constant despite changes in temperature. Designing oscillator circuits whose output frequencies are not affected by varied loadings due to differing cable lengths between telephone and central office. Finding an encapsulant to adequately insulate closely spaced conductors in high humidity.

To customers who use them, handsets with this new circuit will seem like other TOUCH-TONE Trimline sets—though a trifle lighter. But this new telephone technology opens the way to greater freedom for designers and even better telephones for Bell System customers.

From the Research and Development Unit of the Bell System—

Bell Labs

Photograph courtesy of NASA



Moonrocks bought bread in America

America didn't send its dollars to the moon, it sent them to the corner grocery store. The moon rocks were acquired enroute.

The few chunks of metal we put on the moon weren't worth a dime until hardworking people throughout this country put their labor into digging that metal out of the Earth. They used their brains and their hands to shape that metal into the machines of the Saturn/Apollo.

America paid these men and women workers... from Michigan and Mississippi, from Tulane and Tuskegee, from the ghetto and suburbs... and they bought cars and gas, met the rent, and yes, bought bread.

Not moonrocks. Bread.

Right here in America. Where the moon belongs to everyone.

MCDONNELL DOUGLAS

Openings exist on our creative opportunity aerospace team. Send your resume to: McDonnell Douglas, Box 14526, St. Louis, Mo. 63178. An equal opportunity employer.

Scientist or statistician? Some new computer developments are changing things for the better

To the laboratory scientist, the promise of the computer is relief from a growing burden of rather boring statistical work. He is much less interested in the computer's nanosecond-speed and the bit and word-size of its memory than in its ability to accumulate data, plot graphs, make long calculations and generally perform the non-creative tasks that increasingly are reducing his effectiveness as a scientist.

Given the chance, the computer can live up to its promise. But in all too many laboratories, the computer doesn't even stand the chance of a trial because it creates new problems that some scientists consider to be worse than the old. Chief among these is the complexity of putting the computer to work in the laboratory—programming it, mastering the instrument-computer and the man-machine interfaces—which, to the scientist, is often a greater drudgery than the manual data gathering and calculations that the computer eliminates.

Two more or less recent advances in technology will make the computer more readily acceptable to the reticent scientist. The first is the small, instrument-oriented digital computer, a relatively low-cost ($10,000-$20,000) machine with easy-to-use controls, often pre-programmed to do a specific job . . . as in the lunar sample analysis experiment described later. Second is the growing popularity, at lower and lower cost, of shared-time computer leasing, which reduces the physical presence of the computer in the lab to nothing more complex than a typewriter-like keyboard. When coupled with the availability of packaged programs developed by instrument manufacturers for a specific analytical purpose—as in the simulated distillation article described next—shared-time computers will satisfy increasingly larger numbers of scientists.

In both cases, the scientist can capture the advantage of the computer without suffering its complications. Use of the computer requires nothing more complex than answering a computer-initiated dialogue in English and mathematical terms that are already familiar to the analytical technique in question . . . and entering the answer on a keyboard that requires no more than a "hunt and peck" typing skill.

Shared-Time Computer Helps GC Simulate Distillation

A far cry from the alembic used by the 16th century alchemist, the artful glassware used by the modern oil chemist for True Boiling Point (TBP) distillation nevertheless employs the same basic technique: boil and condense. To this day, TBP distillation remains the only accepted way to establish the basic marketing specification of petroleum products . . . and it leaves a lot to be desired. Those who refine petroleum products don't like it because it takes so long: TBP distillation of a wide-boiling distillate can take as long as 100 hours, and the results are useless in controlling the operation of a refinery. Those who buy petroleum products don't like it because the method is not very reproducible, especially as it applies to the initial and final boiling points. Those who perform the distillation don't like it for both of these reasons and because the procedure itself is a long and boring task.

A group of scientists at HP's Avondale Division have devised a completely automatic method that employs gas chromatography (GC) to simulate distillation and produces boiling point distribution data more precisely and in much less time—about 10 minutes—than TBP distillation. The new method employs the HP 7600A Chromatograph System which is capable of automatic unattended operation from sample measurement and injection through GC analysis and digital readout of integration data.

The recipe for simulated distillation with the 7600A is relatively simple. After installing a non-polar column of limited efficiency (most of the methyl-silane silicone rubber phases are satisfactory), set the GC for a linear program of 6 to 10°C/minute starting at −20°C, load the sample tray with as many as 36 different calibration and analytical samples, even of widely diverse boiling ranges up to 1000°F . . . and push the *start* button: the rest is automatic.

The 7600A automatically injects the samples and prepares a punched tape record of the GC retention time and area measurements at precise time intervals. Complete sets of programs provided with the 7600A enable any of the principal time-sharing computer services (including the HP 2000A Time-Shared System) to read the punched tape data, determine the initial and final boiling points of each sample, assign boiling temperatures to each data point and print out the analysis report of boiling point distribution of each sample at 1% increments.

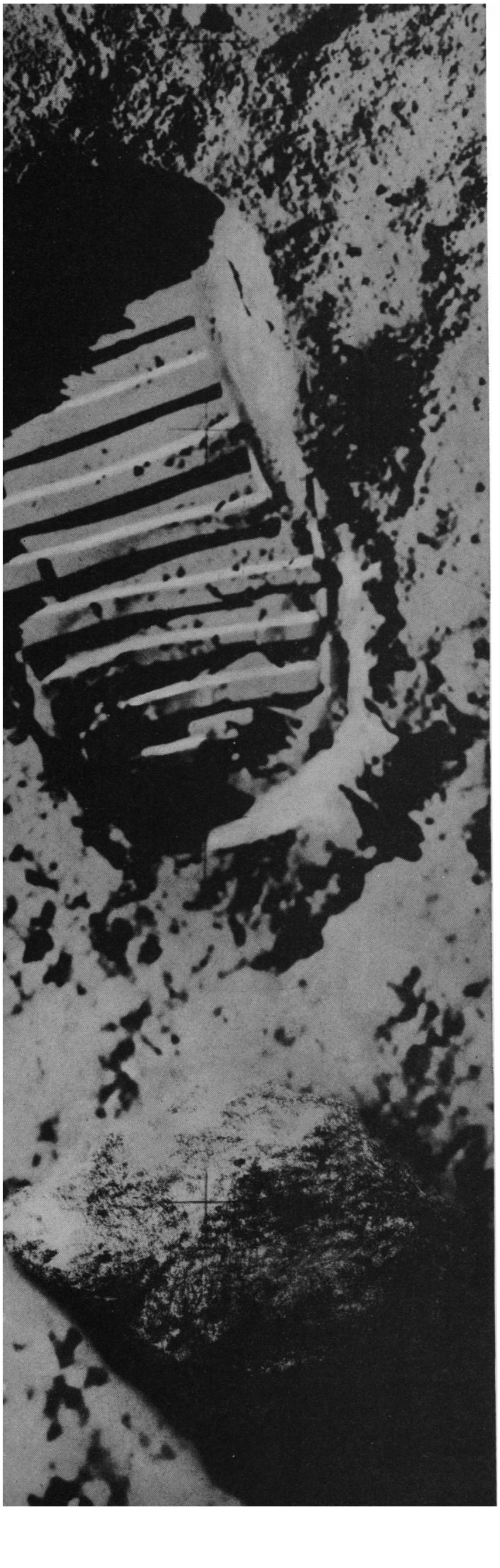
No knowledge of computer programming is required by the analyst. At each stage of the computer-performed calculations, the computer asks for the information it requires and the operator answers by typing the requested number or word on the time-share terminal keyboard.

The precision of the 7600A Simulated Distillation method with wide boiling range samples is greater than is possible by any distillation method. Its speed—an average of 10 minutes per sample—completely outclasses distillation methods.

This new automated Simulated Distillation method is examined in much more meaningful detail in Vol. 2, No. 3 of *Analytical Advances*. Request your copy today.

Dedicated Computer Extracts hidden information from Lunar sample

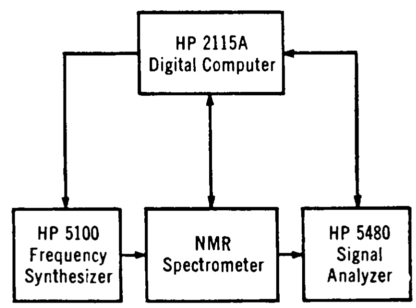
Some of the most respected scientific teams in the U.S. and eight foreign countries are performing analytical investigations on the lunar material returned to earth by the Apollo 11 crew. Among the 100-odd investigations scheduled by NASA, a nuclear magnetic resonance (NMR) analysis will be conducted by a Jet Propulsion Laboratory team headed by Dr. S. L. Manatt. Its goal is to characterize hydrogen nuclei in lunar material and attempt to establish whether any of it can be traced to free or crystalline water molecules presently on the moon's surface. The JPL scientists will also be on the lookout for heavy hydrogen whose presence will allow some conclusions about the history of the moon's surface and about the effect of the solar wind. A study



of oxygen-17 may give them important clues about the current chemical environment of the moon (from surface samples) and about the presence of a lunar sea or ocean in the distant past (from core samples).

Present-day commercial NMR spectrometers are capable of accomplishing, unaided, the work assigned to the JPL team with a creditable degree of success. But when you're analyzing samples that cost about a million dollars a gram to acquire, you're not satisfied with anything short of the best possible performance from your analytical instruments.

In the JPL team's quest for enhancing NMR sensitivity, they devised a system that combines the NMR spectrometer with a frequency synthesizer and signal analyzer under the control of a small digital computer, the HP 2115A, dedicated to this task alone.



The computer-controlled system extracts very weak NMR signals from heavy noise, enhancing instrument sensitivity as much as 100 times. It also performs fast Fourier Transforms of the NMR signal, converting it from time to frequency domain, for a further increase in sensitivity of another order of magnitude.

Here's how it works: the computer digitally sweeps both the frequency synthesizer and signal analyzer through programmed frequencies. Synthesizer output excites the NMR spectrometer which develops noise-covered resonance spikes for each nucleus in the lunar sample; under computer control, the frequency synthesizer also shifts NMR excitation between the resonance and transition frequencies of the nucleus under observation, thereby permitting measurement of relaxation or resonance decay times. The NMR output signal is fed to the signal analyzer which extracts the data from the noise and presents a calibrated display of the average signal at all times. The computer then processes the waveform, converts it from time to frequency domain by Fourier transformation and displays the result immediately in analog as well as digital form. End results of computer-controlled signal averaging and Fourier Transform is to increase spectrometer sensitivity as much as a thousand-fold. (Photo courtesy of NASA.)

Detailed information on HP Signal Analyzers and Computers is available on request. Write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

ANALYTICAL INSTRUMENTS

00971

30 January 1970, Volume 167, Number 3918

SCIENCE

The Moon Issue

The successful Apollo 11 mission placed experimental equipment on the moon and brought back 22 kilograms of lunar materials. The samples presented unique scientific opportunities, but they also presented potential problems. One was the possible contamination of the earth from the moon. Less talked about, but more real, was the possibility of a black market in lunar specimens. Even more likely was the hazard of a wild scramble for publication immediately after samples became available. It was necessary to ensure receipt of the materials by qualified investigators and to prevent flagrant duplication of effort. While many kinds of approaches were to be encouraged, excessive allocation or destruction of a limited supply was to be avoided.

In meeting its responsibilities in these matters, the National Aeronautics and Space Administration employed the power of government wisely. In the choice of investigators and the allocation of samples it followed the advice of groups of highly qualified scientists, including the Lunar Sample Analysis Planning Team (see page 449 of this issue). These groups did their work well. They selected a distinguished body of American scientists and responded generously to qualified applicants from abroad. To ensure proper custody of samples and orderly procedures with respect to publication, NASA released materials only after suitable contracts had been signed. One provision was that investigators were not to divulge information prematurely; instead, all were to participate in a Lunar Science Conference held at Houston, Texas, from 5 to 8 January. On arrival at the meeting, each principal investigator was to submit a written report.

In accord with its goal to publish these articles promptly in a journal of wide circulation, NASA negotiated with *Science*. Our decision to publish these reports was a close one. The material was to be four times the volume of a usual issue. There were worrisome problems of quality control, coupled with the difficulty of handling a large number of reports on a tight schedule. There was also the financial burden. On the positive side was the fact that the examination of lunar samples was a unique event and that *Science* with its broad international circulation (120 countries) could best serve as publisher. A small but nontrivial aspect was the challenge that the task presented to the staff of *Science*.

The financial question was resolved by a contract with NASA on essentially a no-loss, no-gain basis. Obtaining the best possible quality in the manuscripts while avoiding excessive length took some doing. For most investigators, the time between receipt of samples and submittal of manuscripts was only 3 months. The natural tendency was to make measurements until the last moment and then to throw together an article hastily. *Science* insisted that manuscripts be subjected to the reviewing process. Publication of defective material was to be delayed until satisfactory revisions had been made. Rigid limitations on length were established. Authors responded well to the guidelines by submitting manuscripts that were better than usual and that were within the length limitations. *Science* sent a team of editors to Houston and assembled a group of reviewers (page 781), they completed their work on the spot and interacted with authors to make improvements.

Some readers may feel that this issue of *Science* provides more than they care to know about the moon, but others will treasure it as an important part of the scientific record of a great accomplishment.

—PHILIP H. ABELSON