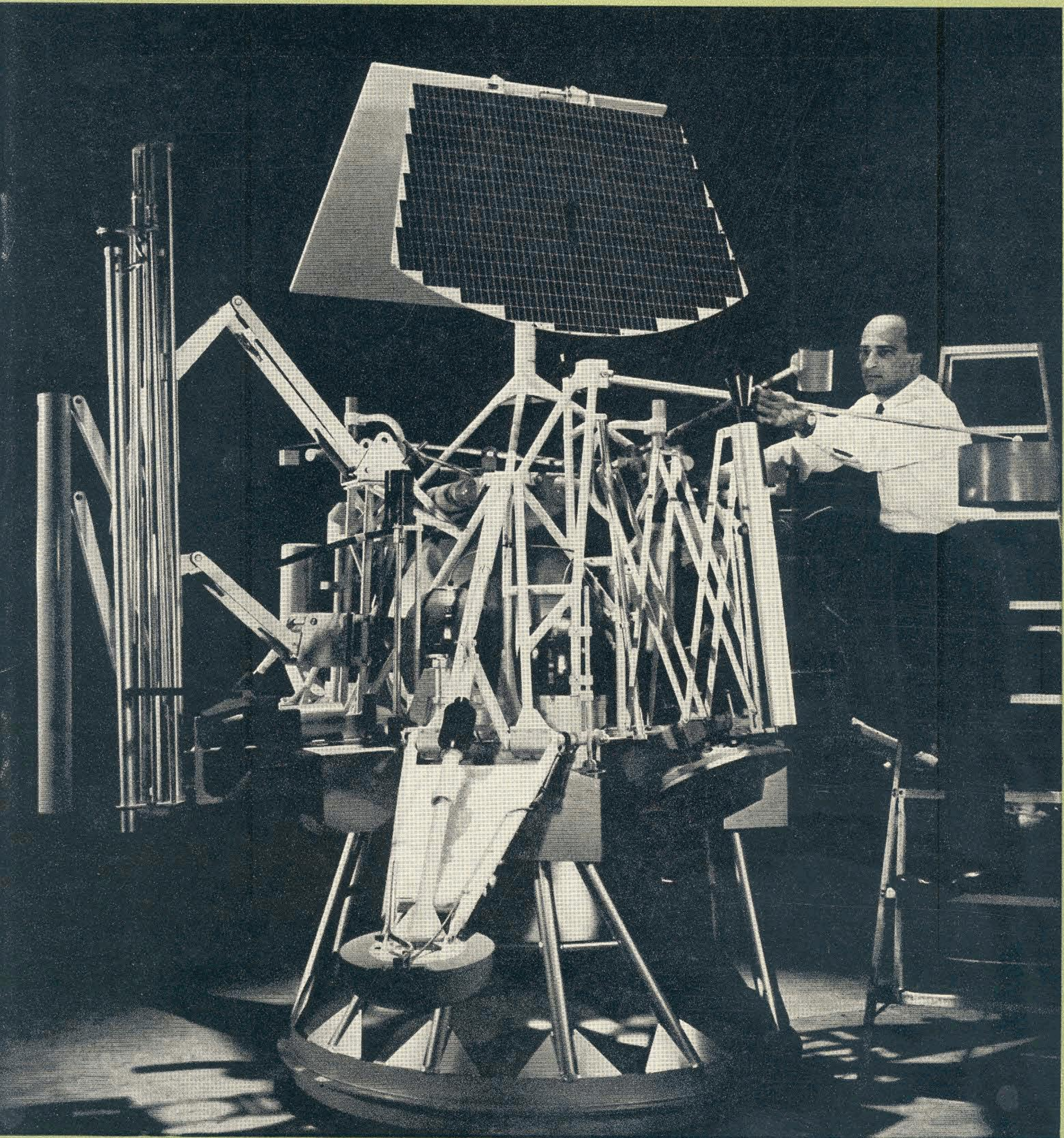
ENGINEERING | AND | SCIENCE

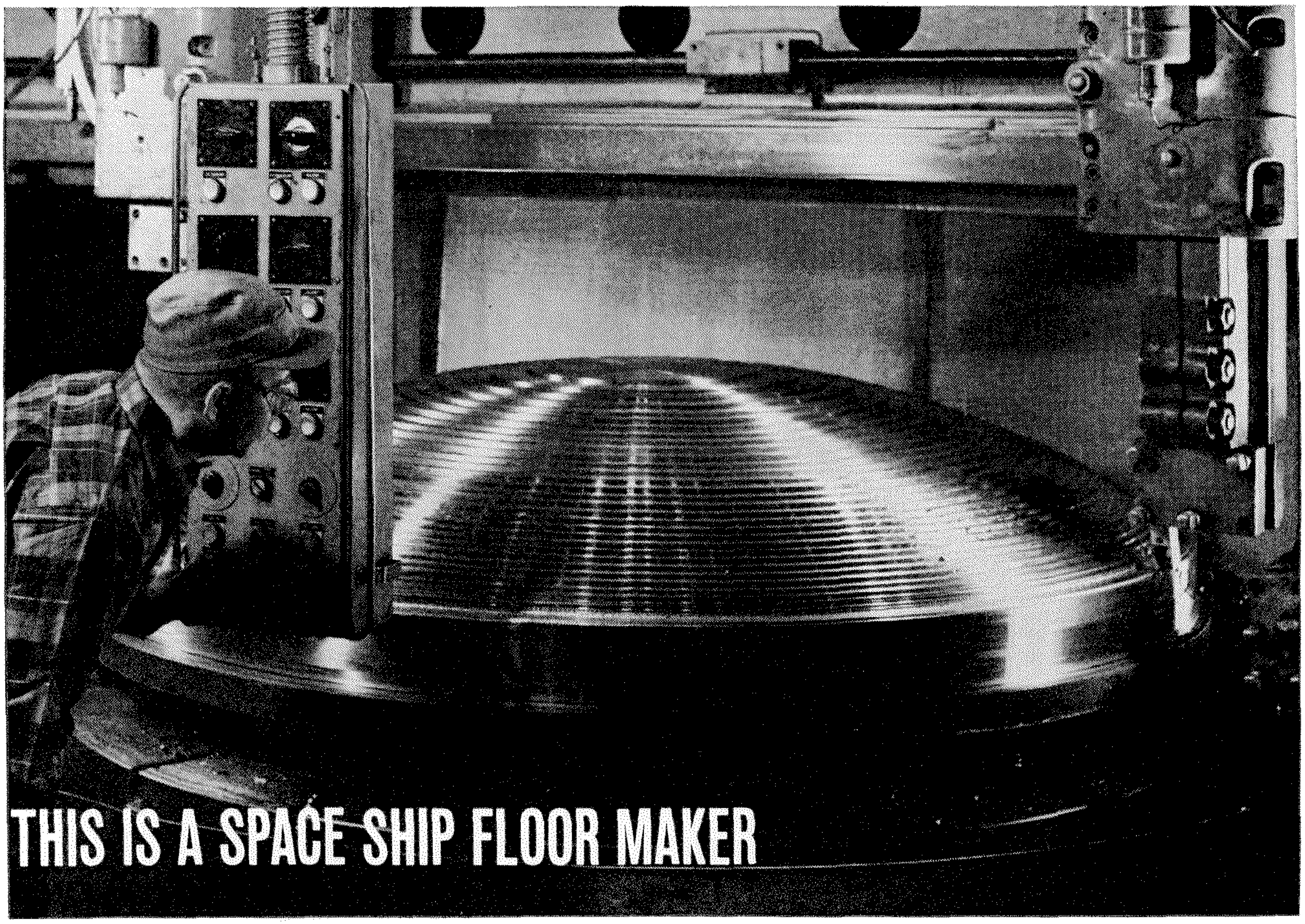
March 1961



Life on other planets? . . . page 11

Published at the California Institute of Technology

Sometime within the next several years, the first American will soar into orbit around the earth. He will be sealed in a small, cone-shaped space capsule mounted atop an Atlas missile. The missile will climb 100 miles in less than six minutes, where the capsule will disengage and go into orbit. The man will be alone in space.



The vehicle for this historic voyage is already in production under the auspices of the National Aeronautics and Space Administration's "Project Mercury." One of the methods of heat protection is a beryllium heat sink, forged on two giant steel dies. Both dies are USS Quality Steel Forgings. The top die (shown being rough-machined on one of our vertical boring mills) will be convex, 20 inches thick and will weigh 26,520 pounds. The bottom die, concave and 18 inches thick, weighs 27,700 pounds. Both are 92 inches in diameter.

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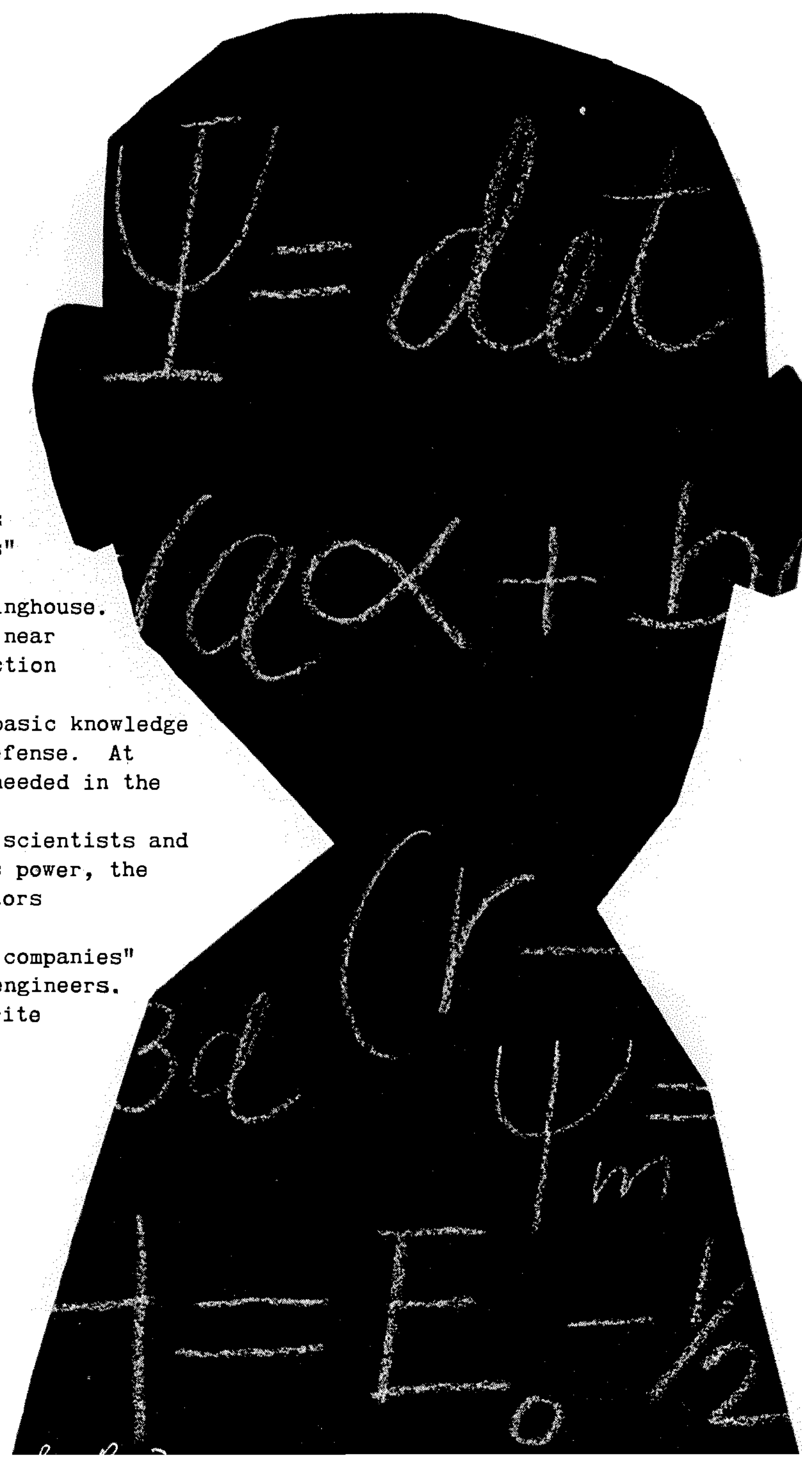

A phenomenon of modern America is the so-called "think company." It owns no factories, manufactures no products and makes no shipments, but just "thinks" about problems--and brilliant ways to solve them.

We have a number of "think companies" within Westinghouse.

One is a group of scientists in the research labs near Pittsburgh who seek basic knowledge, like the production of light by solids, and the origin of magnetism.

Other Westinghouse scientists in Baltimore apply basic knowledge to that most demanding of all problems...national defense. At Cheswick, Pa., another group thinks about products needed in the American home 10 or 15 years from now.

As a result of this kind of thinking Westinghouse scientists and engineers have achieved startling advances in atomic power, the launching system for Polaris, thermoelectric generators and many other developments.

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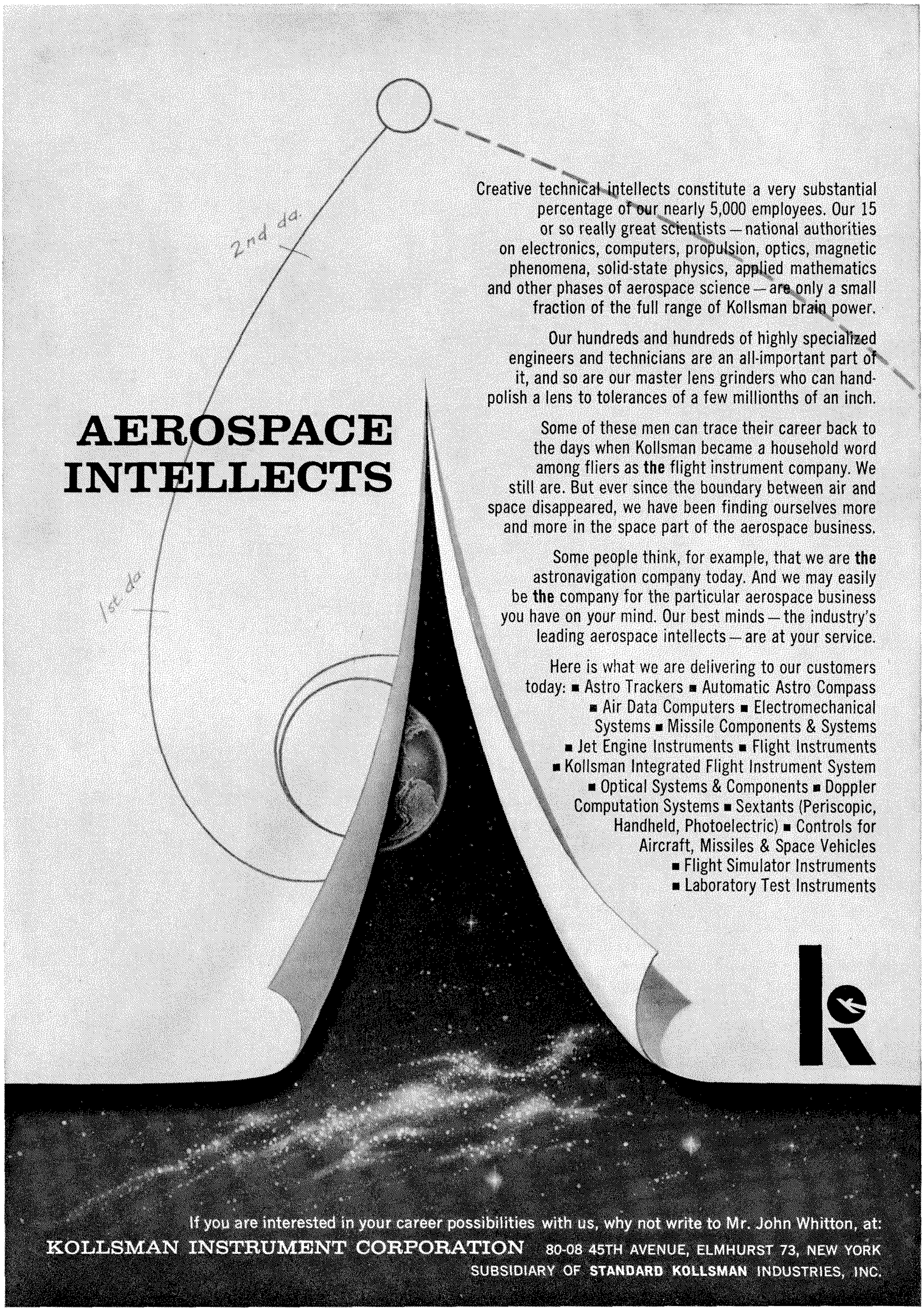
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ENGINEERING | AND | SCIENCE

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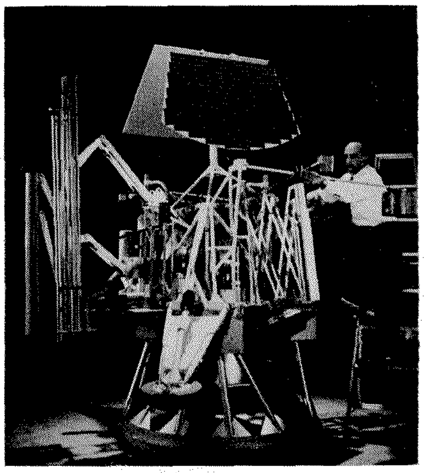

On Our Cover
a full-scale model of the Surveyor spacecraft which will be used to explore the planets Mars and Venus, and the moon, for the presence of biological material. Seven Surveyors are being built by the Hughes Aircraft Company under the direction of Caltech's Jet Propulsion Laboratory.

JPL has been engaged in a program of planetary study for more than a year. Experimental systems now under development, or in the planning stage, at JPL include devices which will detect and analyze organic matter on the planetary surfaces, and inspect samples of soil for microorganisms.

All of this leads, of course, to one question: "Is There Life on Other Planets?"– the title of Norman Horowitz's article on page 11, which has been transcribed from a talk given at Long Beach City College last November 23.

Dr. Horowitz, professor of biology, has been on the Caltech faculty since 1939, when he received his PhD here.

Charles Richter
professor of seismology at Caltech, and developer of the Richter earthquake-measurement scale, writes about his life as a Fulbright Scholar in Japan on page 24.

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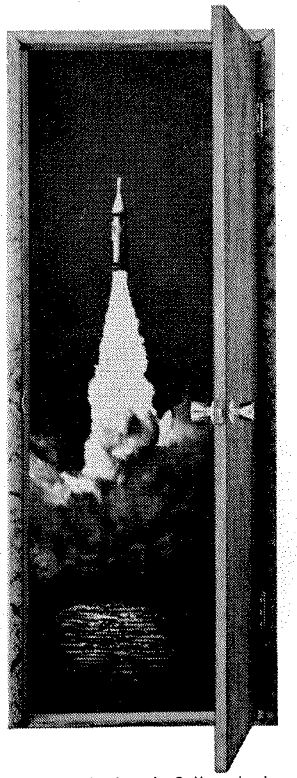
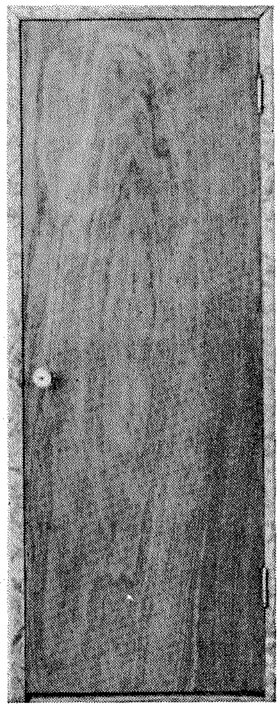
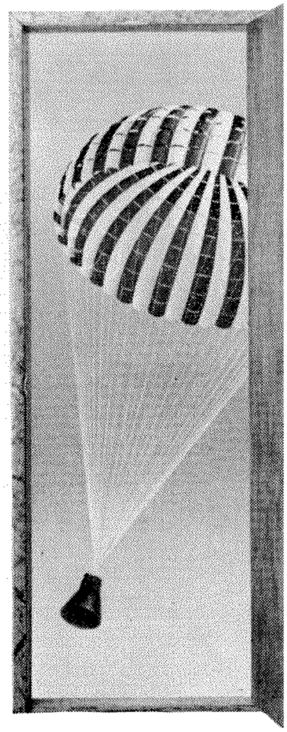


POLARIS: Northrop's Datico checks out Polaris at all levels of maintenance and operation.

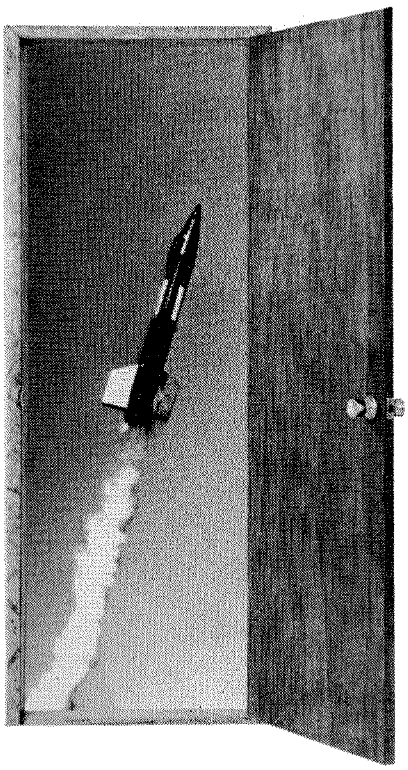


SKYBOLT: Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.

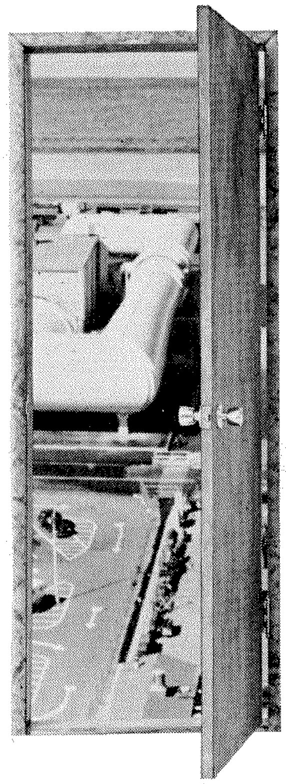


MERCURY: The Northrop landing system is designed to bring the Mercury astronaut down safely.

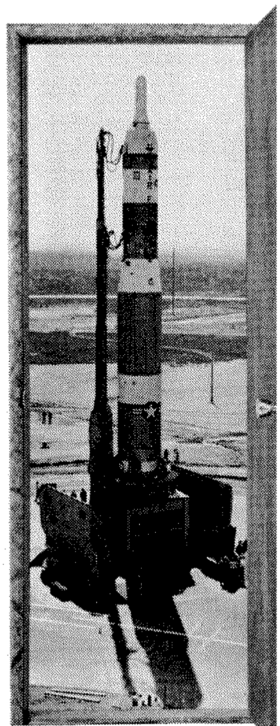
Northrop is now active in more



X-15: Northrop produces Q-Ball, the flight angle sensor for safe re-entry of X-15 and other aerospace vehicles.



AERODYNAMICS: Northrop's Laminar Flow Control technique is designed to greatly increase aircraft range, flexibility, cargo and passenger capacity.



TITAN: Northrop supplies complete technical and industrial management to activate the T-2 Titan missile base

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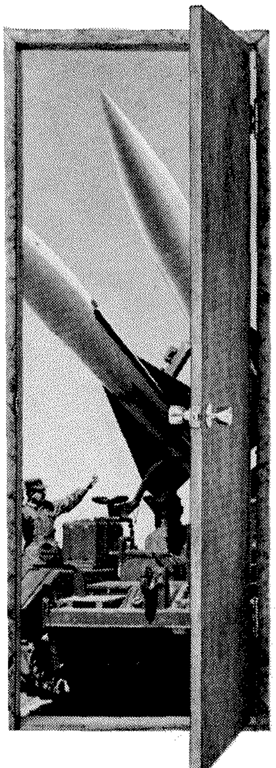
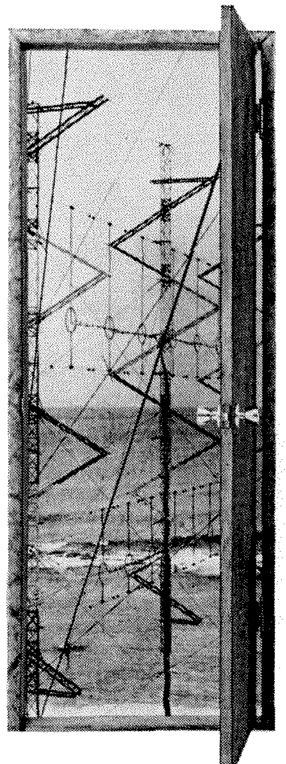
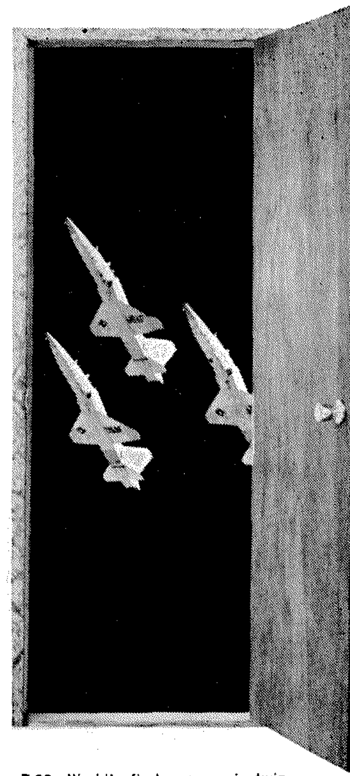


IAWK: Northrop produces airframe omponents, ground handling and aunching equipment for this air de- ense missile.

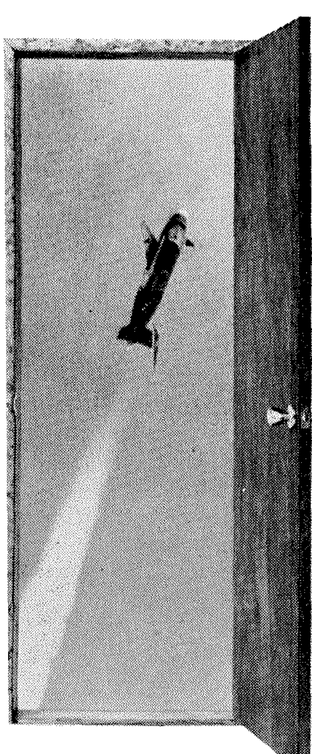


COMMUNICATIONS: Northrop designs the trans-Pacific Scatter Communications Network and other world-wide communication systems for U.S. and free world governments.



T-38: World's first supersonic twin-jet trainer is built by Northrop for the United States Air Force.

than 70 important programs



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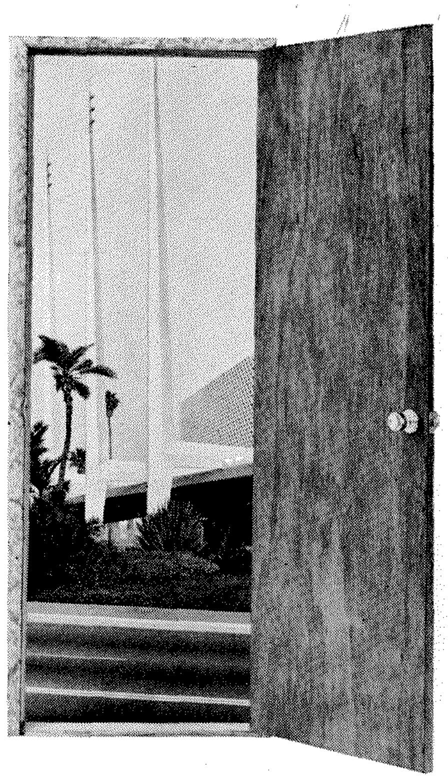

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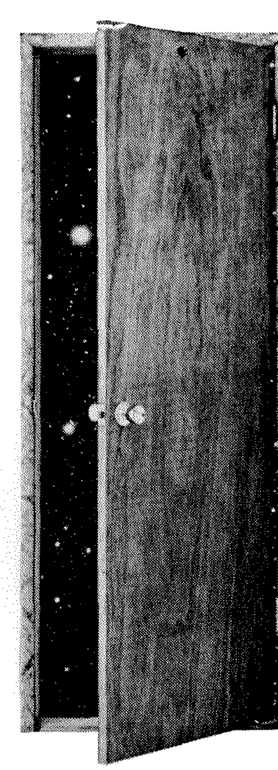

SPACE RESEARCH: Northrop's accelerated space research programs reach into such advanced areas as maneuverability, rendezvous, space vehicle maintenance, space probes, and the survival of men in space.

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Books

India and the West

by Barbara Ward

W. W. Norton & Co. *$4.50*

Miss Ward's new book includes the material that made up her Haynes Foundation Lecture Series at Caltech in February, 1960. Her research on the problems of India has been conducted on a Carnegie Fellowship on Economic Assistance.

Subtitled "Pattern for a Common Policy," Miss Ward's book first considers the development of the modern economy in the West:

"As Western society grappled with the problems and upheaveals of the new economics," says Miss Ward, "It produced two broad versions of modernization; some states achieved their transformation within the framework of decentralized power and free institutions; others were driven by the stress of change to maintain – or lapse into – dictatorial rule. Among these latter communities, Communism has provided the basis for the most thorough and enduring experiments in tyranny."

Today, India is undergoing the profound process of economic change and development which began in the West about 200 years ago. The greater part of her book is concerned with this Indian experiment, which, as Miss Ward says, belongs "in the mainstream of three great contemporary revolutions – the development of the mixed economy and of welfare-capitalism in the West, the counter-revolution of Communist ideology and State capitalism in Russia and China, and the unavoidable duel between these two revolutions for influence in the e x c o l o n i a l and uncommitted world."

It is Miss Ward's thesis that "India's experiment of economic growth within the framework of political freedom can be decisive for the whole future of mankind." The success of this experiment, she maintains, would show the developing countries of the world that economic growth can be attained by democratic means, and she proposes a plan whereby the West could guarantee the success of the Indian – and similar – experiments.

Barbara Ward (Lady Jackson) is a British economist who now makes her home in Ghana, where her husband, Sir Robert Jackson, is chairman of the Development Commission. She is assistant editor of *The Economist*, and is also the author of such other books as *The West at Bay, Policy for the West, Faith and Freedom*, and *Interplay of East and West.*

Great American Scientists

by the Editors of Fortune

Prentice-Hall, Inc. *$3.50*

When the editors of *Fortune* decided last year to find out who were America's greatest living scientists, the results of their search appeared in a series of four articles, which make up this book.

Fortune came up with a list of 40 great scientists – 11 physicists, 11 biologists, 10 chemists, and 8 astronomers. It is of particular interest here that 7 of the 40 men are at Caltech – two physicists (Richard P. Feynman and Murray Gell-Mann); three biologists (George W. Beadle, Max Delbruck, Alfred H. Sturtevant); one chemist (Linus Pauling); and one astronomer (Jesse L. Greenstein).

Fortune has attempted to trace, though brief biographies of these 40 men, "the unfolding and maturing of American science . . . to outline the principal advances in . . . physics, chemistry, astronomy, and biology . . . over the last four decades."

This is a large order, but *Fortune* handles it neatly and in the best popular style. (In fact, in book form – when it is removed from the awesome, outsized, executive-office format of *Fortune* magazine – the same material seems brighter, sharper, and even shorter.) Certainly, the book comes close to the purpose set forth by the editors in a prefatory note:

"This book will have achieved its goal if readers who may be embarrassed by their ignorance of science discover in it some sense of the grandeur of the scientific enterprise and why it has proved irresistible to some of the world's finest minds for the last three hundred and fifty years."

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IMPORTANT DEVELOPMENTS AT JPL...

PIONEERING IN SPACE RESEARCH

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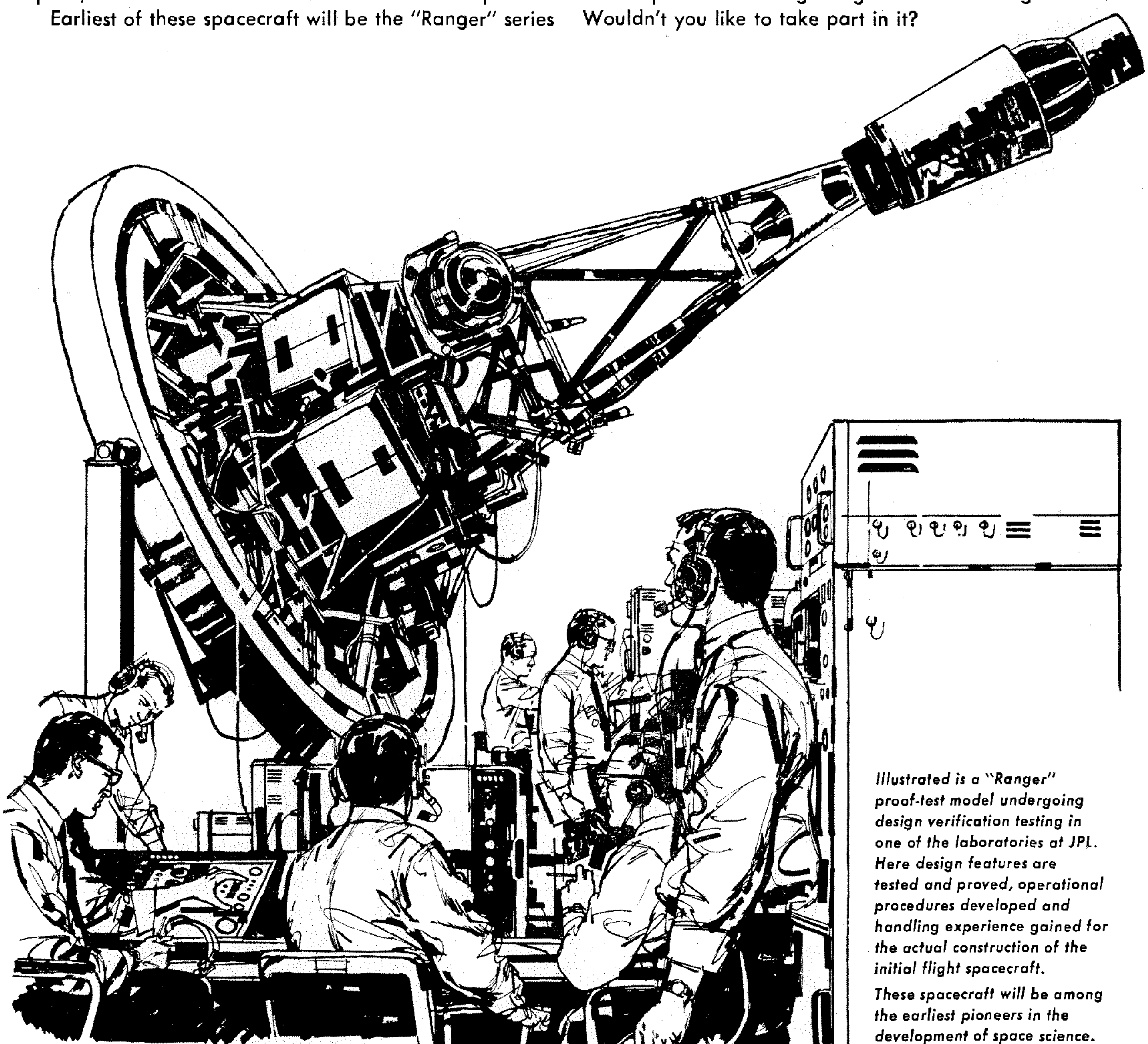
JPL will conduct the missions, utilizing these spacecraft to orbit and land on the moon, to probe interplanetary space, and to orbit and land on the near and far planets.

Earliest of these spacecraft will be the "Ranger" series now being designed, developed and tested at JPL. The mission of this particular series will include first, exploration of the environment and later the landing of instrumented capsules on the moon.

Never before has such a wide vista of opportunity, or a greater incentive been open to men trained in all fields of modern science and engineering. Every day at JPL new problems arise, new theories are advanced, new methods tested, new materials used and new principles discovered. This creates a stimulating work atmosphere for trained individuals and an unlimited field for constructive development of a long-range and rewarding career. Wouldn't you like to take part in it?



Illustrated is a "Ranger" proof-test model undergoing design verification testing in one of the laboratories at JPL. Here design features are tested and proved, operational procedures developed and handling experience gained for the actual construction of the initial flight spacecraft.

These spacecraft will be among the earliest pioneers in the development of space science.

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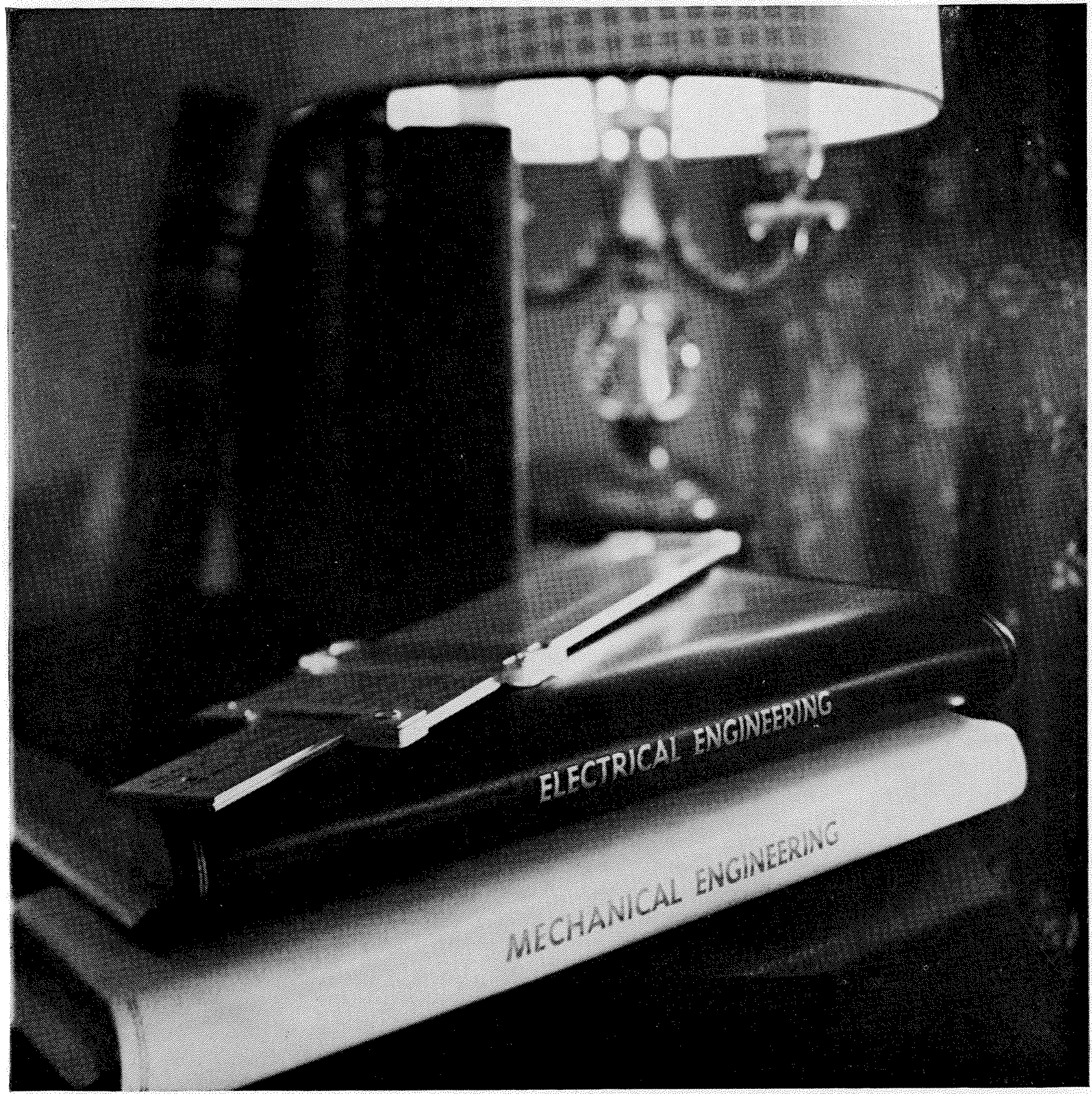

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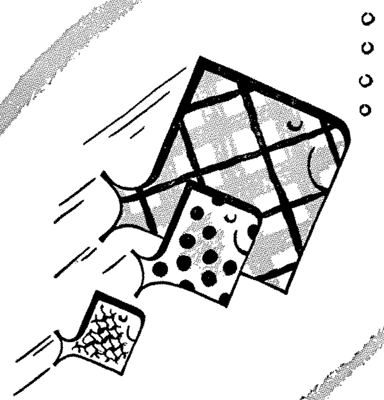

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ENGINEERING AND SCIENCE
March 1961, Volume XXIV, No. 6

IS THERE LIFE ON OTHER PLANETS?

A Caltech biologist considers the possibilities

by Norman Horowitz

Within the next ten years we will be sending rockets to the vicinity of the nearest planets, Venus and Mars. Within the next twenty years we will be exploring the surfaces of these planets – not with human explorers, but by means of automatic instruments landed on the planets which will send back information by radio to the earth. It will be a very long time, if ever, before human beings get as far away as Mars or Venus. But we hope to get a great deal of information about the physics and chemistry and biology of these planets long before men ever get there.

Of all the scientific problems that will present themselves to our exploring instruments, none is so interesting to the general public – or, for that matter, to scientists – as the question: Does life exist on other planets?

The discovery of life on another planet would be one of the momentous events of human history. The study of organisms of other planets would tell us whether our particular form of living matter, based on proteins and nucleic acids, is the only possible kind of life, or whether some other kind of material is capable of showing the attributes of living matter. Knowledge of this kind would greatly deepen our understanding of the origin of life on the earth.

Nucleic acids and proteins are the basic unique materials of living matter on the earth. If we understood how they were generated, we would know how life arose on the earth. They are both very complicated molecules. A good bit is known about their chemical structure, but there is still a lot of work to be done. We know that they resemble one another in one way; they are both high polymers. They are both very large molecules, composed of small sub-units, laid end to end in long chains.

As a result of discoveries of this sort – the discovery that all organisms, even viruses, are built up of these same kinds of materials—biologists have come to realize that life is a manifestation of certain molecular combinations. We know that these molecular combinations cannot have existed forever.

Cosmologists tell us that even the elements have not existed forever. Perhaps matter itself hasn't existed forever. And so it is impossible to believe that nucleic acids and proteins have always existed. Life must have had an origin at some time, and we think its origin consisted in the production of these molecules in some random kind of chemical reaction.

What can we say about the possibilities for the development of molecules of this sort on the earth? The astronomers provide us with a picture of the primitive earth which suggests in general terms how the spontaneous generation of this type of molecule may have come about. Although the question is by no means settled, many astronomers and cosmologists consider it likely that the solar system was formed about five billion years ago from a dust cloud that surrounded the sun. This dust cloud condensed into the planets. What would the cloud have been made of? The best answer we can get is to look into space around us and see what kinds of matter we find.

If you look at the distribution of elements in space, you find that one element predominates, and that is hydrogen. After hydrogen comes helium, and after helium comes oxygen, nitrogen, carbon, and the other lighter elements. It seems reasonable to assume that the dust cloud was a random sample of cosmic matter, and that it too was composed largely of hydrogen, mixed with some helium, carbon, oxygen, nitrogen, and so on. Carbon, oxygen, and nitrogen are the elements which are important for the production of the organic material that we need in order to create the first living molecules.

If we try to imagine the synthesis of something like nucleic acid or protein on the earth today, we

Venus, between us and the sun, is covered with impenetrable clouds; its surface has never been seen.

find it is impossible to conceive of this happening in a spontaneous way. We can conceive of doing it in the laboratory, but we can't imagine it occurring in a lake, say, spontaneously. There are two reasons for this. First of all, any pinch of soil or drop of water that one picks up on the earth today contains microorganisms, and microorganisms are hungry all the time; when they find organic matter in their environment they consume it. That is one reason why the spontaneous generation of complicated molecules would be impossible today: they could not evolve. The generation of a molecule as complicated as a protein or a nucleic acid cannot occur in just one step. This requires a long evolution, a building up of organic compounds of ever-increasing complexity. The production of such large molecules would be the final step in a long chain of chemical reactions. This chain would be stopped by microorganisms.

Even if there were no microorganisms today, we could not imagine organic syntheses of any complexity going on in our atmosphere, or in the seas, because we have an atmosphere which contains 20 percent of oxygen. Oxygen is a reactive element. It combines readily with organic matter and destroys it. Organic materials do not have a chance to evolve into complicated structures in an atmosphere that contains as much oxygen as ours.

And that is why it is interesting to learn that the astronomers provide us, in the primitive earth, not with an atmosphere of oxygen, but with an atmosphere that is mainly hydrogen. In addition, there will be the lighter elements — carbon, oxygen, nitrogen, and the rest.

If we ask chemists what are the stable forms of carbon, oxygen, and nitrogen in the presence of so much hydrogen, they tell us that carbon will be present as methane, CH_4; nitrogen as ammonia, NH_3; and oxygen as water, H_2O. Today we've lost the methane and the ammonia, oxygen is present partly as free oxygen and partly combined as water, and nitrogen is present as gaseous nitrogen. The reason for the change is that the earth has lost its envelope of hydrogen. Hydrogen is a light gas and the gravitational field of the earth is not strong enough to hold it. In the course of time, the hydrogen has diffused out into space. But in the early stages of the development of the earth, according to this theory, it had an envelope of hydrogen, and as a result we had carbon as methane, nitrogen as ammonia, and oxygen in the form of water.

Professor Harold Urey and a student of his, Dr. Stanley Miller, who are now at the University of California campus at La Jolla, got the brilliant idea of making a mixture of this primordial atmosphere and passing a spark discharge through it to see what would happen — as if, on the primitive earth, there were lightning.

They found that a large variety of organic material was produced — of much greater complexity than the stuff they started with. Among these organic materials, interestingly enough, were a number of amino acids. Amino acids are the building blocks from which the proteins are made; so this experiment suggested the possibility that, on a primitive earth with an atmosphere containing hydrogen, there was actually the possibility of a real evolution — a building up of organic material into quite complex forms.

The beginning of life

The duration of this experiment was only a week. Nature had a couple of billion years and all the oceans in which to carry out the same experiments, instead of a 500cc flask. So this experiment and others of its kind lend support to the notion that life arose on the earth during this primitive time when the chemical nature of the atmosphere was predisposed toward the evolution of organic material. It is thought that, in the course of a couple of billion years, something as complicated as a protein molecule or a nucleic acid molecule could have been generated spontaneously by a random chemical combination.

What does this tell us about life on the other planets? According to this view, life will arise where conditions are favorable. If the other planets had an atmosphere similar to the one that we imagine the primitive earth had, and if conditions remained favorable for a sufficiently long period, then there is no reason why life could not have started on other planets as well as on the earth. There is no reason to believe that the earth is unique in this matter.

The planet nearest to the sun is Mercury, which we can dismiss as a possible abode of life *because* it is so close to the sun, is very small, and has no detectable atmosphere. Mercury is just a little larger than our moon. It keeps one face to the sun all the time, just as our moon always keeps the same side to the earth — and for the same reason. The earth exerts such a strong tidal force on the moon that it prevents the moon from turning with respect to the earth. The big tidal pull of the sun on Mercury produces the same result.

On the illuminated side the temperature of Mercury must be of the order of 400°C. The dark side is probably the coldest spot in the solar system — just a degree or two above absolute zero. It is very unlikely that any extensive organic syntheses have occurred on Mercury.

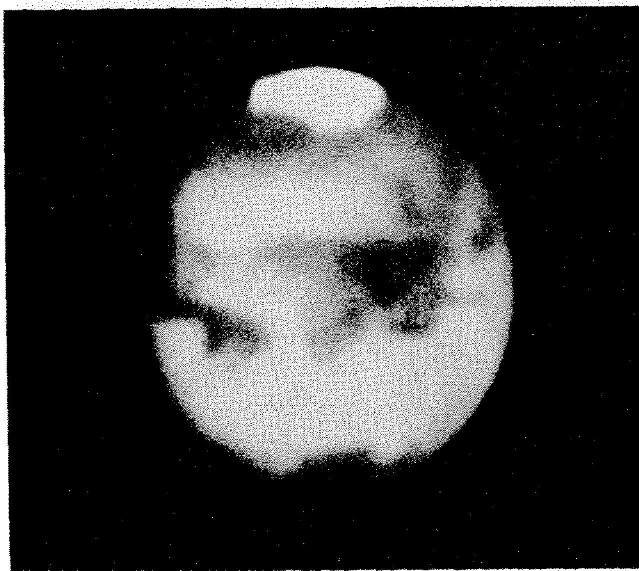
Venus, our nearest neighbor

The next planet out from the sun is Venus. Venus is our nearest neighbor among the planets. It is about the same size as the earth too. And it is not so close to the sun that you would expect *a priori* that it would be too hot for life. If a planet the size of the earth were moved to the neighborhood of Venus, a temperature increase of something like 50°C would be expected. We know of organisms that can live at temperatures 50° warmer than our own. Venus at first glance seems like a possibly interesting planet from a biological point of view.

You would think, being as close to us as it is (its closest approach is about 25 million miles) that we ought to be able to see something on Venus. Unfortunately, this is not true. Astronomers tell us that Venus is a most frustrating planet to look at. For one thing, it is between us and the sun, so that when it is closest to us, we are looking at the dark side, and we cannot see anything. When it is fully illuminated, it is on the far side of the sun — so far away that we don't see anything. When it is in an intermediate position, and we do have a look at it, we find that it is covered by impenetrable clouds; the surface has never been seen.

We know a little about the atmosphere of Venus. We know that it contains much carbon dioxide. No oxygen has been detected. And, according to recent measurements, there is the possibility of a little water. The presence of water is important for the origin of life, since water is an indispensable solvent for the kinds of chemical reactions that we are interested in.

Temperature measurements have been made by measuring the emission of radio waves from Venus, and it seems that the temperature at the surface is a good bit warmer than the 60 or 70°C predicted from the simplest calculations. It appears to be about 300°. The difference could be due to the greenhouse effect of the thick atmosphere of carbon dioxide which Venus has. Carbon dioxide traps heat, so that the planetary surface should be much warmer than would be expected if a body the size of Venus were simply placed at the right distance from the sun. If this temperature is correct, then it is not very likely that anything is living on Venus, because organic material is unstable at this temperature. Many biologically important substances decompose at temperatures far below 300°C.



Of all the planets, next to the earth, Mars is the most favorable as a possible abode of life.

An interesting point about the temperature of Venus is that it appears, from the radio measurements, to be about the same at night as in the daytime — i.e., the dark side has nearly the same temperature as the bright side. This suggests that there are tremendous winds on the surface that circulate the atmosphere so that even at night there is no cooling.

One of the important things biologists want to learn is the actual temperature of the surface of Venus. One of the first missions of a spacecraft into the vicinity of Venus will be to make temperature measurements.

The next planet out which we know something about is the earth, and beyond the earth is Mars. Of all the planets of the solar system, next to the earth, Mars is the most favorable as a possible abode of life. Astronomers can actually see Mars. We are between the sun and Mars, so that the illuminated side of Mars can be seen fairly well. Mars is not as close to us as Venus, and it will be harder to go to Mars by rocket because we have to go away from the sun instead of toward it. So the trip to Venus will almost certainly be made before the trip to Mars, though Mars, we think, will be more interesting biologically.

The temperature on Mars has been measured. On a summer day, at the equator of Mars, it gets to about 25°C at noon. But at night it is very cold; it probably goes to −50°C or lower as soon as the sun sets, because the Martian atmosphere is very thin. Neither oxygen nor water vapor have been detected in it, and there are no open bodies of water on the planet, but there are reasons for thinking that a small amount of water is present in the atmosphere. There is carbon dioxide in the Martian atmosphere, and there is probably argon, and nitrogen. The atmospheric pressure and the climate are similar to what would obtain at the top of a 50,000-foot mountain on earth.

If one looks at Mars with a telescope, he can see polar caps on the planet. The polar caps behave like snow optically, and most people think they are snow, though this is not universally agreed on. If the cap material is snow, this is very important biologically, of course, because this means that there is water on the planet.

Growth on Mars?

Then there are the dark areas on Mars. These provide us with the only evidence we have that life exists outside the earth. Observations of these areas have led some astronomers to the idea that things are growing on Mars. The dark areas are not constant in shape. They change with the seasons. As the Martian spring comes around, observers notice a progressive darkening of these areas, moving from the pole toward the equator.

This is just the opposite of what occurs on the earth. This is because Mars is a very dry planet, according to those who believe that the dark patches are vegetation. In the wintertime, the Martian water is locked up as ice at the pole. When spring comes, the ice begins to evaporate and, as water vapor in the air, moves toward the equator. Then the plants (if they are plants) begin to grow, and this wave of darkening which can be observed on Mars continues until the summer. By summertime, it reaches the equator, and sometimes beyond it. Then it retreats.

Spectroscopic evidence also suggests that these patches may represent something living. W. M. Sinton, of the Lowell Observatory, has studied the light which is reflected from the dark patches and has compared it with the light which comes from the bright areas. The bright areas on Mars are believed to be deserts. The light coming from the dark areas, when analyzed spectroscopically, shows absorption bands which are also found in organic substances. This observation has lent strength to the idea that these changing dark areas do in fact contain carbon compounds. And if they contain carbon compounds, they may be living.

Another kind of argument has been raised in connection with the dark regions. Astronomers occasionally see great dust clouds swirling up from the desert areas on Mars. These clouds may persist for weeks. It is argued that the dust clouds settling out over the planet would eventually cover the dark patches, which would have become invisible unless they were capable of growing up through the dust layer.

What kinds of experiments can we do with instrumented rockets to find out about life on the planets?

First of all, much can be done from the earth. Our own atmosphere absorbs certain wave lengths of light so that we cannot make all the spectroscopic measurements on the planets that we would like. It is possible to mount telescopes in balloons that will bring them up above much of our atmosphere – or even to orbit them in satellites and have them automatically aimed at the planets. In this way it will be possible to get better answers to questions about the composition of the planetary atmospheres. Such measurements can also give us better estimates of the temperatures of the planets.

Knowing the composition of the atmospheres, we can get some idea of the amount of ultraviolet reaching the planets. This is important biologically because ultraviolet light is destructive to organic material; if we know what the ultraviolet flux is on the surface of the planets, it will tell us a lot about the possibilities of an accumulation of organic materials there.

Planetary rockets

Another group of experiments will be mounted in rockets that will go to the vicinity of the planets – that is, within 50,000 miles of the planetary surfaces. From these rockets we hope to take pictures of the planets and to make further spectroscopic studies in the infrared and ultraviolet. From these measurements, it should be possible to get a fairly good idea of the chemical nature of the planetary surfaces and atmospheres. More critical biological observations will be made when spacecraft finally land on the planets. One obvious experiment is to drop a television camera by parachute or balloon. In this way, evidences of large organisms and of civilizations could be obtained. It is unlikely that anything of this kind will be found on either Mars or Venus. A colleague of mine, Dr. Albert Tyler, has suggested sending a mousetrap to Mars, with a television camera to watch it. This sort of experiment is being planned, but not with a mousetrap. An experiment much more likely to succeed involves a trap which will catch, not mice, but microorganisms.

If there is life at all on Mars, there will certainly be microbial life. Microbial life is simpler than other forms; it can withstand difficult conditions more readily than higher forms of life; and, on the earth, it is ubiquitous. Automatic devices are being designed to be landed on Mars that will inoculate culture media with Martian soil and monitor the growth of microorganisms by the increase in turbidity, or by measuring metabolism. It may even be possible to observe the microorganisms through a microscope attached to a television camera.

If we do detect microorganisms on Mars by instrumented rockets, the next thing we would want to do is find out whether they are chemically similar to our own life. Do these microorganisms contain nucleic acids and proteins? This is the most fundamental question that a biologist would like to ask of a Martian organism. As Joshua Lederberg has remarked, *Scientists operate a full-scale model of a Surveyor spacecraft, scheduled to make a soft landing on the moon in 1963. At the left is Leo Stoolman (MS '42, PhD '53) of the Hughes Aircraft Company, which is building seven Surveyors for Caltech's Jet Propulsion Laboratory. At the right, Walker Gilberson of JPL checks the probe which will measure the moon's surface characteristics. While instruments analyze lunar material and atmosphere, television cameras will observe the operations.*

if there are intelligent beings on Mars, this is the first thing we would ask of a Martian biochemist. If there are no Martian biochemists, then we will have to devise experiments for carrying out chemical analysis of these organisms. Possibly by that time we will be able to bring back samples of Martian soil and cultivate the organisms in our own laboratories. That is the experiment that will give us the best information of all.

I should note how important it is that we, in sending rockets to Mars or Venus, do not accidentally contaminate those planets with microorganisms from the earth. Suppose Mars did contain organic material, and perhaps even some living things. We know that if we import strange organisms from other places on the earth, into a new environment, they often find the new environment so satisfactory that they take it over and destroy the indigenous life. If such a thing occurred on Mars, it would be a scientific catastrophe.

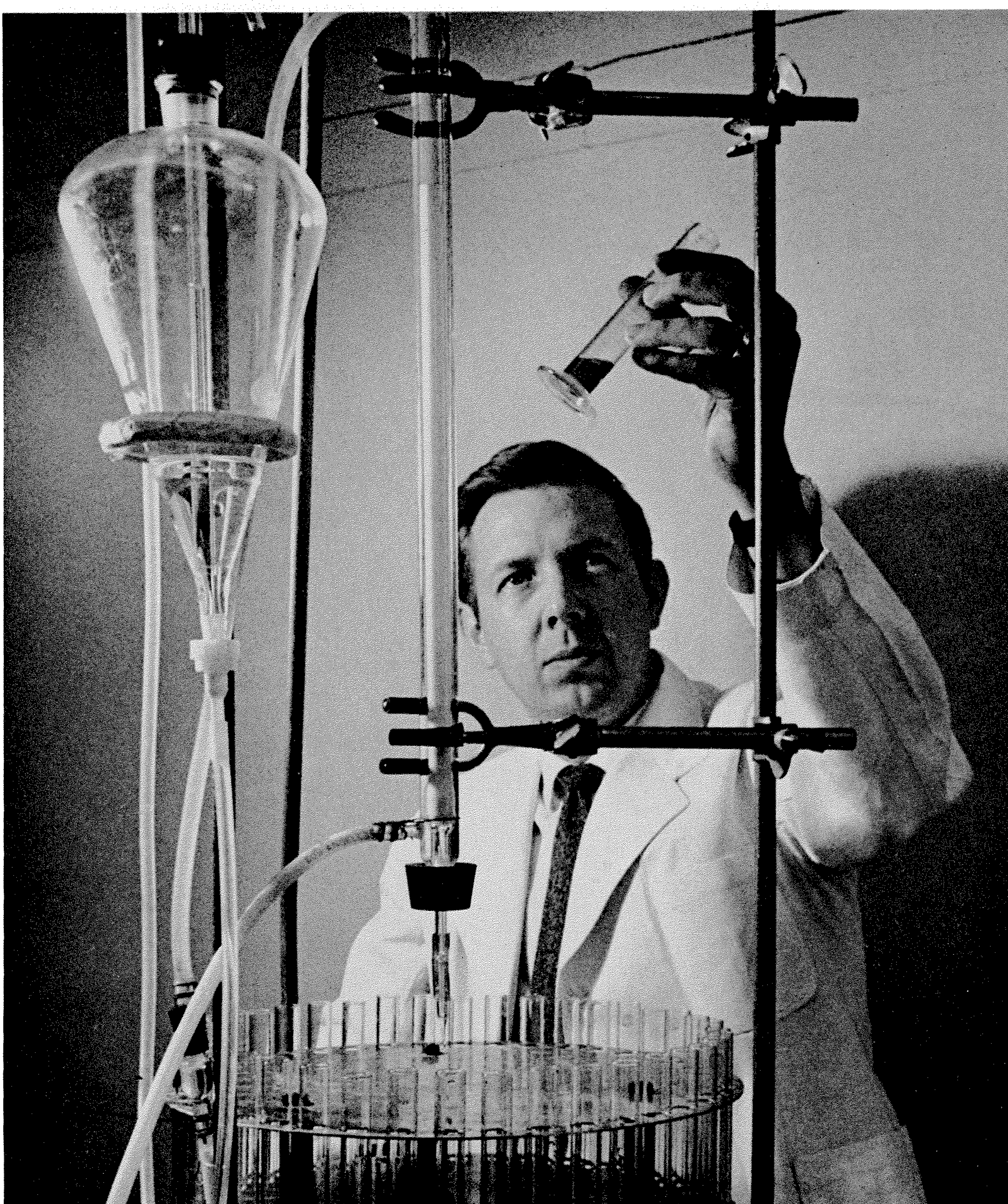
Even if there is no life on the planets they may still be of great biological interest, because they may be repositories of organic material from past ages. Such chemical fossils would be of tremendous interest to us as possible stages in the development of our own planet. Even the moon may be of interest in this regard, as has recently been made clear by Carl Sagan of the University of California.

These are some of the prospects for the study of life in outer space. I have not touched on the question of how a totally unfamiliar form of living matter would be recognized. It is curious to note how, once we leave our familiar environment, even the question "What is life?" – which seems very philosophical and abstract here – takes on immediate practical purpose.

Research in Progress

ENGINEERING. A 1500-pound earth-quake-manufacturing machine, developed by Caltech engineers, was hoisted up this 110-foot tower at Encino Dam last month. After being bolted in place, the machine shook the top of the tower with an energy equal to that of a fairly strong earth-quake. This was the first field test of the machine, developed to make possible the more efficient design of earthquake-resistant structures.

BIOLOGY. Much of the experimental work on visual perception in Caltech's biology laboratories is performed with amphibians and fish. The fish are trained to differentiate between colors and patterns, coming to the surface and jumping out to snap for food only when the right pattern (polka dots or squares on white plaques) or the right color is shown to them. Sometimes flashing red and green lights are used to check the speed of response. Here, Harbans Arora, research fellow in biology, presents colored feeders (wooden balls painted red and green). The fish, which has been trained to respond to red light, will rise to the surface for this color. Responses are analyzed later by recording brain activities on an oscilloscope.



CHEMISTRY. Most individuals have one main type of hemoglobin in their blood; some have several. In order to study the various types, the hemoglobins must be separated. Here, at Caltech, graduate student Richard T. Jones, M.D., examines a hemoglobin sample before placing it on the chromatographic column attached to the upper part of a fraction collector. The hemoglobin solution is allowed to soak in, and is then followed by a chemical solution which causes the various hemoglobins to move down the column at different rates. As each hemoglobin washes off the column, it is automatically collected in test tubes. From such studies, chemists learn about the chemical structure of the various types of hemoglobin.

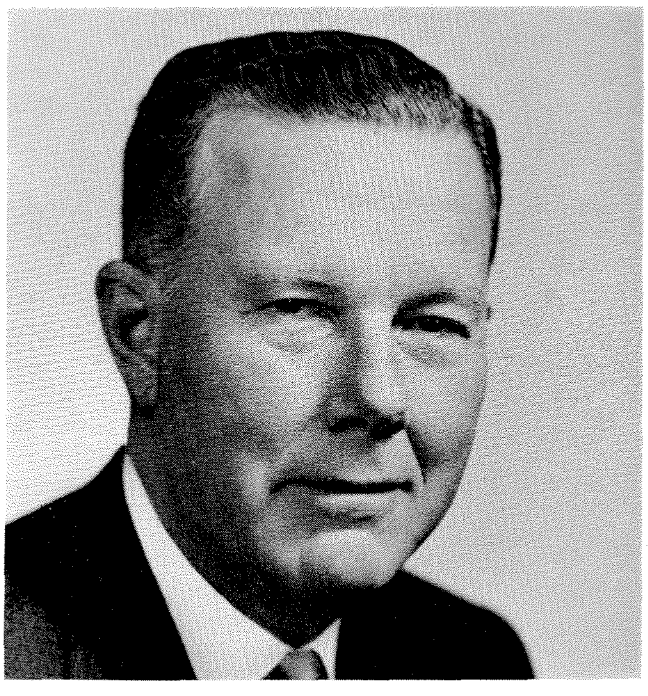
The Month at Caltech

New Trustee

L. F. McCollum, president of the Continental Oil Company, was elected to the Caltech board of trustees this month. He is the fourth national trustee named by Caltech in a move to broaden the geographic base of its board membership. Three others recently elected were Robert F. Ingersoll, Frank Pace, Jr. and Thomas J. Watson.

Mr. McCollum received a geology degree from the University of Texas in 1925 and went to work in Texas as a scout and geologist for the Humble Oil and Refining Company. In 1934 he became exploration manager of the Carter Oil Company in Tulsa, Oklahoma, and served as president of the company from 1941 to 1943. He then moved to New York as assistant coordinator of all Standard Oil Company of New Jersey production activities in 1943. He became coordinator in 1944 and president in 1947.

Mr. McCollum holds directorships in six Continental subsidiaries and affiliates and is also a director of the Morgan Guaranty Trust Company in New York and the Chrysler Corporation. He is chairman of the Airport Expansion Committee of the U.S. Department of Commerce, vice chairman of its Business Advisory Council, and chairman of its committee on International Trade and Commerce. He is a member of the executive committee and board of directors of the American Petroleum Institute, and serves on the advisory boards of the University of Texas Geology Foundation and of the department of petroleum engineering.



L. F. McCollum, Caltech trustee.

Margaret Mead

Anthropologist Margaret Mead will be on campus from April 10-12 as the second of the Caltech YMCA's Leaders of America this year. Dr. Mead is adjunct professor of anthropology at Columbia University in New York and associate curator of ethnology at New York's Museum of Natural History. She is well known for her studies of native peoples on the islands of the Pacific. In recent years, she has turned her attention to the problems of contemporary cultures in the light of the perspective gained from her knowledge of small, homogeneous and stable societies. Dr. Mead is a graduate of Barnard (1923) and received her MA and PhD from Columbia University in 1924 and 1929. Dr. Mead will have numerous informal discussions with students, and will give two formal lectures on April 10 and 11. Her first talk will be about the effects of Western technology on primitive cultures, and her second one will deal with "The College Man's Dilemma – Four Years of Sexual Uncertainty."

Aerobiology in Germany

Alexander Goetz, associate professor of physics at Caltech, has been appointed advisory director of the Science Division of the Institute of Aerobiology in Grafschaft, West Germany. He will spend three months a year there in two six-week periods on a contract that runs until 1963. His work will concern the organization and direction of research on colloidal air pollution in the form of extremely small liquid or solid particles (smog, for example). The research will be aimed at neutralizing such atmospheric byproducts. The German Institute of Aerobiology was started after World War II, originally for the study of the effects of mining and industrial air pollution on respiration.

Dr. Goetz, who has been on the Caltech faculty for 34 years, has spent the last dozen years in studies of aerosols under the sponsorship of the U.S. Public Health Service and the California State Department of Health.

Three Sloan Grants

Three Caltech professors received two-year unrestricted grants from the Alfred P. Sloan Foundation this month. Felix Boehm, associate professor of physics, will receive $10,000 a year; Robert M. Mazo, assistant professor of physical chemistry, and G. Wilse Robinson, associate professor of physical chemistry, will each receive $6,000 a year. They are among 70 university scientists at 35 United States and two Canadian institutions receiving the grants.

Dr. Boehm plans to continue his investigations of the unusual patterns of the collective excitation of deformed nuclei in rare earths. A native of Switzerland, Dr. Boehm was graduated from the Swiss Federal Institute of Technology in Zurich. He received his PhD there in 1951. In 1952 he came to the United States to do postgraduate work at Columbia University and joined the Caltech faculty in 1953.

Dr. Mazo will continue theoretical work on fluids connected with transport properties. A native of Brooklyn, Dr. Mazo received his BS from Harvard in 1952 and his MS and PhD from Yale in 1953 and 1955. He has been at Caltech since 1958.

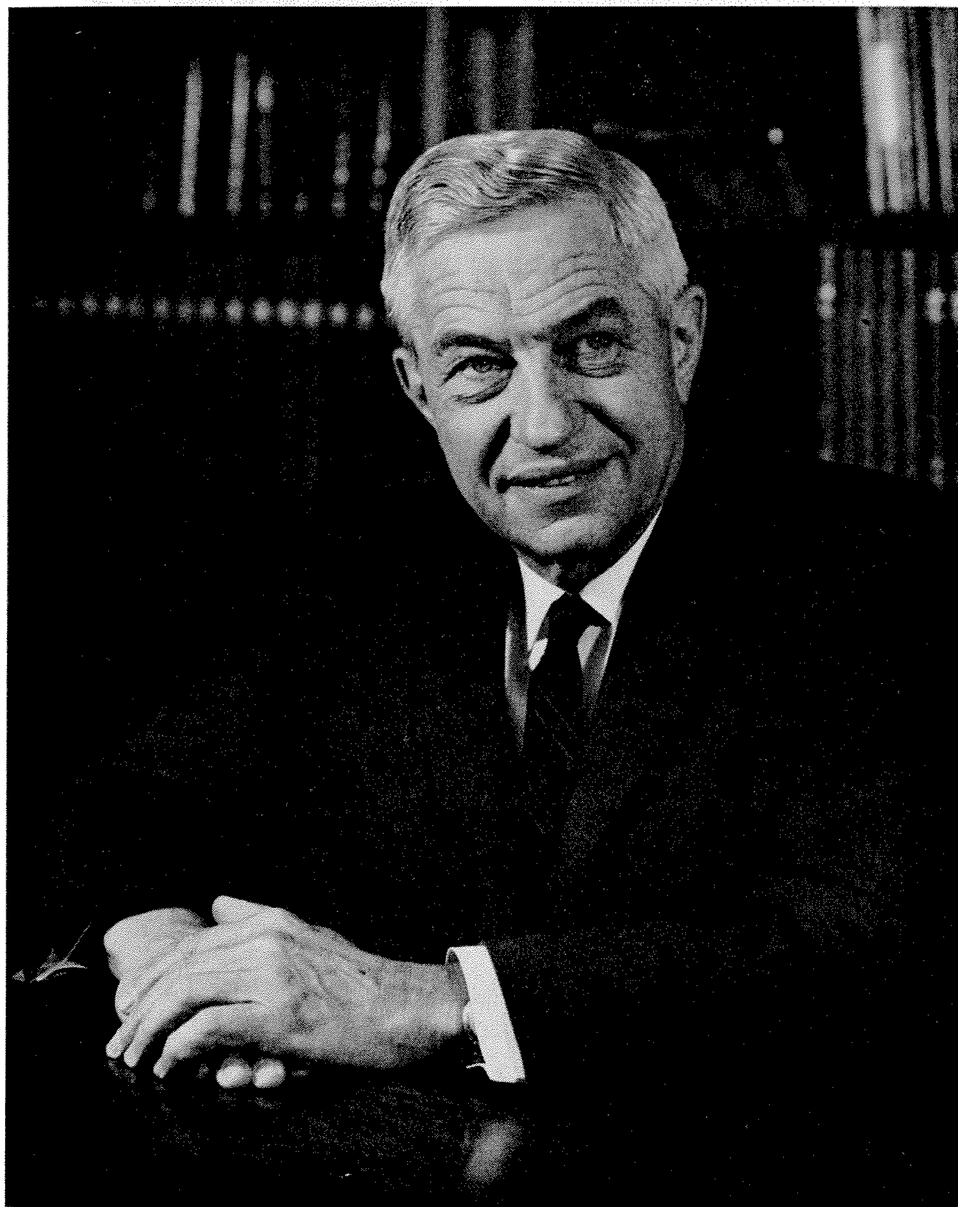
Dr. Robinson will use his grant for more work in low temperature chemistry. He received his BS and MS from Georgia Institute of Technology and his PhD from the University of Iowa in 1952. He was an assistant professor at Johns Hopkins University from 1954 to 1959, when he came to Caltech.

Carnegie Lecturers

Dr. I. I. Rabi, Nobel laureate in physics from Columbia University in New York, and Sir Solly Zuckerman, M.D., professor of anatomy at the University of Birmingham in England, were the principal participants in a discussion on "Science and Public Policy" at Caltech on March 15. The meeting was one of the Carnegie Lecture Series held on the campus throughout the academic year.

Dr. Rabi is a member of the National Research Advisory Committee. In 1957 he was chairman of the President's Science Advisory Committee, and in 1955

Carnegie lecturers Sir Solly Zuckerman and I. I. Rabi with Caltech faculty members after a luncheon discussion at the Athenaeum.



Caltech's President Lee A. DuBridge, winner of Pasadena's Arthur Noble Award

was vice president of the International Conference on the Peaceful Uses of Atomic Energy.

Sir Solly is scientific advisor to the British Ministry of Defense, chairman of the British Defense Research Policy Committee, and deputy chairman of England's Advisory Council on Scientific Policy.

Industrial Associates Conference

The Institute's Industrial Associates held a two-day conference, March 23-24, on the Application of Modern Techniques to the Study of the Structure and Properties of Metals and Alloys.

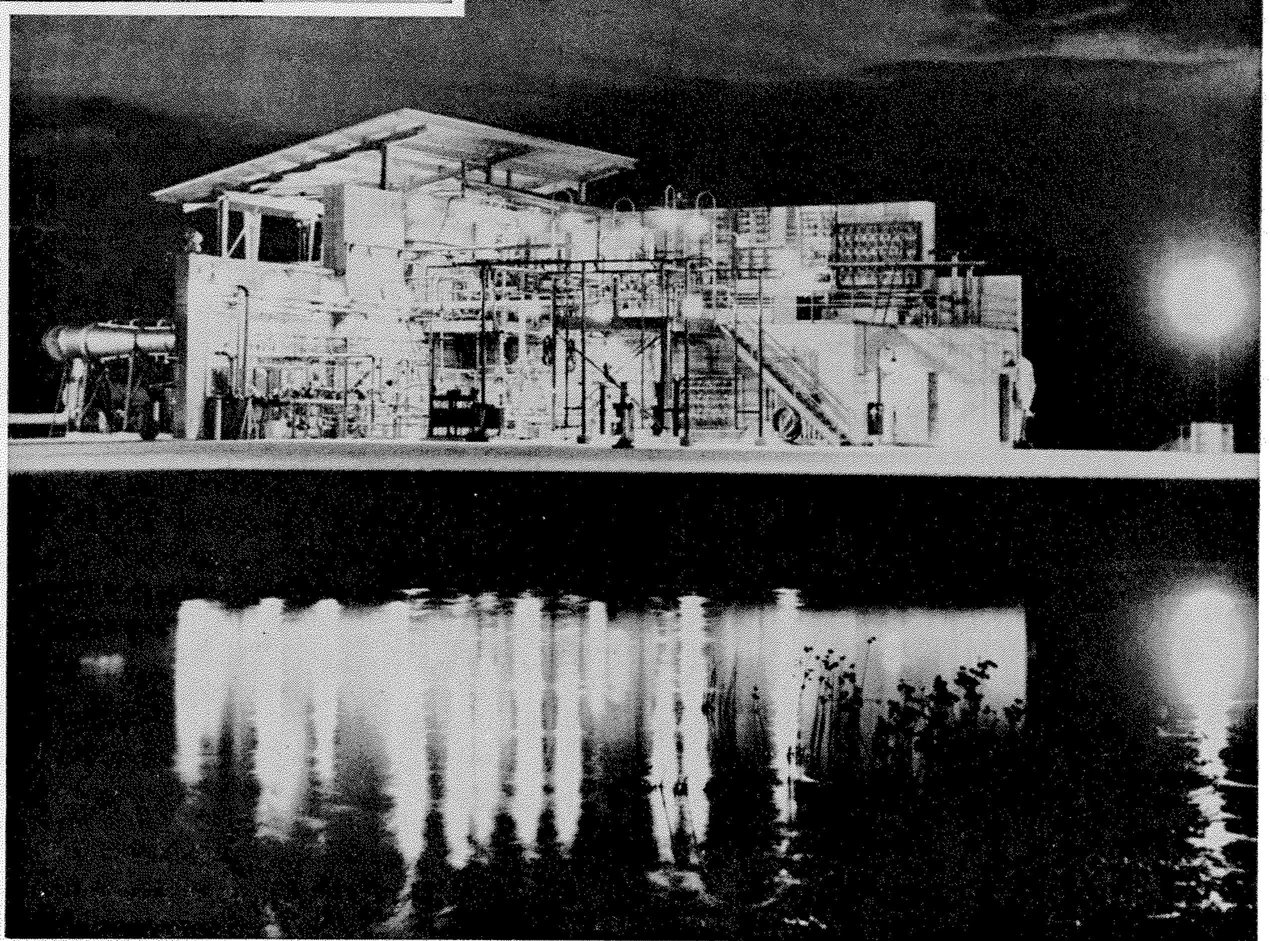
Caltech representatives at the conference included F. S. Buffington, associate professor of mechanical engineering; Donald S. Clark, professor of mechanical engineering; Pol Duwez, professor of mechanical engineering; James E. Mercereau, assistant professor of physics; Linus Pauling, professor of chemistry; Thad Vreeland, Jr., associate professor of mechanical engineering; and David S. Wood, associate professor of mechanical engineering.

Pasadena's Noble Prize

President Lee A. DuBridge will receive the city of Pasadena's Arthur Noble Award on April 11 at a banquet at the Huntington-Sheraton Hotel. The award was set up in 1924 to honor the person making the greatest contribution to the city for community betterment, particularly in the cultural or esthetic area.

During the past 20 years, Dr. DuBridge has received 16 honorary degrees. He has served on 15 advisory boards and committees for the Army, Navy, Air Force, Atomic Energy Committee, and the President. He is currently on the National Manpower Council, the National Science Board, National Advisory Health Council and the advisory panel on science and technology for the Committee on Science and Aeronautics for the House of Representatives.

What would YOU do as an engineer a



Development testing of liquid hydrogen-fueled rockets is carried out in specially built test stands like this at Pratt & Whitney Aircraft's Florida Research and Development Center. Every phase of an experimental engine test may be controlled by engineers from a remote blockhouse (inset), with closed-circuit television providing a means for visual observation.

Pratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

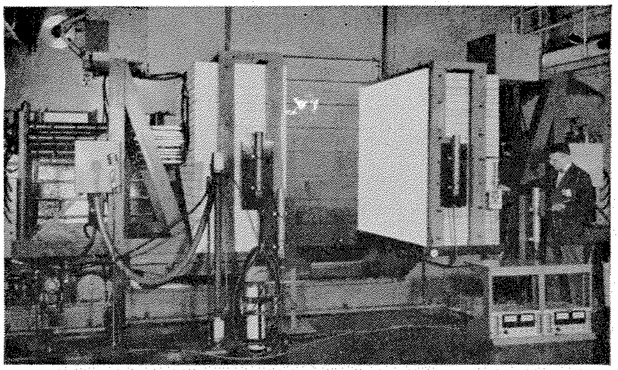
Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

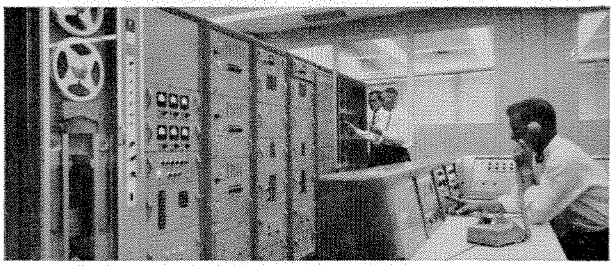
The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

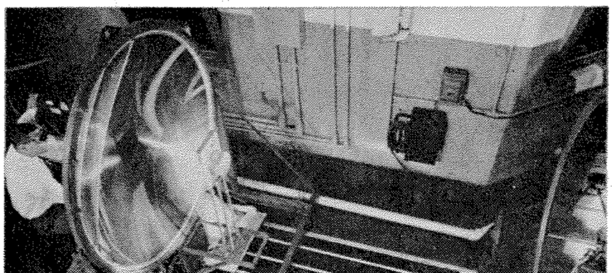
For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.



Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

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A Seismologist in Japan

by Charles Richter

My visit to Japan realized a project of many years, originating with my very good friend, Professor Chuji Tsuboi of Tokyo University. He has been a repeated visitor to Caltech for more than 20 years and in Japan he is, deservedly, a personage of much prestige.

It appeared to both of us wisest for me to visit Japan during the academic year of 1959-1960, with no further postponement. The second world conference on earthquake engineering was to convene at Tokyo in July, 1960, and I had already considered leaving Pasadena to attend the assembly of the International Union of Geodesy and Geophysics, at Helsinki in July and August.

Preliminary arrangements were made in Tokyo, and I then applied for a Fulbright research scholarship. This was granted at the usual time for such awards, in the spring of 1959.

We sailed from Seattle in September, on the motor ship *Hikawa Maru*, which was the last passenger vessel in regular service between Japan and the United States, and has since been decommissioned.

Hikawa Maru docked at Yokohama on October 2, as scheduled. Pleasant impressions had already been created by correspondence with Fulbright House, officially the headquarters of the United States educational commission in Japan, and by the genial personality and general courtesy of its chief, Dr. Iwao Nishimura, who had accompanied us on the voyage. To these were now added a whole series of highly efficient and productive arrangements. Preliminary orientation, begun on the ship, was continued through a well-arranged lecture series, including a thoughtful and informative address by Ambassador MacArthur. Comfortable accommodation was found for us in one of the most modern apartments in Tokyo, expensive indeed on the Japanese scale, but within our means due to advantageous exchange.

At Tokyo University, where a chosen few of the

"IT'S HERE—IF YOU WANT TO WORK FOR IT"

Even before Ron Spetrino received his engineering degree from Case he had good job offers from six companies.

He joined The Ohio Bell Telephone Company —his reason: "I was convinced an engineer could go further here—if he was willing to work for it."

As soon as Ron got his feet on the ground in telephone engineering, he was tapped for a tough assignment. The job—to engineer switching equipment modifications needed to prepare Cleveland for nationwide customer dialing of long distance calls.

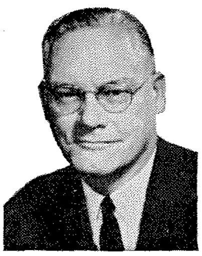
Ron wrapped it up in five months, and found he had earned a shot at another tough assignment. In this job Ron helped engineer a completely new long distance switching center for Cleveland. This switching center connected Cleveland with the nationwide customer dialing network. It was about a year later that Ron put the finishing touches on the specs for this $1,600,000 project.

Today, as a Supervising Engineer, Ron heads a staff of five engineers and is responsible for telephone switching in much of the greater Cleveland area.

He supervises the design and purchase of $3 million worth of equipment a year. And even more important, he is charged with developing the technical and managerial skills of his staff.

Ron knows what he's talking about when he says, "In this business you have to do more than a good job. We expect a man to be a self-developer. We expect him to take responsibility from his first day on the job and think for himself. You don't get ahead around here by just doing time."

If you want a job in which you're given every chance to prove yourself, and real responsibility right from the start—you'll want to see your Placement Office for further information.



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BELL TELEPHONE COMPANIES

Fulbright group were welcomed by President Kaya, I was embarrassed to find that Professor Tsuboi had vacated one of his offices for me. Since this office contained his excellent personal library of books, periodicals, and reprints, in Japanese, English and other languages, I was rarely at a loss for reference material.

Geophysics, especially seismology, is a highly active field of research in Japan. If one includes the entire staff of assistants and students, the personnel considerably exceeds in numbers the corresponding figure for the entire United States. If one judges productive research in the only convenient way, by looking at publications and noting the institutions from which papers are presented at meetings, one finds that most of the work is going on at a few large institutions, either universities or government bureaus.

Tokyo University clearly occupies the first place. It still retains the prestige which attached to it as the Imperial University. Its academic standards are generally the highest in Japan, and competition for admission is extremely keen; its degree confers a distinction hardly approached otherwise in the country.

The Geophysical Institute, to which I was attached, is under the Faculty of Sciences. The celebrated Earthquake Research Institute is also located at Tokyo University; its administration is essentially independent of other branches, its head being directly responsible only to the president of the University. Its staff is drawn from specialists in various fields – geology, physics, engineering, oceanography, volcanology. Not a few, like Professor Tsuboi, occupy two professorships, one under the Faculty of Sciences and one under the Earthquake Research Institute.

Seismological stations

In Tokyo is also the headquarters of the Japan Meteorological Agency, which has a very large seismological division. More than 100 of approximately 140 seismological stations in Japan are operated by this group. Data are assembled, reports issued, and most of the research conducted at Tokyo. An especially important outpost is at Matsushiro, in the mountainous backbone of the main island, a day's journey northward from Tokyo. Instruments are installed there in extensive tunnels in granodioritic rock; the relatively low level of background "noise" makes this one of the most sensitive seismological installations in Japan, and an important contributor to the international seismological network.

Tokyo itself is of course a very disturbed location, unsatisfactory for work with small earthquakes; consequently the Earthquake Research Institute also has an outpost at Tsukubasan, about 40 miles from Tokyo, on massive granitic rock which provides an even quieter site than Matsushiro. Here it has been possible to carry on work with microearthquakes, the very smallest true earthquakes recorded by sensitive instruments (and not to be confused with microseisms, which are more or less continuous disturbances due to a variety of causes – chiefly meteorological or artificial).

There is only space for mere mention of the important geophysical and seismological work, including publications of many kinds, of the Geophysical Institutes of Kyoto University, Tohoku University (at Sendai), Kyushu University (at Fukuoka), and Hokkaido University (at Sapporo).

Largest city in the world

I found that simple arithmetic had prepared me fairly well for the impact of arriving and existing in Tokyo. This is now the largest city in the world, with a population on the rise from 8 toward 9 million – while, if one wishes to consider the metropolitan center as a whole one must include Yokohama, with another million and a half. The quaintness described by visitors of 30 years ago is no longer so much in evidence, though much of it can still be found on looking around the corner. The jinrikisha has practically disappeared, except that one specimen is still in operation in Hibiya Park, not far from the Imperial Hotel, where tourists may ride about and be photographed. Modern Western-style apartments, hotels and business blocks are rising everywhere. Tokyo Tower, a television structure resembling the Eiffel Tower, is 1092 feet high and is claimed to be the tallest independent steel tower in the world.

Public transportation in Tokyo is fast and efficient, but always loaded near capacity and in rush hours quite overloaded. There are electric railways, government and private, including a mostly elevated loop and cross-city line; over 40 numbered surface streetcar lines, and two connecting subways; and innumerable buses operated by the city and several private corporations. Taxis are numerous and not expensive; one can cross central Tokyo for a little over 200 yen (equivalent to about 60 cents), without being expected to tip. The corresponding rail or bus fare will be 30 or 40 yen at most.

The traffic situation is not good, in spite of automatic signals and traffic officers. Crooked streets with awkward intersections result in pileups, often aggravated by street work. Public improvement is at present going more toward building than streets; excavations for utilities go on everywhere.

Tokyo has a fairly high accident rate, a matter of serious public concern. Police boxes all over the city post the total of traffic fatalities and injuries for each

continued on page 28

ONE IN A SERIES

Bendix answers your questions

WHAT COMPANY SHOULD I JOIN?

When there is a choice of employment opportunities, most graduating engineers and scientists make some sort of list of the advantages offered by each prospective employer.

Some men put salary at the top of the list. Many lean toward the company offering them the best chance at creativity . . . the widest scope for developing their interests and increasing their professional stature. Others favor job security, company size and stability, or geographic location. The final choice generally is made on the basis of the biggest "package" of advantages offered.

Probably no organization today can offer a longer list of employment advantages than The Bendix Corporation. One of the world's most highly regarded, stable, and diversified engineering-research-manufacturing corporations, Bendix has 25 divisions which produce, literally, "a thousand diversified products." The wide geographic spread of these divisions can be seen in the listing below.

Starting salaries paid by Bendix are competitive with those offered by other companies—naturally, better talents are more highly rewarded. Bendix readily recognizes achievement, and gives the developing engineer and scientist wide latitude in his field of interest.

Ask your Placement Director about Bendix—**where you can build your career to suit your talents.** If you can't arrange a personal interview, write to C. C. Cleveland, The Bendix Corporation, Fisher Building, Detroit 2, Michigan, for more details.

CAREER OPPORTUNITIES IN: CALIFORNIA · CONNECTICUT · INDIANA · IOWA · MARYLAND · MICHIGAN · MISSOURI · NEW JERSEY · NEW YORK · OHIO · PENNSYLVANIA

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Fisher Bldg., Detroit 2, Mich.

A THOUSAND DIVERSIFIED PRODUCTS SERVING THESE FIELDS:

automotive • electronics • missiles & space • aviation • nucleonics • computer • machine tools • sonar • marine day. Traffic deaths average 2 or 3 daily; injuries run normally from 150 to 250, sometimes appreciably higher.

Heavy traffic of course adds to the dust problem. The climate is relatively wet; but the soil is very fine, and its surface dries quickly, so that after a day or two without rain the slightest breeze picks up a cloud of dust. Shopkeepers throw water on the sidewalks, which decreases dust but increases mud.

Finding one's way in Tokyo is often complicated, even for a Japanese familiar with the city. For a foreigner it is at first appalling. With a few exceptions, such as the famous Ginza, streets have no names. There is no door-to-door system of house numbering, and even when numbers exist they are not displayed. The American occupation attached a system of arbitrary names to Tokyo thoroughfares, such as D Avenue and 15th Street. Many signposts showing these still remain, and if the Westerner has a map showing such names he can use it to find his way around. But these names are not known to the Japanese, and particularly not to Japanese taxi drivers. Moreover, the haphazard layout of Tokyo makes even the sign-posting confusing, so that one may find D and F Avenues posted in the same direction from the same point, or K Avenue indicated in three different directions.

A typical address

A typical address in Tokyo has four elements: the name of the ward (*ku*, of which there are 23 in Tokyo); the name of the district (*chō* or *machi*); the number of a sub-district (*chōme*); and what might be called the house number (*banchi*). Strictly this is a lot number, so it is not unusual to find several houses on the same *banchi*. Worse, there is no orderly arrangement of the numbers along streets; they scatter irregularly over the district, having originally been assigned more or less in the historical order in which the lots were occupied. No wonder that, when taking a taxi to an unfamiliar address, at least half an hour must be allowed, after the driver reaches the approximate neighborhood, for inquiries and investigation.

The postal system is geared to these addresses; mail is delivered promptly and efficiently, even if the names are written in Roman transliteration instead of Japanese characters.

Our apartment house address was 32, Nampeidai-machi, Shibuya-ku. (Our small district of Nampeidai is not subdivided into chōme.) Shibuya ward is a large formerly suburban area, two to three miles west and southwest of the center of Tokyo. Its business, amusement, and shopping center is one of the liveliest in the city; five or six such centers have grown up at the points where interurban lines depart from the loop. We were on the ninth floor of a ten-story apartment building, set on a hill west of Shibuya station, with a wide view over the city. From our window we could see Tokyo Tower to the left, and in reasonably good weather Mt. Fuji to the right; on the few rare clear days we could see the hills across Tokyo and Sagami Bays.

The perfect maid

Our apartment was Westernized to the extent of tables, chairs, and beds, with electric lighting, telephone, and an automatic gas water heater. The gas stove was a small two-burner fixture. We had to provide kitchenware and utensils, as well as a small icebox. The bath was of the usual small, deep and narrow Japanese type; my wife managed to bathe in it, but I resorted to dipping water, using a Japanese wooden bucket with a handle. The other plumbing was quite Western-style. The floor was carpeted with material which immediately displayed any careless shoeprints; shoes were regularly exchanged for slippers on entering.

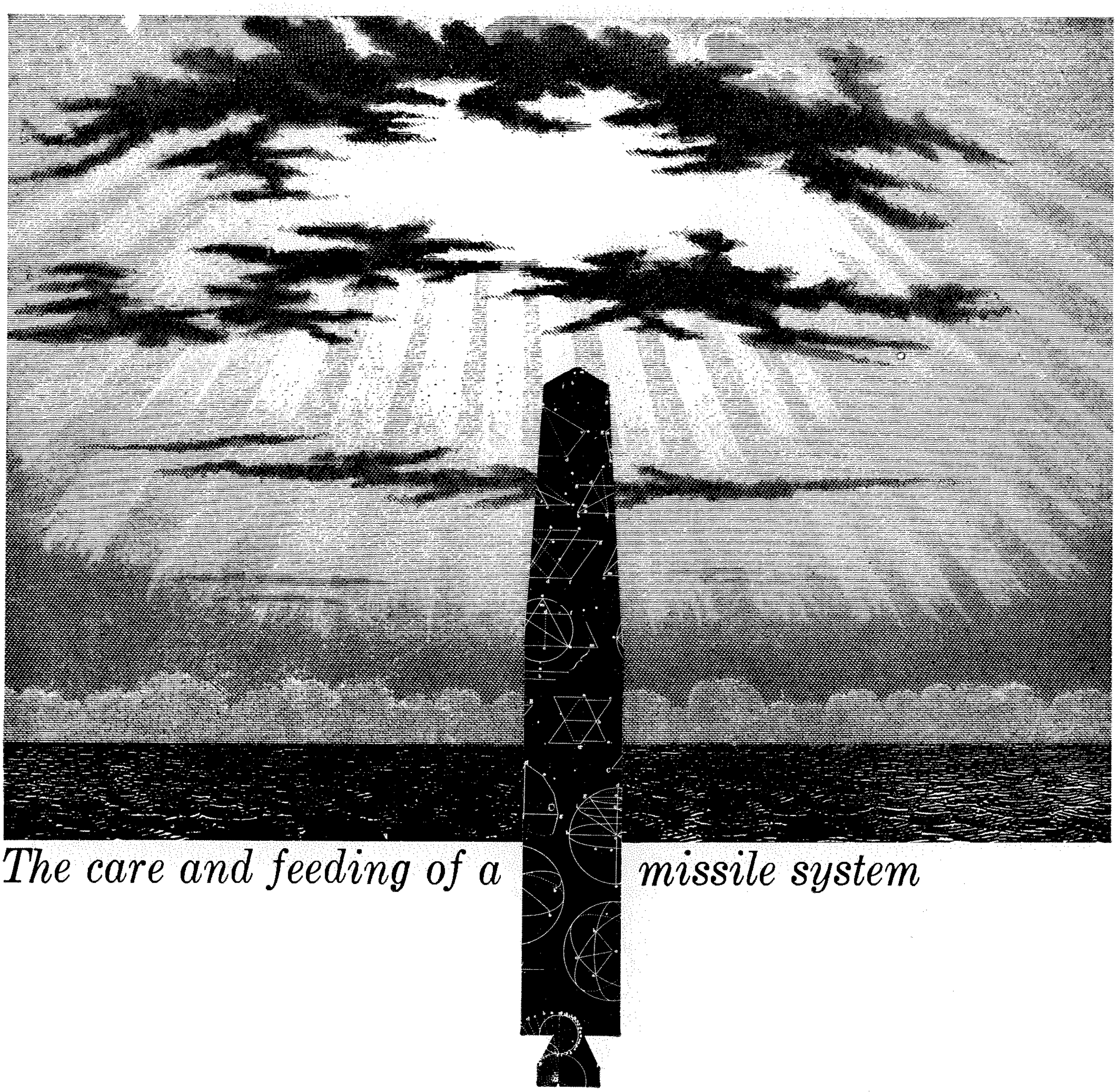
Our apartment existence revolved around our marvelous maid, Sumiko-san. She was a complete household manager, did all the shopping, kept the place spotlessly clean, did the washing, and was an excellent cook in Western, Japanese, and Chinese styles. Her English, which she had learned for herself without any formal schooling, was perfectly adequate for all ordinary purposes. Of all the highly satisfactory arrangements which we owe to the Fulbright staff in Tokyo, none meant more to us than finding Sumiko.

I cannot leave the subject of Tokyo without speaking of the political demonstrations we witnessed there. Actually, our first encounter with snake-dancing and chanting crowds was in Kyoto; but with the development of the crisis over the new security treaty we became increasingly familiar with such affairs in Tokyo.

I owe it to my Japanese friends to emphasize that these demonstrations were not overtly anti-American, but anti-Kishi. Although their ultimate effect was directed against American policy, and though many of the participants were anti-American and made fiery speeches to that effect, the bulk of the demonstrators are fairly described as liberals, not radicals, with a desire for friendly relations with America. We were not personally inconvenienced; indeed, few Americans were. The only conspicuously mistreated American was Mr. Hagerty, in an incident which was deplored by the large majority of Japanese of all political affiliations.

For a large part of the demonstrations we had a box seat. Mr. Kishi's residence was in Nampeidai,

continued on page 30



The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box 600-E, Douglas Aircraft Company, Santa Monica, California.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB® ■ GROUND SUPPORT EQUIPMENT and our ninth-floor window looked out in that direction. We became accustomed to demonstrators streaming under our window, usually preceded by sound trucks blaring out radical songs. Communist banners were much in evidence; nevertheless, only a small fraction of the crowds were Communist, or even had Communist sympathies.

Grim humor resulted when Communist headquarters criticized some of the demonstrators, saying that the student organization must take part of the blame for the one death, a girl who was trampled in the mob attempting to storm the Diet gates. For this the indignant students staged a hostile attack on the Communist office.

My chief reaction to the whole affair was regret at the effect on the university. Even those of staff members and students who were not directly involved were disturbed, and the time of research men was taken for faculty conferences. One of the most urgent needs in Japan, as everywhere today, is for trained men; and I cannot agree that any political issue should be allowed to interfere with that training.

Learning the language

Much more of my time than I had originally intended was spent in reading and studying Japanese. I never acquired conversational competence; I could understand only a few words with difficulty, and could use effectively only the words necessary to buy tickets, direct taxi drivers, and the like. My reading slowly progressed to the point where I could decipher most ordinary street signs, and could recognize the characters in place names. With this ability the horrible lost feeling which plagues foreign visitors in Tokyo disappeared; I was able to go about on the public transportation with confidence, and could be certain of not getting lost anywhere in the city in daylight.

Everyone who stays in Japan long learns to recognize a few characters, such as those for "entrance" and "exit." My wife, after some sad experiences, learned to recognize the two characters which spell Shibuya, so that she could spot a car or bus headed for home.

I began with the subway, since the station names are posted in Roman transliteration as well as in Oriental characters, and the relatively small number of stops limits one's possible mistakes. The government electric railway is nearly as well posted, but getting about on it is a trifle more complicated. Gradually, with caution, I began using streetcars and buses, and learning to read place names posted at car and bus stops. I acquired and studied a Japanese guidebook to Tokyo.

If we count the Roman transliteration, of which there are two versions, Japanese is written in four different ways. There are two indigenous syllabaries, either of them competent to write out the language; but a large part of the writing is in the originally-Chinese characters *(kanji)*. Japanese printed text is largely a combination of these characters and one syllabary *(hiragana)*, with a sprinkling of the other syllabary *(katakana)*, used chiefly to represent foreign names, and foreign words current in the Japanese language, such as *pan* for bread, *bātā* for butter, *chiizu* for cheese. *(Chizu*, with a short i, means a map. Mistakes between long and short vowels are full of such traps.) Many street signs use the syllabaries to replace or supplement the *kanji*.

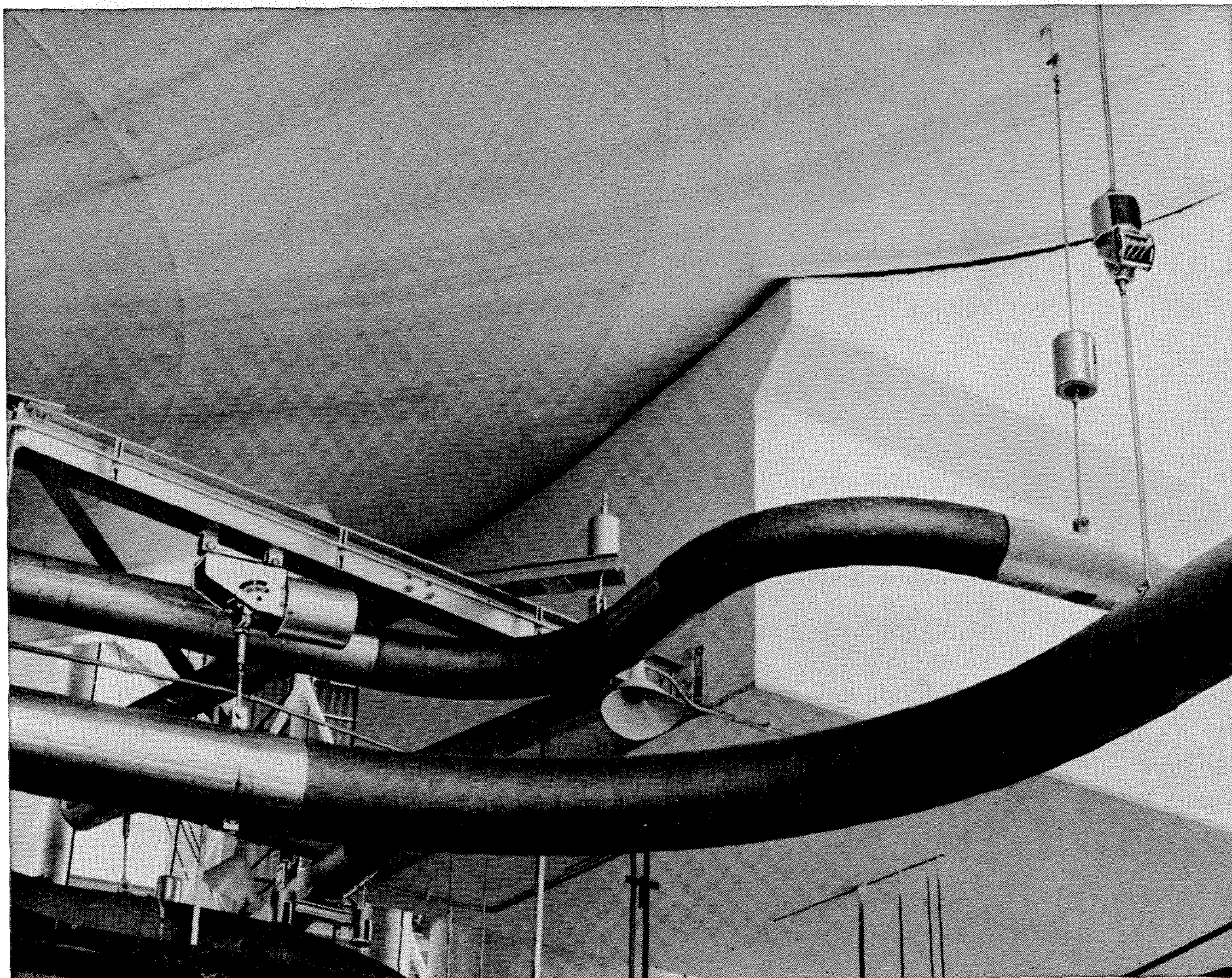
Thousands of characters

Street signs were of course not my chief texts. I was busily reading instruction books and learning characters. Thousands of characters were formerly in use, and will be encountered in reference reading; my valued Rose-Innes dictionary shows nearly 5000. In 1947, by official decree, 1850 characters were designated for ordinary use; newspapers and official documents are limited to these.

One serious difficulty in learning Japanese is the completely different pattern of associated meanings. Ideas which are distinct in English may prove almost inseparable in Japanese, and vice versa. The Japanese, for instance, use no general word for "brother" or for "sister;" the usual terms mean specifically "elder brother," "elder sister," "younger brother," "younger sister." On the other hand, there is a nice word, *kyodai*, which means "brothers and sisters," an exact equivalent of "siblings," which has been revived as a technical word in English.

Scientific precision is difficult in Japanese, and many of their best research men find it easier to think and write in English terms. On the other hand, Japanese has a wonderful facility for expressing shades of doubt, probability, and uncertainty. Attempts by Japanese to transfer these nuances into English occasionally produce the inspired effects which both interest and amuse us. My favorite instance is this, from a scientific paper: "According to a newspaper, the following volcanic eruption is likely to have happened."

I cannot close without adding a note of appreciation. The uniform courtesy and consideration everywhere in Japan is unforgettable. No trouble was too much for our Japanese hosts. As a Fulbright scholar, I was a guest of the nation; it was an enviably privileged position. To the Fulbright staff, and to our hosts at the University and elsewhere, I can only express my heartfelt but inadequate thanks.



Grinnell Spring Hangers support the pipes carrying steam from the heat exchangers to the turbines.

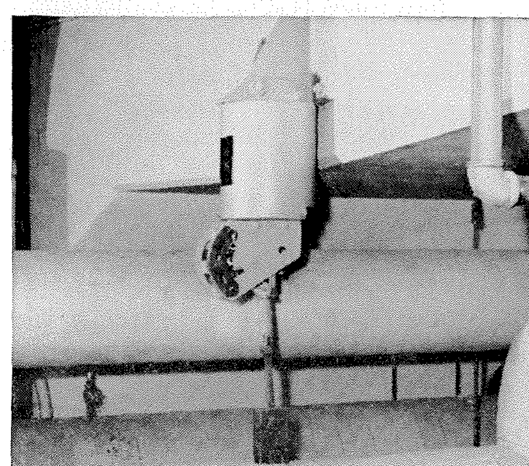
Grinnell Hangers cradle high-pressure piping at new Yankee Atomic Power Plant

At the new Yankee Atomic Power Plant in Rowe, Mass., uranium fuel in the nuclear reactor keeps the water which flows through the reactor at about 500°F. This pressurized water, at 2,000 pounds per square inch pressure, transfers the heat through piping to a steam generator where steam is produced for running power turbines.

Piping that undergoes such high pressures and temperatures must have rugged, *reliable* support. Chosen for this tough job: Grinnell Pipe Hangers!

Grinnell Constant Support Hangers are used where reactive forces at terminal points must be kept within specified limits. Grinnell Variable Spring Hangers are used where piping is subject to vertical movement and does not require a constant support type.

For a complete line of engineered pipe hangers and supports . . . for skilled advice and assistance . . . for experienced field engineering service . . . call on Grinnell Company, Providence 1, Rhode Island.



Turbine extraction lead gets support from Grinnell Constant Support Hanger

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Alumni News

Board Nominations

The Board of Directors of the Alumni Association met as a Nominating Committee on February 28, 1961, in accordance with Section 5.01 of the By-Laws. Five vacancies will occur on the Board at the end of the fiscal year (June 1961)– one vacancy to be filled from the present Board, and four members to be elected by the Association. The present members of the Board and their retirement years are:

Ralph J. Barry '38	1961	John D. Gee '53	1962
Franklin G. Crawford '30	1961	William L. Holladay '24	1962
Holley D. Dickinson '36	1961	Ralph W. Jones '38	1961
Frederick Drury, Jr. '50	1961	Howard B. Lewis, Jr. '48	1962
Claude B. Nolte '37	1962		

The following nominations have been made:

President – Holley B. Dickinson '36	(1 year)
Vice-President – William L. Holladay '24	(1 year)
Secretary – Donald S. Clark '29	(1 year)
Treasurer – John R. Fee '51	(1 year)
Director – William H. Saylor '32	(2 years)
Director – Peter V. H. Serrell '36	(2 years)
Director – Charles P. Strickland '43	(2 years)
Director – William H. Simons '49	(2 years)

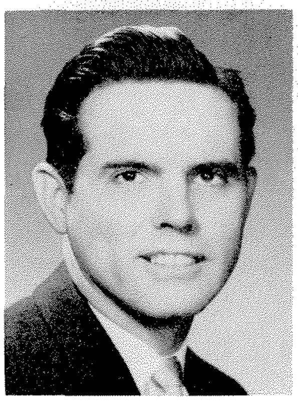
Section 5.01 of the By-Laws provides that the membership may make additional nominations for the four (4) Directors by petition signed by at least twenty-five (25) members in good standing, provided the petition is received by the Secretary not later than April 15. In accordance with Section 5.02 of the By-Laws, if further nominations are not received by April 15, the Secretary casts a unanimous ballot for the members nominated by the Board. Otherwise a letter ballot is required.

Statements about the nominees are presented below.

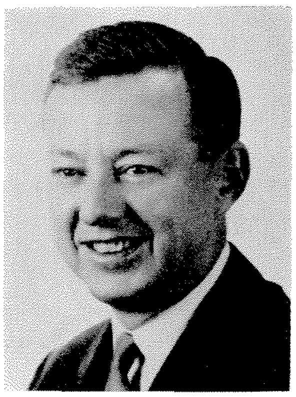
– *Donald S. Clark, Secretary*

William H. Saylor received his BS in civil engineering in 1932 and then spent a year in graduate study at the University of California in Berkeley. He was a junior engineer with the Metropolitan Water District of Southern California for the next five years. From 1938 to 1943 he was head of the Dam Design Section of the U.S. Engineers, and in 1945, after two years as a research engineer at Caltech, he became head of the Underwater Ordnance Department and associate director of the U.S. Naval Ordnance Test Station. In 1955 he helped to found a new computer research and development group called the data systems department of the Norden Division of the United Aircraft Corporation in Costa Mesa, and is now chief mechanical engineer there.

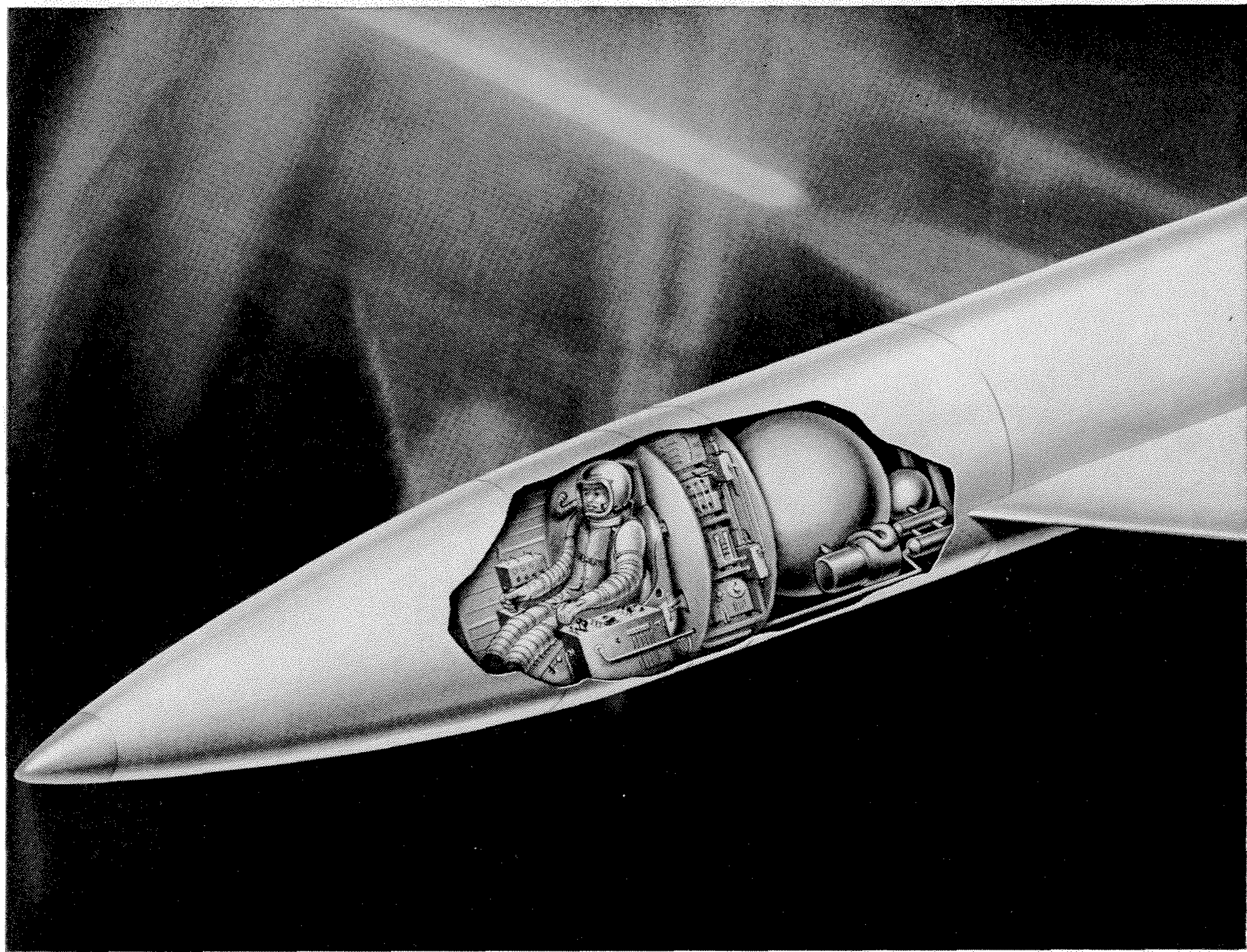
Peter V. H. Serrell received his BS in engineering in 1936, and after a year as an exchange fellow in Germany, he returned to Caltech to get his MS in mechanical engineering in 1939. In the next few years he worked on the staffs of the Guggenheim Aeronautical Laboratory, the Southern California Cooperative Wind Tunnel, and JPL. He was cofounder in 1948 of the Sandberg-Serrell Corporation and served them as vice president and then as president. He joined the industrial research firm of Arthur D. Little in Santa Monica as a senior engineer in June 1960.



William H. Simons received his BS in mechanical engineering in 1949, then worked for the Ingersoll-Rand Company as an engineering trainee, and subsequently as sales engineer in San Francisco, until 1951. After two years as a line officer in the U.S. Navy, he joined the James, Pond & Clark Mfg. Corporation in Pasadena, where he became engineering and manufacturing manager in 1955. He received his BS in ME through night school at USC in 1957.



Charles P. Strickland, Jr., received his BS in applied chemistry in 1943. From 1943 to 1946 he served in the Navy – including one year as B division officer on an aircraft carrier, and a year at the Postgraduate School of the Naval Academy in Annapolis. In 1948 he joined the York Corporation, a subsidiary of the Borg-Warner Corporation, subsequently becoming industrial sales engineer in the Los Angeles office. From 1956 to 1958 he was industrial sales manager for the Southwest District of York Corporation in Houston. He is now regional manager of operations in nine western states.



Forthcoming space exploration will require exotic fuels and new concepts in energy conversion to keep men alive and equipment operating for long periods of time beyond the earth's atmosphere. Advanced hydrogen systems recently developed by The Garrett Corporation have solved this problem of providing the electrical, hydraulic and pneumatic power, plus cooling and heating required aboard a satellite or space capsule during launching, outer space flight and re-entry.

Besides such spacecraft and missile systems, other product areas in which Garrett engineers work include small gas turbine engines, flight data systems for air and underwater use, nuclear and solar power systems, cryogenic systems and controls, and air conditioning and pressurization systems for conventional aircraft and advanced flight vehicles.

Such diversity of interest not only makes work more interesting at Garrett, but gives the engineer an opportunity to increase his knowledge and chances for responsibility and advancement.

An orientation program lasting a period of months is also available for the newly graduated engineer, working on assignments with experienced engineers in laboratory, preliminary design and development projects. In this way his most profitable area of interest can be found.

Should you be interested in a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles.

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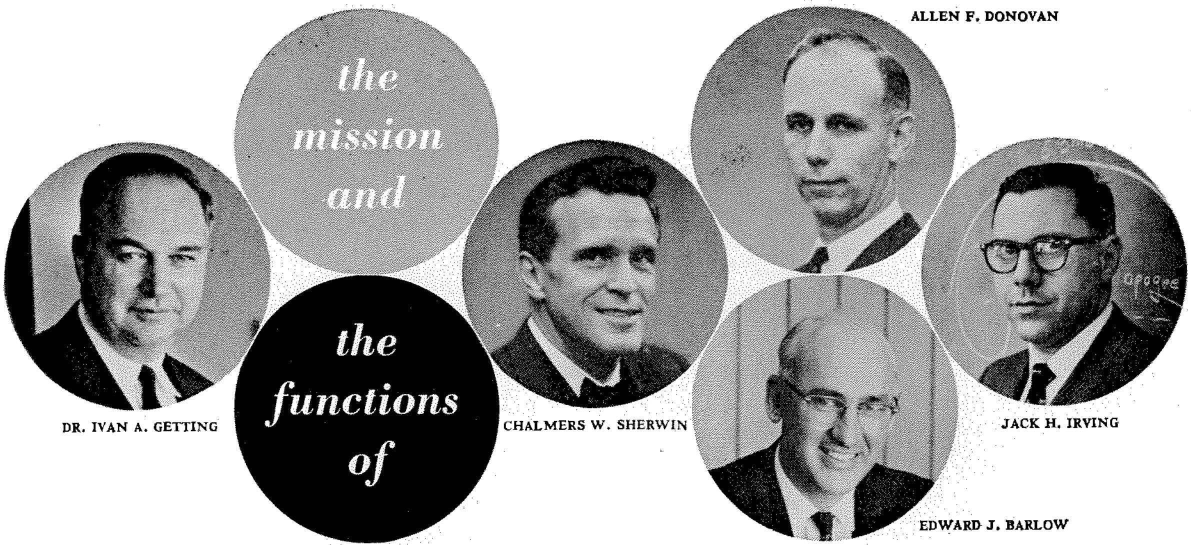

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"To preserve our free institutions, it is absolutely essential that the United States find the most effective means of advancing the science and technology of space and also of applying them to military space systems. This is the mission of Aerospace Corporation."

IVAN A. GETTING
PRESIDENT
AEROSPACE CORPORATION

In accomplishing its mission, this non-profit public service organization performs the unique role of space systems architect. Aerospace Corporation provides scientific and technical leadership to the science/industry team responsible for developing complete space and ballistic missile systems on behalf of the United States Air Force.

Specific responsibilities of the new corporation include advanced systems analysis, research and experimentation, initial systems engineering, and general technical supervision of new systems through their critical phases.

The broad charter of Aerospace Corporation offers its scientists and engineers more than the usual scope for creative expression and significant achievement, within a stimulating atmosphere of dedication to the public interest.

Aerospace Corporation scientists and engineers are already engaged in a wide variety of specific systems projects and forward research programs, under the leadership of scientist/administrators including corporation president Dr. Ivan A. Getting, senior vice president Allen F. Donovan, and vice presidents Edward J. Barlow, William W. Drake, Jr., Jack H. Irving, and Chalmers W. Sherwin.

Immediate opportunities exist for MS and PhD candidates completing requirements in engineering, physics, chemistry and mathematics, and interested in:

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- Space communications
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Gravity is both a bane and a boon to man's efforts—and a thorough understanding of it is of great significance in the completion of Allison's energy conversion mission.

Gravity conditions our thinking on advanced assignments. For example, in outer space there is a disorientation of conventional design. The fact that large accelerations can be obtained with low thrust forces has taken us into the new field of electrical propulsion, ion and magnetohydrodynamic rockets.

In our inquiries, we supplement our own resources by calling on many talents and capabilities: General Motors Corporation, its Divisions, other individuals and organizations. By applying this systems engineering concept to new projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis 6, Indiana

Personals

1914

Everett S. Gardiner died of a heart attack on November 26, 1960. He had been retired for many years. He had served as a private consultant on development problems in real estate on Balboa Island.

1917

Alexander Kensey, chairman of the board of the Coast Envelope Company of Los Angeles and San Francisco, died on January 31 at the Hoag Memorial Hospital in Newport Beach, California.

Alex had spent his entire business career with Coast Envelope and had been president since 1949. He had assumed the title of chairman just recently in order to guide a Coast merger with the Hammermill Paper Company.

Alex was born in Bucharest, Roumania, on January 7, 1895, and came to this country as a child. He leaves his wife and a son, John, 24.

1928

W. Morton Jacobs is now president of the Pacific Lighting Gas Supply Company, a subsidiary of Pacific Lighting Corporation in San Francisco. He was formerly vice president and assistant general manager of the Southern California Gas Company, another subsidiary. Mort will also continue part time in his position as vice president of the parent company in San Francisco.

1934

Milford Childers, MS '35 ME, MS '36 AE, research and development engineer at Lockheed Aircraft, was named "Engineer of the Year" by the San Fernando Valley Chapter of the California Society of Professional Engineers last month. The title is annually conferred on the valley engineer who has made an outstanding contribution to the field of engineering and who takes an active part in civic betterment. He has been with Lockheed since 1937, and is currently assigned to the staff of the chief engineer in spacecraft.

1939

Brig. Gen. R. Loyal Easton (Ret.), MS, died of a heart attack on November 19, 1960. He was head of the science department of Starke University School in Montgomery, Ala. He is survived by his wife.

Richard K. Pond writes from Fanwood, N.J., that "after five harrowing years as superintendent of production at Westinghouse – during which time we went through a prolonged strike, expanded production, commenced manufacture of new products, and built a new plant – I was much relieved to be appointed manager of management services last March. The Westinghouse Corporation created this new activity because they recognized the rapid developments taking place in the fields of business management, organization planning, data processing, systems improvement, etc., so they combined under one head the several individual efforts being made in these areas.

"On the home front, we find the years slipping by all too rapidly. My older daughter is now attending the University of Rhode Island, studying home economics, while our younger daughter is in junior high and showing great interest in scientific subjects."

1940

Homer J. Stewart, PhD, recently returned to his posts as professor of aero-

continued on page 40

WHY DOUGLAS AIRCRAFT CHOSE "PVs"

• **BETTER LIGHTING.** "PV" means "Perfect Vision"® Luminaire. The initial foot candle reading in every section of the 120,000 square foot room illustrated above was in **excess of 200 foot candles** with no glare or hotspots.

• **LOWER FIRST COST. Installed** cost slightly less than $1.20 per square foot.

• **LOWER MAINTENANCE COST.**

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Consulting Engineers: Holmes & Narver, Inc.
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Save the Date!

ANNUAL ALUMNI SEMINAR

SATURDAY, MAY 6, 1961

Morning and Afternoon Lectures

James Bonner:	*The Ballet of the Big Molecules*
Heinz Ellersieck:	*Berlin - Hostage and Live Bait*
David Elliot:	*Is World Disarmament Possible?*
Irene Goddard:	*Oxygen Isotopes – Footprints of Time*
Robert Leighton:	*New Views of the Sun*
Bruce Murray:	*Water on the Moon?*
C. J. Pings:	*Living on Cracked Ice*
Eberhardt Rechtin:	*What Should Space Cost?*
H. P. Robertson:	*Proofs of Relativity*
Cushing Strout:	*Anti-Americanism in Europe*
John Todd:	*The Monte Carlo Method*
T. Y. Wu:	*How Does a Fish Swim?*

Exhibits

Dabney Hall: Public Affairs Room and CIT Development Program exhibit

Sloan Laboratory: Tandem Accelerator and Frictionless Motion

Keck Laboratories Open House: Water Resources, Materials, and Environmental Health

Dinner Program

The speaker at the Huntington-Sheraton Hotel dinner program will be announced in the April issue of *Engineering and Science.*

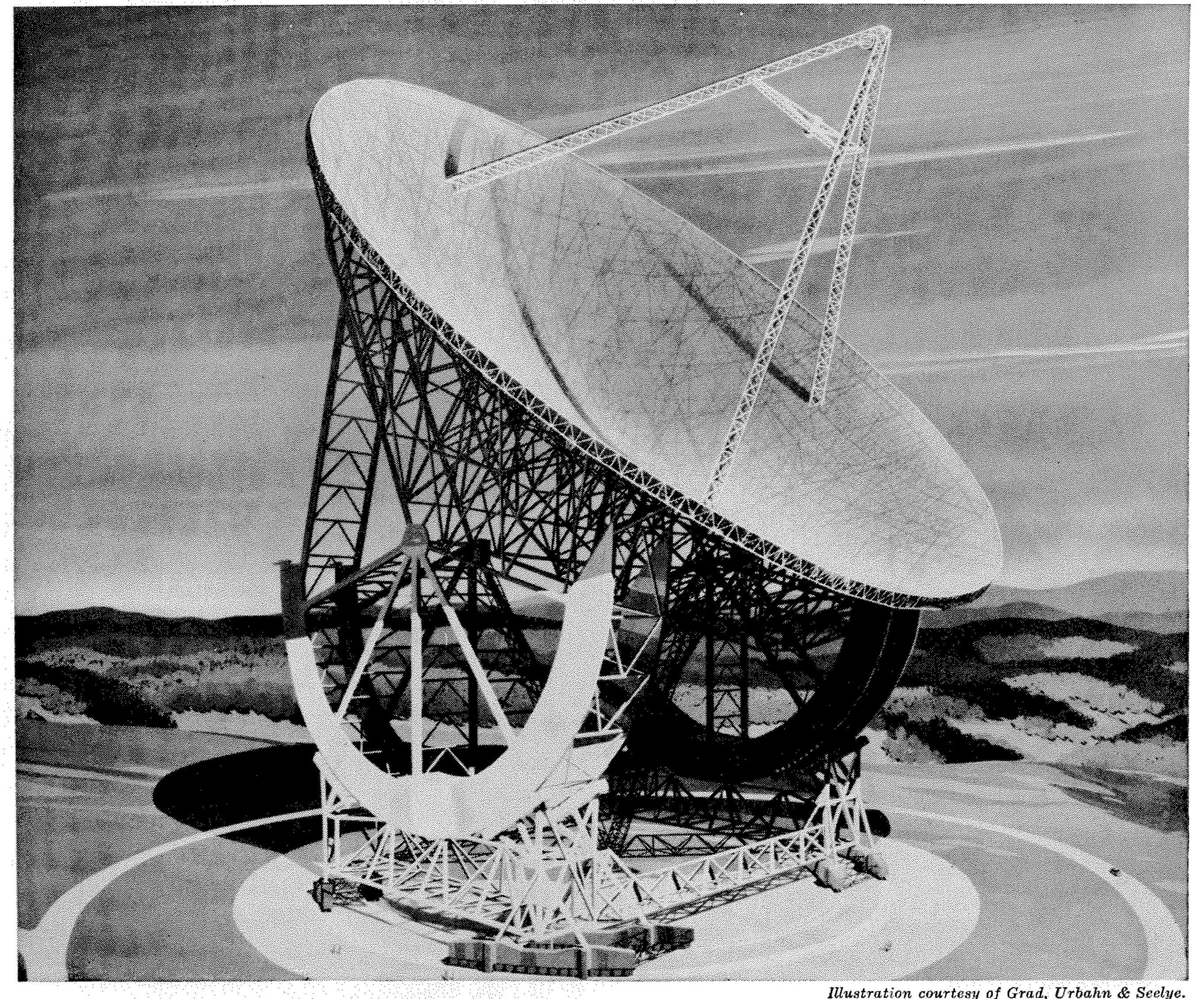


Illustration courtesy of Grad, Urbahn & Seelye.

Inco Nickel helps give engineers the solution to metal problems in new radio telescope

How do you design a precision instrument that will "see" 38 billion light years into space? This problem was answered by the engineers working on this revolutionary, new radio telescope.

But these engineers faced another challenging problem—*How do you actually build it?* How do you build a telescope as tall as a 66-story building with a reflector so big it could hold six football fields?

How do you build a rotating mechanism that can swing this giant up or down, or sideways, to aim at any spot in the Universe with pin-point accuracy? Just the tiniest amount of wear or distortion in this mechanism could throw the telescope millions of miles off target in the far reaches of space!

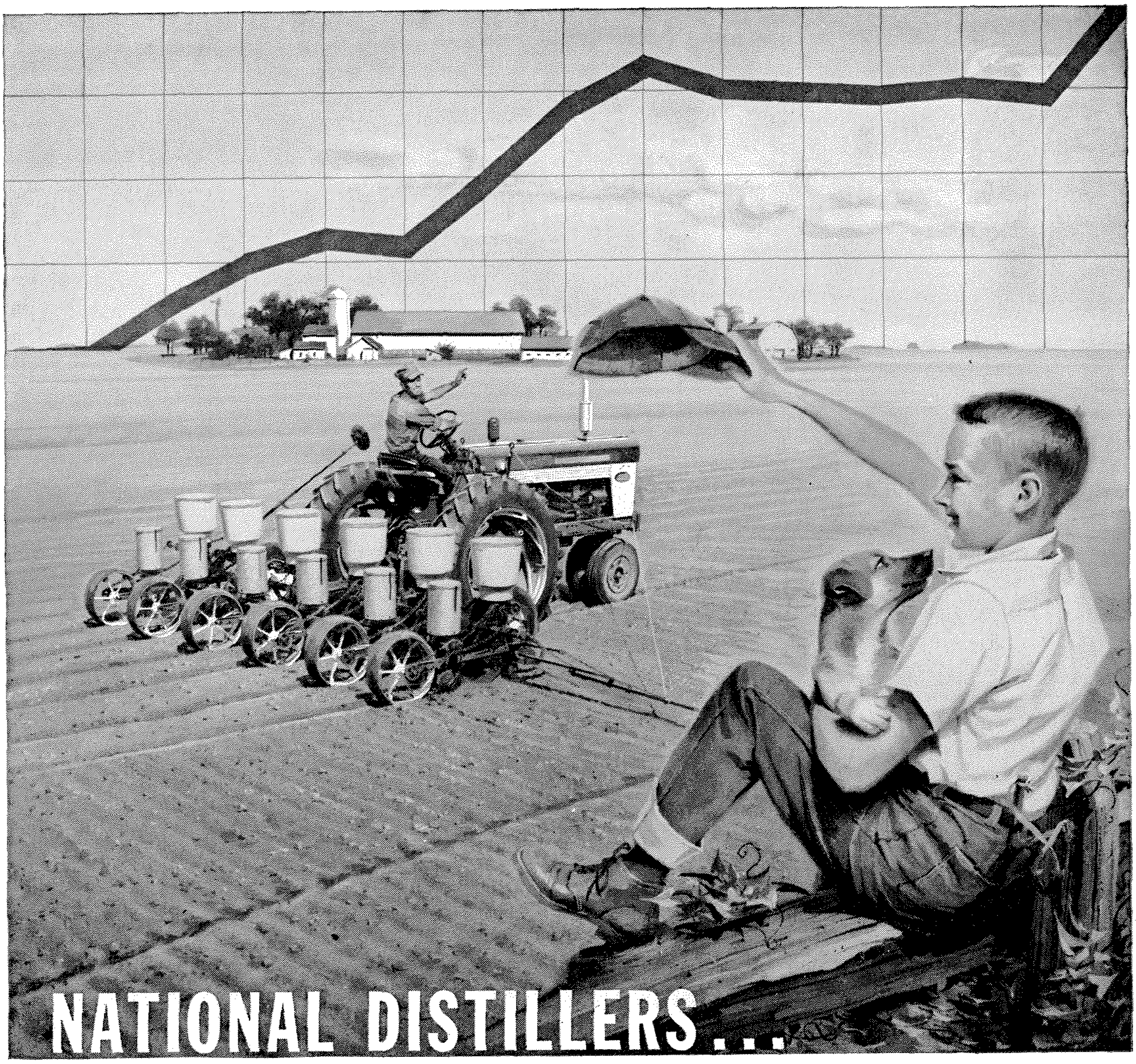
Where could they get construction materials tough and strong enough? Nickel gave them the answer! Nickel in steel gave these engineers a material tough enough to maintain precision in the rotating mechanism even under the anticipated 20,000-ton load. And Nickel, to be used in the steel members, gave them the high strength at minimum weight needed to support the giant reflector.

The radio telescope is one of the many developments in which Nickel has solved important problems. Most probably you, yourself, in the near future, will be faced with problems just as difficult. When you are, you can count on Nickel—and the cooperation of Inco—to help get the job done . . . and done right!

If you'd like to get acquainted with Nickel steels, write us for a copy of, "Nickel Alloy Steels and Other Nickel Alloys in Engineering Construction Machinery." Educational Services, The International Nickel Company, Inc., New York 5, N. Y.

INCO TRADE MARK **International Nickel**

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) — producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium, Sulfur and Platinum, Palladium and Other Precious Metals



expanding in fertilizers . . . a growth industry

Fertilizer consumption in the United States is up 88% in 15 years—from 13,466,000 to 25,313,000 tons.

In the same 15 years, consumption in the 16 central states increased almost 140%—from 4,607,000 to 11,009,000 tons. This is the primary market for National Distillers and Chemical Corporation's fertilizer chemicals—ammonia, nitrogen solutions and sulfuric and phosphoric acids manufactured at U. S. I. division plants in Illinois, Iowa and Kansas.

Now National has taken an important forward step in integrating its fertilizer operations by merger with Federal Chemical Company. Federal is a 76-year-old mixed fertilizer manufacturer with six modern plants in Kentucky, Tennessee, Illinois, Indiana and Ohio, heart of the mid-west farm belt.

A Career at National . . . National Distillers' progress in the expanding fertilizer chemicals field is part and parcel of its substantial growth in industrial chemicals, metals and plastics. Chemists and engineers seeking a challenging career in a growing organization are invited to contact our Professional Employment Manager, 99 Park Avenue, New York 16, N. Y.

NATIONAL DISTILLERS and CHEMICAL CORPORATION

NEW YORK 16, N. Y.

THE COMPANY WITH THE FIVE INDUSTRY FUTURE

LIQUORS • INDUSTRIAL CHEMICALS • PLASTICS • FERTILIZER CHEMICALS • METALS

INERTIAL ENGINEERING INGENUITY

Litton's LN-3 Inertial Navigation System for the NATO F-104, now in production, owes its excellent performance to Litton-designed technical features such as:

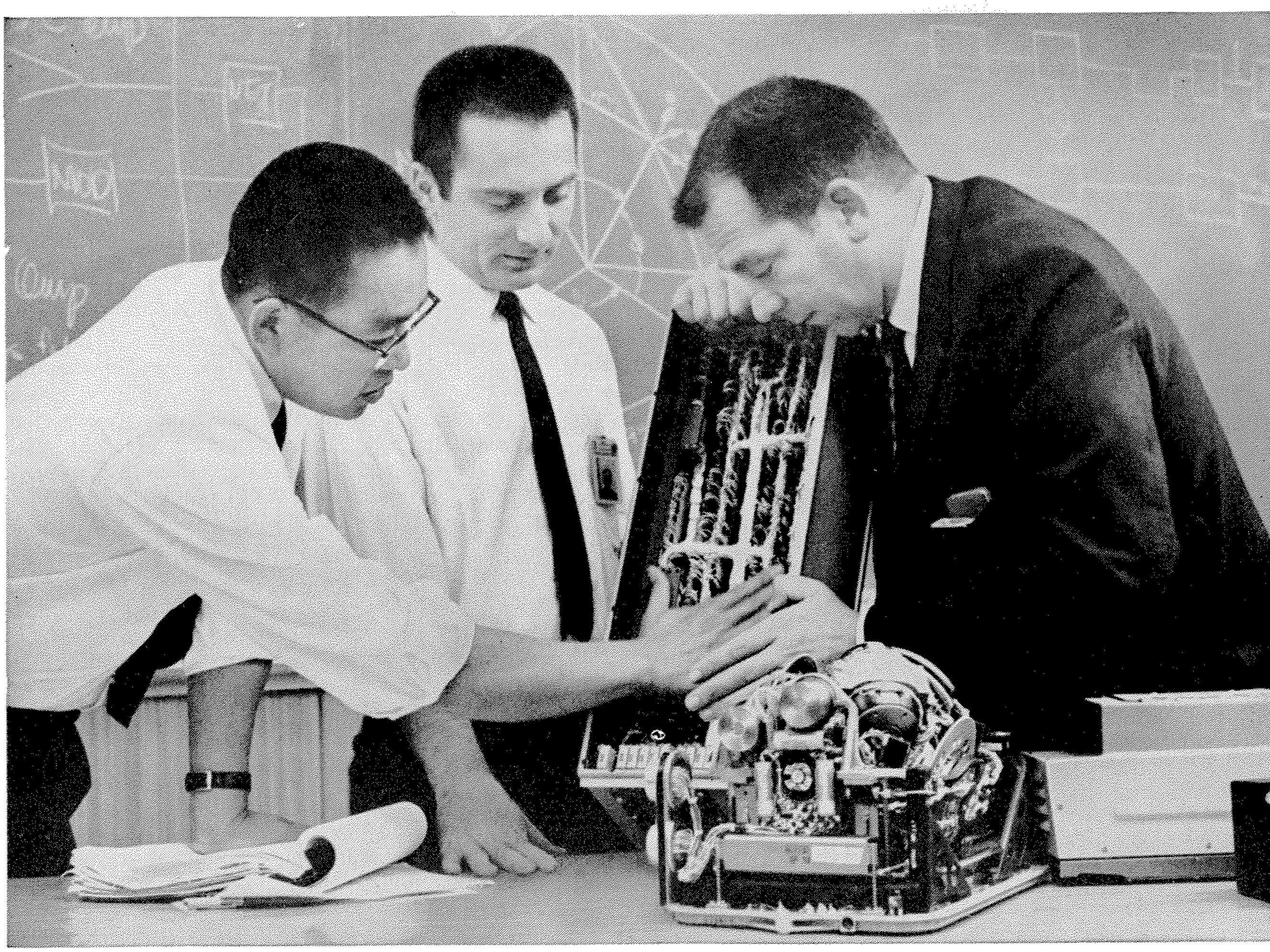
Integrators with linearity of better than 1 part in 10,000.

Fully transistorized d.c. amplifiers with internal gain better than 10^7 with offsets, referred to the input, of 20 microvolts maximum. Operational characteristics are constant between —55°C. and 85°C.

Systems of the future require evaluation of computer performance and evaluation of other system units, such as *miniature* inertial platforms. Would you care to move ahead in this field shoulder-to-shoulder with acknowledged experts? If so, contact Mr. Harvey Lashier, Office of Advanced Scientific Education, Canoga Avenue at Ventura Freeway, Woodland Hills, California. Telephone: DIamond 6-4040. You can share in generous employee benefits, including stock purchase and tuition-paid education plans. Relocation assistance is provided.

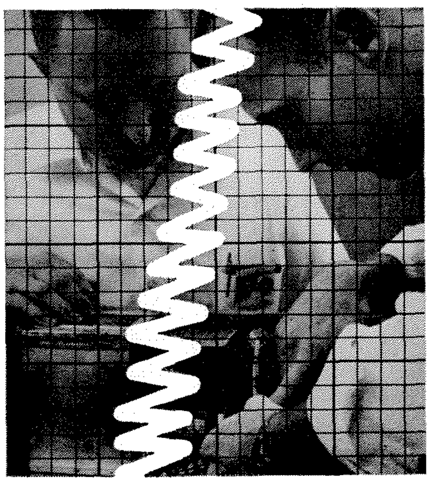
LITTON SYSTEMS, INC.
GUIDANCE & CONTROL SYSTEMS DIVISION
Beverly Hills, California

John Tamura and Robert Ebner discuss the optimization of the LN-3 Computer Integrator design with Dr. Harold Bell, assistant director of the Guidance Systems Laboratory



Inventiveness:

indispensable ingredient of Space Technology Leadership



In the achievement of Space Technology Leadership, on-the-shelf hardware and the existing state-of-the-art are not always equal to the requirements of advanced missile and space systems. In such challenging situations Space Technology Laboratories responds with the full breadth of its resources.

In response to the need for time compression, STL inventiveness produced devices answering urgent requirements of advanced space programs conducted for the Air Force Ballistic Missile Division, National Aeronautics and Space Administration, and Advanced Research Projects Agency. Among these: Telebit, first digital computer to enter space; the first multi-million-mile space communications system of Pioneer V; a continuous-wave radio guidance system and light-weight autopilots for Able-series space vehicles; and a low-thrust multi-start space engine for maneuverable satellites.

On this foundation of inventiveness STL continues to broaden in scope, translating creative concept into accomplishment for Space Technology Leadership.

Outstanding scientists and engineers seeking such an environment are invited to investigate opportunities available at STL. Resumes and inquiries directed to the attention of Dr. R. C. Potter, Manager of Professional Placement and Development, will receive meticulous attention.

SPACE TECHNOLOGY LABORATORIES, INC.

P.O. Box 95005JJ
Los Angeles 45, California

a subsidiary of Thompson Ramo Wooldridge, Inc.

nautics at Caltech and special assistant to the director of JPL. During his assignment in Washington, he was director of NASA's program planning and evaluation department, and was instrumental in developing the NASA ten-year plan for space exploration.

1941

Leland G. Swart, MS, is a member of the technical staff and supervisor of the underwater systems development division for Bell Laboratories in Whippany, N.J. He is also a member of the Kiwanis, sings in St. Johns on the Mountain Episcopal Church Choir, and is active in local civic clubs. The Swarts have two girls, 16 and 12, and a boy, 4.

1942

Ben F. Howell, MS, PhD '49, head of the department of geophysics and geochemistry at Pennsylvania State University, has been re-elected for another three-year period as secretary of the section of seismology of the American Geophysical Union.

1944

Herbert J. Cabral is now deputy manager of the Polaris missile launching and handling project at Westinghouse Electric Corporation's Sunnyvale division. He has been with the company since 1946.

Charles S. Cox has been named an officer of the Pacific Southwest Regional Committee of the American Geophysical Union for a three-year period.

Jepson Garland writes from London that "with my wife, Bobby, and three daughters, Nancy, 6; Susie, 4; and Cindy, 2; I have spent the last 18 months here on an assignment for the Fluor Corporation, Ltd. I have been project engineer on an oil refinery expansion project being constructed in Minatitlan, Mexico.

"We have skiied in the French and Swiss Alps and the kids can all yodel now. We've also traveled extensively in Western Europe. I'll be returning to Fluor's Los Angeles office in April."

1945

P. W. Kohlhaas is now executive vice president of Patterson - Emerson - Comstock, Inc., a large electrical construction and engineering firm, at their home office in Pittsburgh.

Charles E. Lamar was recently promoted to vice president of marketing for the Southern Pipe division in Azusa of U.S. Industries, Inc. *Douglas Stromsoe,* '23, is division president.

1947

Irving Michelson, MS, PhD '51, professor of mechanical engineering at the Technology Center at Illinois Institute of Technology, is on leave this spring at the Université de Nancy in France as a visiting professor.

Eugene M. Shoemaker, MS '48, chief of astrogeologic studies for the U.S. Geological Survey, spoke on terrestrial impact on the earth and moon at a special geology seminar at Caltech last month.

1950

Howell Tyson, Jr., joined the technical staff of the IBM Corporation in Los Angeles last summer. He was formerly staff engineer at the EAI Computation Center in L.A. The Tysons have three girls – 8½, 6, and 3.

1952

Keith L. Winsor is now manager of the advanced electronics department of the advanced electronics and information systems division of Electro-Optical Systems, Inc., in Pasadena. He was formerly project chief of the components section at the Wiancko Engineering Company.

1953

Sheldon Rubin, MS '54, PhD '56, writes that "I've recently been named head of the technical engineering section in the radar and missile laboratory of Hughes Aircraft Company in Culver City. The mechanical design of the electronic equipment in the Surveyor lunar soft-landing spacecraft will be performed in this section.

"We have great expectations for our recently arrived son, Goeffrey, (Caltech, approx. '82) because he is already master of the household."

1955

Cdr. Roy S. Cornwell, AE, is now at the Lawrence Radiation Laboratory in Livermore, Calif., as a military research assistant. He is working on Project Pluto. Roy came to the lab from the Naval Air Rocket Test Station in Lake Denmark, N.J. Before that he had spent four and a half years as a night fighter pilot in the Atlantic Fleet. The Cornwells have three children – 5, 3, and 1.

1958

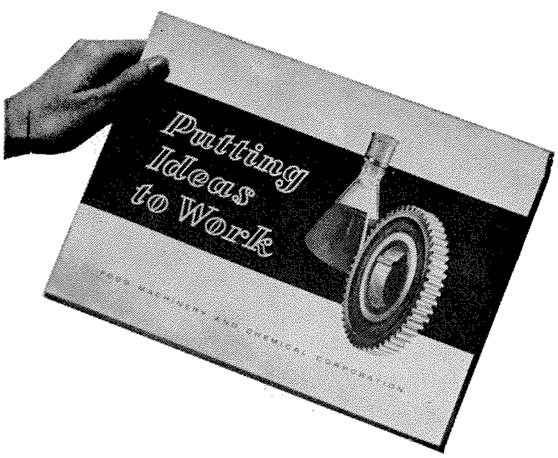
Jon R. Valbert, MS '59, graduate student and instructor in chemical engineering at MIT, has been elected to membership in Phi Lambda Upsilon, the national honorary chemistry and chemical engineering society there. Members are chosen on the basis of academic achievement, and on participation in extracurricular activities. During the summers Jon has worked as an engineer for Standard Oil of Indiana, and for Morton Salt; and as a technician at Inland Steel.

A REAL CAREER OPPORTUNITY FOR GRADUATES

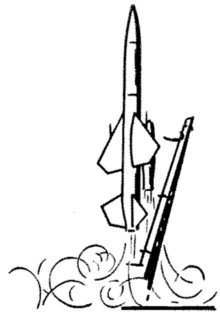
COMMERCIAL OPERATIONS:

Graduates planning careers in chemical, electrical or mechanical engineering, will be interested in evaluating the opportunities offered by Food Machinery and Chemical Corporation, with headquarters in San Jose, California—a nation-wide organization that puts ideas to work through creative research and practical engineering.

FMC offers career opportunities in these fields: Agricultural Chemicals • Agricultural Equipment • Automotive Servicing Equipment • Food Canning & Freezing Equipment • Defense Materiel • Fire Fighting Equipment • Industrial Chemicals • Materials Handling Equipment • Power Gardening Equipment • Packaging Equipment • Food Packing and Processing Equipment • Petroleum Specialty Equipment • Pumps and Water Systems • Waste Disposal Equipment



DEFENSE OPERATIONS:



FMC's Ordnance Division, located at San Jose, California, produces mobile support equipment for military programs including amphibious tracked vehicles and missile ground support equipment. This fully integrated organization and its well equipped facilities provide coordinated control of each phase of every project from design concept through development and production.

The division possesses complete prototype and quantity production manufacturing facilities along with a wide variety of test equipment and processes, as well as complete testing grounds for tracked vehicles and missile handling equipment. Young graduates employed by FMC have the opportunity of working with men of outstanding engineering talent and leadership in mechanical, structural, electrical, hydraulic, and metallurgical specialties.

This challenging field offers tremendous possibilities for the young engineer. Because of rapid advancements in this sphere of activity, FMC is constantly looking for men with the special capabilities for creative engineering and development.

To acquaint students with the broad scope of career opportunities in FMC's diversified activities, we invite you to write for copies of our brochure, "*Putting Ideas to Work*," which graphically presents FMC's operations and product lines.

Address: **Personnel Administration Department**
P. O. Box 760, San Jose, California,
or Industrial Relations Department
161 East 42nd Street, New York 17, New York

Putting Ideas to Work

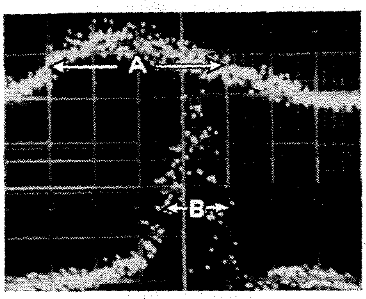
FOOD MACHINERY AND CHEMICAL CORPORATION

"CHARGED PARTICLES"

Nanosecond Pulsing

The timing of nuclear events and the discrimination between them continues to be a major hurdle for the experimental physicist.

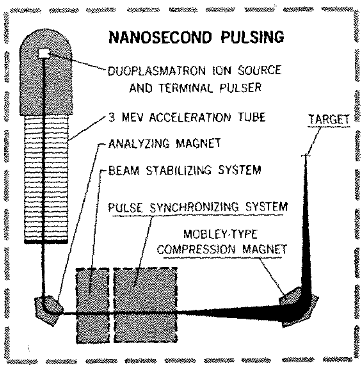
We don't need a market research program to reveal the need for apparatus which will assist the experimenter to do accurate neutron time-of-flight work or to determine excited state lifetimes in the milli-u-sec. region. Ultra-short high-intensity pulses of charged particles, and the resulting neutron bursts, provide one of the most promising techniques in these experimental areas.



Lumatron scope presentation of 8-nanosecond terminal-pulsed beam (A) and compression to 2-nanosecond post acceleration pulse (B).

We have completed the development of a system for producing and measuring *pulsed proton beams with an intensity of several milliamperes and a pulse duration of less than one nanosecond (10^{-9} seconds).* The first research results from this apparatus are soon to be reported.[1]

The beam is accelerated to 3-Mev by a Van de Graaff fitted with a terminal pulser of the deflection type, delivering ion pulses of 10 ns duration every 1000 ns at the input end of the acceleration tube. After acceleration, the pulse is compressed by a 90° double-focusing Mobley[2] magnet whose radius of curvature is 30 inches. The deflection electrodes at the entrance of the magnet are driven by a 10 Mc sinusoidal voltage which is synchronized with the pulse from the accelerator. Observations were made with a time-to-pulse-height-conversion measurement system checked by nuclear methods.



Isotopes of Rare Purity

The need for pure isotopes in work concerned with nuclear structure and particle reactions has led us to develop a new, broad-range electromagnetic isotope separator that is faster, simpler to use and provides purer samples than any comparable equipment we've seen.

This instrument is designed to produce up to 10 microamperes of individual particle beams — *with a mass resolving power better than 400.* Separation is achieved in a 5000-gauss, 160 cm radius magnetic field. Time for recovery of samples after collection is less than two minutes. Those who have had their decay schemes disappear before their eyes will appreciate this bit of engineering in working with short-lived isotopes.

The instrument can also be used to produce nuclear targets for studies of energy level, scattering, neutron cross-section or other phenomena, as well as pure radioactive tracers. Two of these instruments are now being built for U.S. atomic energy program. Specifications for the machine are presented herewith.

160 CM ELECTROMAGNETIC ISOTOPE SEPARATOR

Range:	Atomic mass 1 to 400
Current:	10μa of most abundant isotope (100 μ achievable with some loss in resolving power)
Voltage:	80 kv
Magnetic Field:	5000 gauss
Field Stability:	Better than .01 per cent
Ion Sources:	Modified Arc
Operation:	Time for removal of collector after full operation — 2 minutes
Vacuum System:	All metal bakeable gasketing

Accelerator Conference

The 2nd Accelerator Conference held recently in Amsterdam was a rewarding occasion for High Voltage and its Dutch affiliate, High Voltage Engineering (Europa) N.V. Three hundred participants from 24 countries joined in this exchange of information on accelerators and experimental techniques. There was some healthy give and take between the "ideal" machine described by physicists and the "present state of the art," reported by our engineers. If there were no gap between what is wanted and what is commercially available, most of us could pack up and go home.

As things stand, High Voltage continues to push its development to the limit and is glad to share a challenge with its insatiable customers in research.

The Conference Proceedings were published in a January special issue of *Nuclear Instruments and Methods.* Check with your librarian, or write us for a complimentary copy.

HIGH VOLTAGE ENGINEERING CORPORATION
BURLINGTON, MASSACHUSETTS, U.S.A.
•
APPLIED RADIATION CORPORATION
•
HIGH VOLTAGE ENGINEERING (EUROPA) N.V.

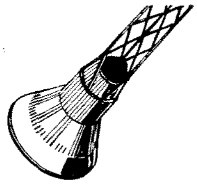
[1] *L. Cranberg, et. al., to be presented at Am. Phys. Soc. Meeting, New York (February 1961)*

[2] *R. C. Mobley, Phys. Rev. 88, 360 (1952)*

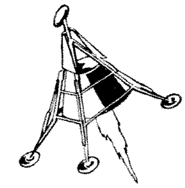
NASA program-highlights

NEXT DECADE IN SPACE

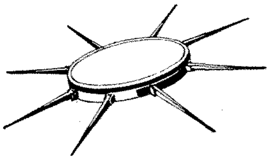
Year 4 to 14 of the Space Age



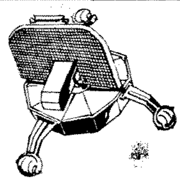
Project Mercury—U. S.'s first manned satellite.



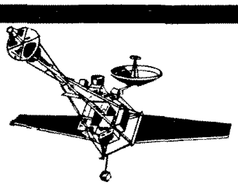
Project Surveyor—First soft landing on moon. Conduct observations from stationary position.



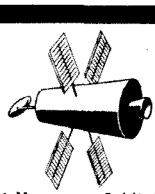
Project Prospector—Soft landing on moon and exploration of area within 50 miles of landing point.



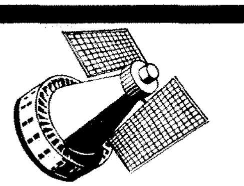
Solar Observatory—350 lb. Large flywheel and extended arms rotate to stabilize. Under construction.



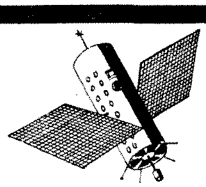
Project Mariner—600 to 1200 lbs. First U. S. Planetary missions to Venus and Mars. Modified craft for hard landings on moon.



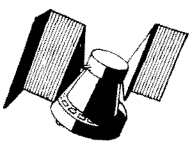
Project Voyager—Orbit Mars and Venus and eject instrumented capsule for atmospheric entry and perhaps landing.



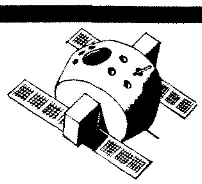
Nimbus—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.



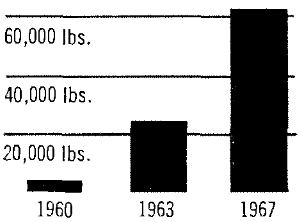
Orbiting Geophysical Observatory—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.



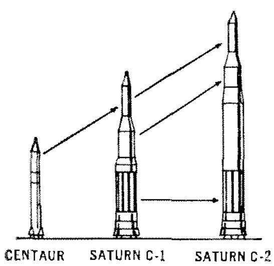
Project Aeros—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.



Orbiting Astronomical Observatory—Standardized, 3500 lb. satellite, for several experiments with different scientific sensors and specialized devices.



Anticipated Growth of NASA Spacecraft in terms of weight of individual near earth satellites.



Launch Vehicles—New and more powerful launch vehicles; chemical, electrical, nuclear propulsion.

These programs facing the scientists and engineers of NASA comprise the most challenging assignment ever given a group of Americans.

You are invited to work alongside the many distinguished and dedicated members of our technical staff. For details about outstanding professional opportunities, address your inquiry to the Personnel Director of any of these NASA Research and Space Flight Centers—

NASA Ames Research Center • Mountain View, California

NASA Flight Research Center • P.O. Box 273, Edwards, California

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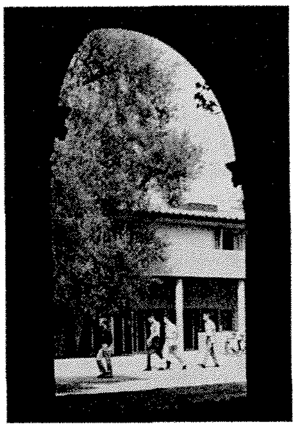
National Aeronautics and Space Administration

CALTECH CALENDAR



ALUMNI EVENTS

May 6	Annual Alumni Seminar Day
June 7	Annual Alumni Meeting and Dinner

ATHLETIC SCHEDULE

Baseball

March 25
Caltech at Naval Tr. Sta.

March 28
Caltech at Claremont-H. Mudd

April 1
Caltech at Azusa

Track

March 25
Santa Barbara Relays

March 31
Caltech at Whittier

April 7
Interclass

Swimming

March 31
Caltech at Claremont-H. Mudd

April 3
Arizona St. at Caltech

Tennis

March 30
Cal Western at Caltech

April 8
Caltech at UC, Riverside

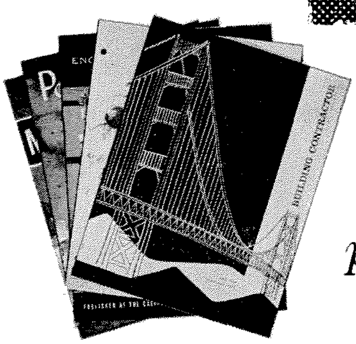
FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

March 31
Document in Madness
—J. Kent Clark

April 7
San Gabriel Mountains—An Old or New Range?
—Leon Silver

April 14
Experimental Studies of the Nervous System
—Theodore J. Voneida



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Visiting alumni cordially invited—no reservation

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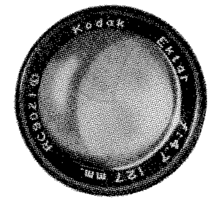
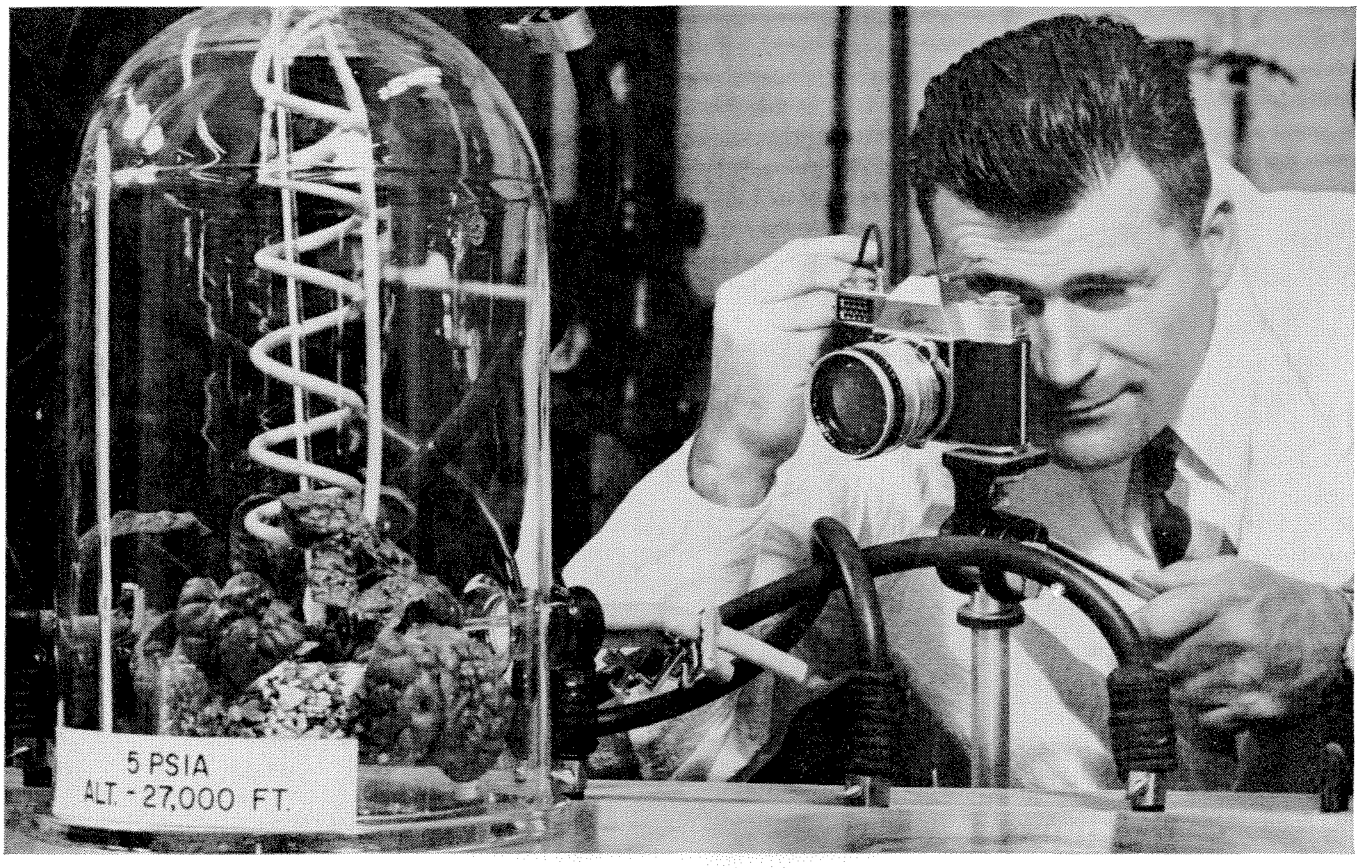
If your sights are set  on space survival–



Scientist photographs the development of experimental "lunar" plant at the Republic Aviation Corporation's "Lunar Garden."

–you'll find **Photography at Work** with you

Solving the problems of a human being living in outer space has become the task of scores of engineers, chemists and botanists. And serving them as a valuable working tool is photography. It records the growth of experimental plants and fungi that can well become the space voyager's food supply. Through autoradiography it can show the absorption of cosmic radioactive material, trace its circulation within the organism.

There's hardly a field on which you can set your sights where photography does not play a part in advancing work and simplifying routine. It saves time and expense in research, on the production line, in the engineering and sales departments, and in the office.

So in whatever you plan to do, take full advantage of all the ways photography can help.

CAREERS WITH KODAK:

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* * *

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N.Y.

EASTMAN KODAK COMPANY
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Kodak
TRADE MARK

One of a series

Interview with General Electric's Byron A. Case Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have over 5 years experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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