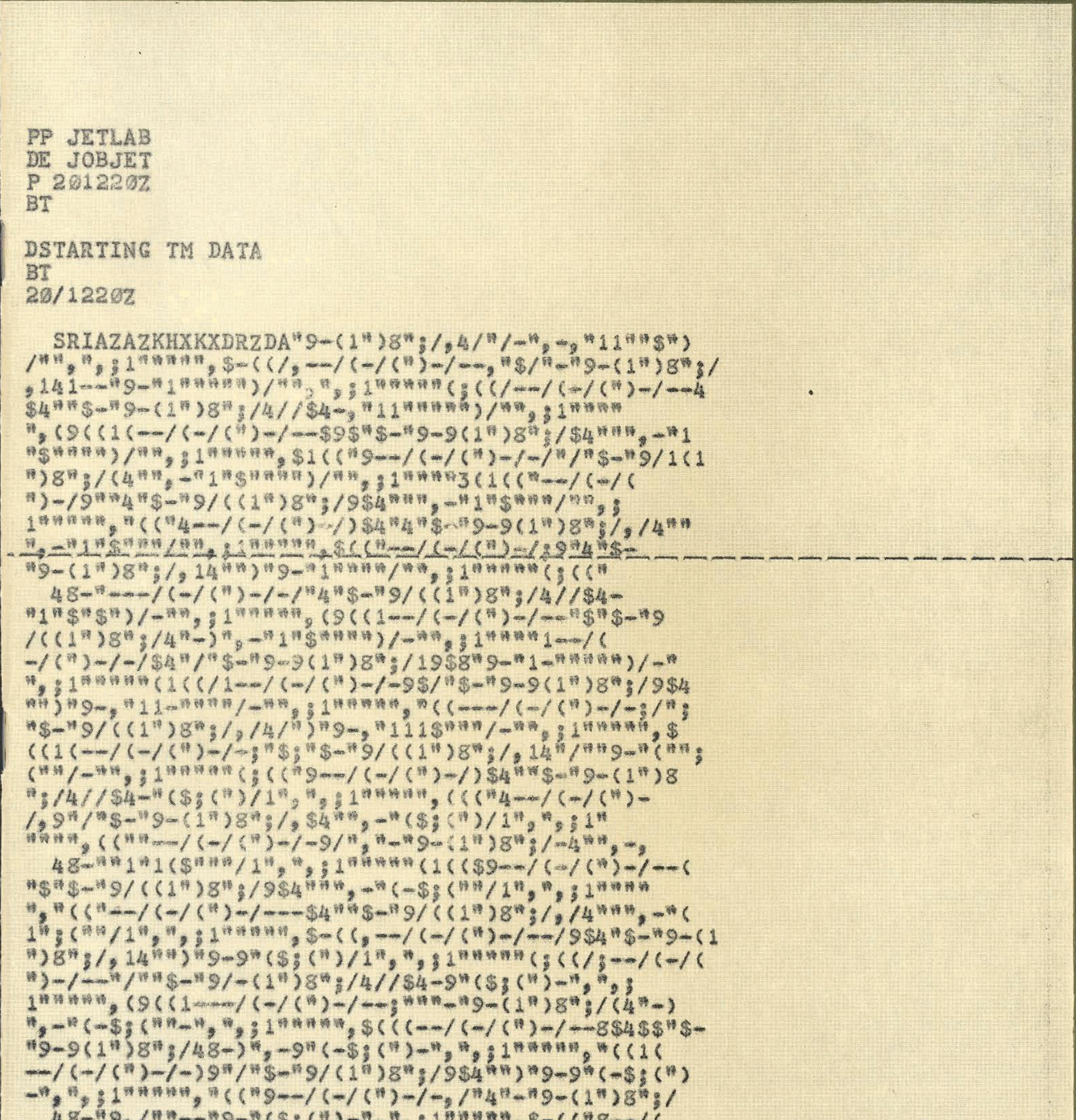
ENGINEERING | AND | SCIENCE

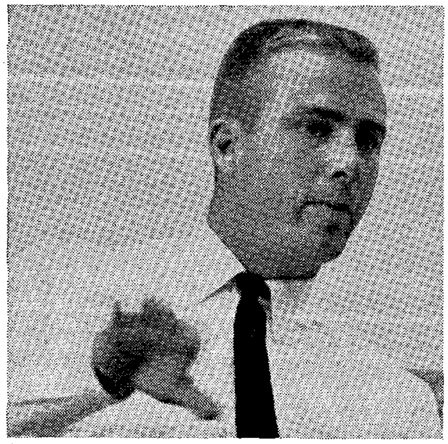
October 1962



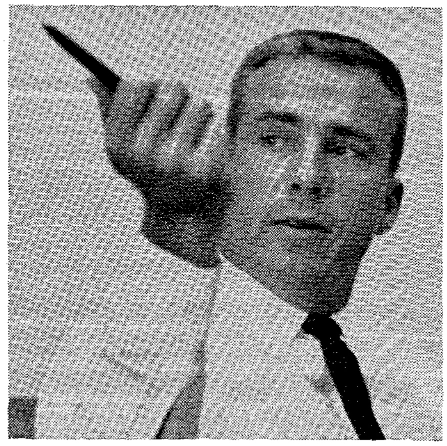
Mariner II . . . page 15

Published at the California Institute of Technology

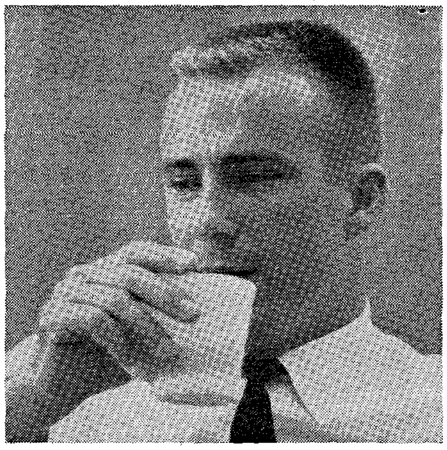
Does your wife mind your doing homework?



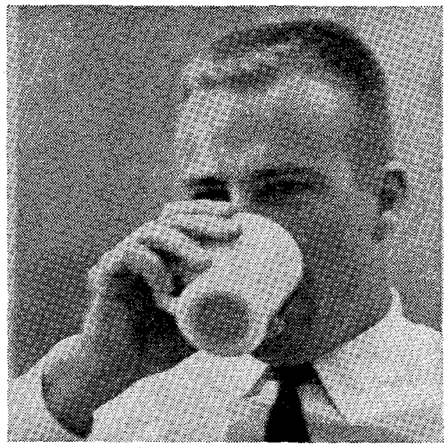
I'm not married. But even if I were, there'd be no problem. After all, my first love is right here.



Sometimes if things are really hot, I come back to the office in the evenings. Then I may take off time here and there. The main thing is to get the job done.

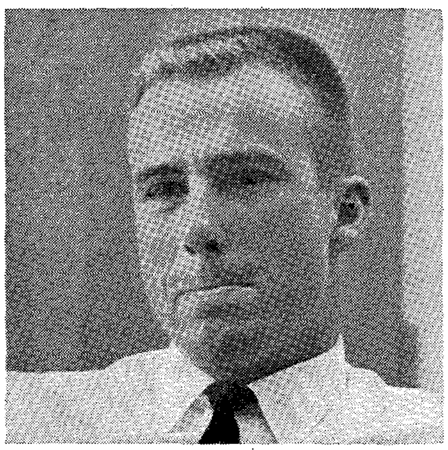


My job? Flight mechanics. I'm working on trajectories for spacecraft JPL hasn't even designed yet. Most of my work is based on advanced propulsion systems. Ion propulsion, for example.

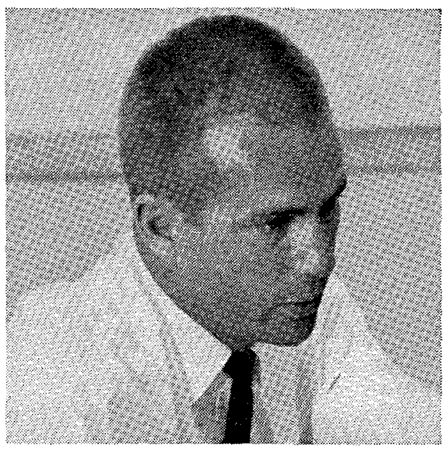


I did my undergraduate work at UCLA. In 1956, I began working at JPL part time, while I was in graduate school. When I got my doctorate, I just naturally stayed on here.

I like it very much. It's a real nice place to work. If I ride my bike, it takes about 15 minutes to get here from home. If I take my car, about 10 minutes.



The people I work with would be pretty hard to beat anywhere. As far as being in the midst of things, you'd have to go some to find a place better than this. The only planetary shots are coming right from here.



As far as technical facilities, again it's hard to beat. Computers, one of the best libraries there is, and Caltech just down the road. I like surfing on off hours. And the Pacific's only an hour away.

You've just been talking with Dr. William Melbourne, scientist at Jet Propulsion Laboratory. He's been at JPL for six years. And he's here to stay. If you'd like to work with men like him...if you'd like to be part of the challenge he faces...then write to JPL today.

"Research and development for America's lunar, planetary and interplanetary exploration programs."

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OCTOBER 1962 VOLUME XXVI NUMBER 1

On Our Cover

is an actual message from Mariner II as it soars on its long journey to the planet Venus. The signal was captured by the Johannesburg Deep Space Instrumentation Facility on September 20 when Mariner II was 3.9 million miles from the earth. The spacecraft talks continuously into one or the other of three giant 85-foot dishes which stand ready to receive in Johannesburg, South Africa; Woomera, Australia; and Goldstone, California.

Messages flow via teletype to the Spacecraft Flight Operations Center at Caltech's Jet Propulsion Laboratory. The digitalized information is fed into a computer and eventually ends up in chart form, giving such data on space as the number and intensity of protons, electrons, and the nuclei of atoms; interplanetary magnetic fields; the density and flow of solar winds; and the density of cosmic dust.

On page 15, a progress report on Mariner II by Robert J. Parks, Caltech '44, director of JPL's planetary program.

Henry Borsook,

author of "Plain Talk About Nutrition" on page 9, is professor of biochemistry at Caltech.

Dr. Borsook was born in London, England, and received all of his degrees from the University of Toronto in Canada – a BA in 1921, an MA in 1922, a PhD in 1924, an MB in 1927, and an MD in 1941. He has been on the Caltech staff since 1929.

Though protein synthesis is his chief research interest, Dr. Borsook has always been concerned with nutrition and the place of vitamins in the diet, and has made outstanding contributions to the development of balanced diets based on plant proteins.

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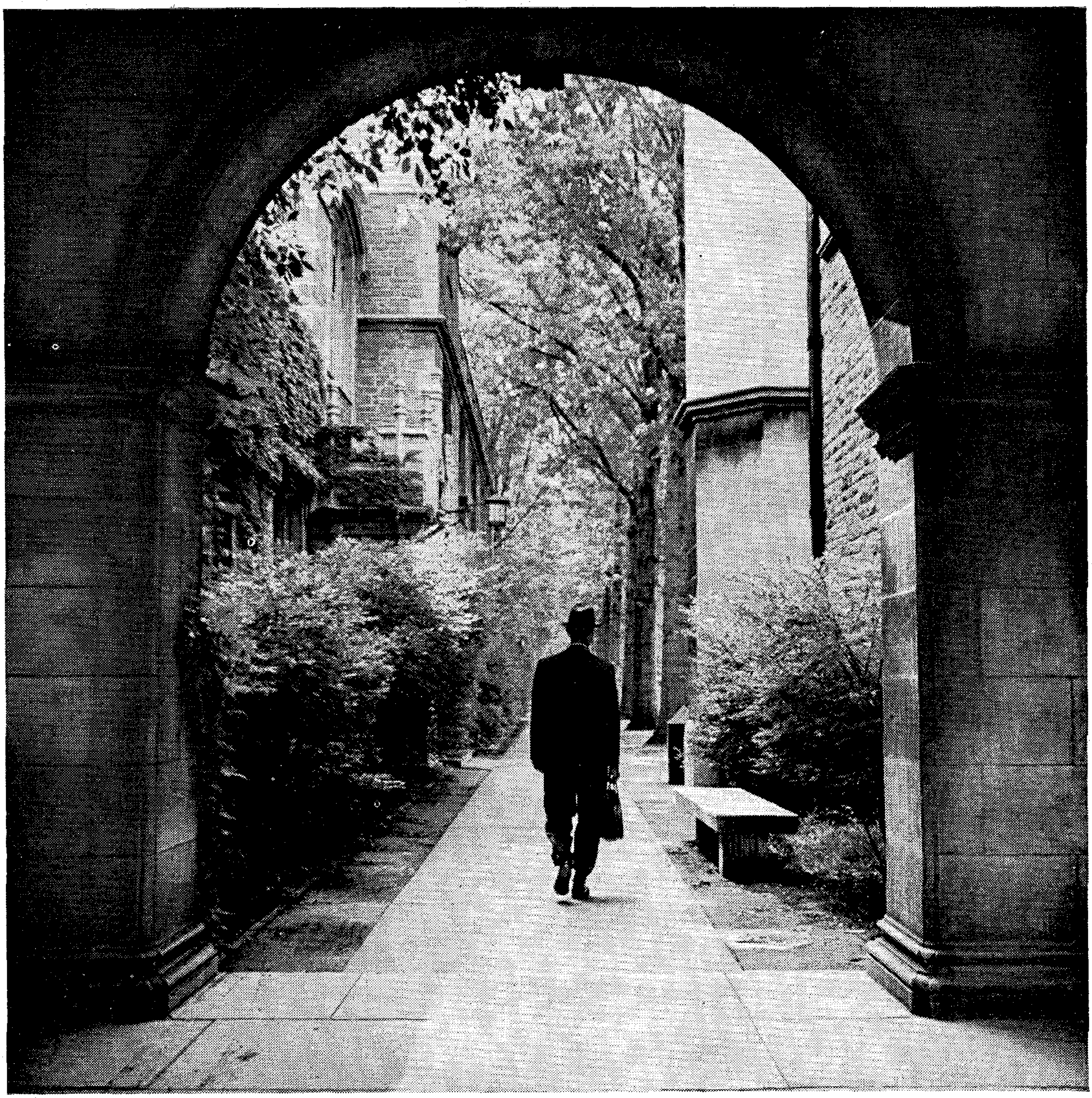


Books

QUANTUM ELECTRODYNAMICS

THEORY OF FUNDAMENTAL PROCESSES

by Richard P. Feynman

W. A. Benjamin, Inc. . . $3.95 each

These are two of the paperback volumes in "Frontiers in Physics," a lecture-note and reprint series designed to make available theories and viewpoints currently being developed in seminars and lectures.

The material in *Quantum Electrodynamics* was originally presented at Caltech as a graduate course in quantum mechanics by Professor Feynman, the lecture notes being taken by A. R. Hibbs, who is now chief of the Arms Control and Disarmament Study Group at Caltech's jet Propulsion Laboratory. In Professor Feynman's words: "The experiment was unsuccessful. The total material was too much for one year—." Although the course as such has not been repeated, this material in the lecture notes is much in demand. For this volume, Hibbs' notes were reworked by E. R. Huggins and H. T. Yura, both graduate students at the time.

Part of the material in the *Theory of Fundamental Processes* was first prepared for a report to the Second Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958; much of it was developed in a special lecture series given by Dr. Feynman at Cornell University in 1958; most of it appeared in a graduate course at Caltech in 1959-60. Dr. Feynman's central purpose in these presentations was to discuss "all those phenomena" (in strong interactions) "for which a more or less complete quantitative theory exists." The notes have been put in final form by H. T. Yura.

A FOR ANDROMEDA

by Fred Hoyle and John Elliot

Harper & Row $3.50

If a radio astronomer intercepts a message from outer space—should he answer back? *A for Andromeda* tells what might happen if he did.

The time is the late 1960's. Somewhere in England, the biggest radio telescope in the world begins to pick up signals from somewhere in Andromeda, 200 million light years away. From the nature of the signals, it appears that another intelligence is trying to communicate with us. The message, which continues for many weeks without repeating itself, appears to be a computer program. A super-computer is built, the data is fed in, and the machine begins to print out figures which are identified as being the relative spacings of the energy levels of the hydrogen atom. When this information is pushed into the intake, the machine comes up next with a description of the structure of carbon, then the structure of protein molecules, then—well, suffice it to say that the end result of this great national effort is the production of a living, breathing, other-worldly blonde, who is given the name of Andromeda and who turns out to be just chockful of trouble.

A for Andromeda was originally written as a seven-part serial for television and was run by the British Broadcasting Company, apparently with great success. If reports of the excitement it stirred up on television are true, then the work must have lost something in the adapation to novel form.

This is the third science-fiction book to come from Fred Hoyle, the British astronomer who has served as a visiting professor at Caltech, off and on, for the last five years. Like Hoyle's previous forays into this field (*The Black Cloud* and *Ossian's Ride*) the basic concept is intriguing and the execution is slapdash. Mr. Hoyle (even with a collaborator, as in the present case) wastes no time on such niceties as characterization, and writes in general like a man who has to run off in five minutes to catch a bus. Seasoned science-fiction fans, who are in the habit of reading that way too, probably won't mind a bit. But ordinary readers are likely to be more than a little confused, not to mention winded.

Science Paperbacks

Some recent titles in the Doubleday Anchor series of paperbacks devoted to the life and earth sciences, known as the Natural History Library and published in cooperation with the American Museum of Natural History:

Cells: Their Structure and Function
by E. H. Mercer $.95

Observations and Experiments in Natural History by Alan Dale $.95

The Voyage of the Beagle by Charles Darwin, edited by Leonard Engel $1.35

Adventures with a Texas Naturalist
by Roy Bedichek $1.45

Puffins by R. M. Lockley $1.25

Early Man in the New World
by Kenneth Macgowan and Joseph A. Hester, Jr. $1.45

The Heathens
by William Howells $1.45

The Heritage of the Bounty
by Harry L. Shapiro $1.25

The Navaho (revised edition)
by Clyde Kluckhohn and Dorothea Leighton $1.45

The Forest People, A Study of the Pygmies of the Congo
by Colin M. Turnbull $1.25

The Yosemite by John Muir $.95

Grand Canyon
by Joseph Wood Krutch $1.25

The Land of Little Rain
by Mary Austin $.95

Theodore Roosevelt's America
edited by Farida A. Wiley $1.45

Between the Planets (revised edition)
by Fletcher G. Watson $1.25

Additions to the Doubleday Anchor Science Study series of paperbacks devoted to the physical and life sciences:

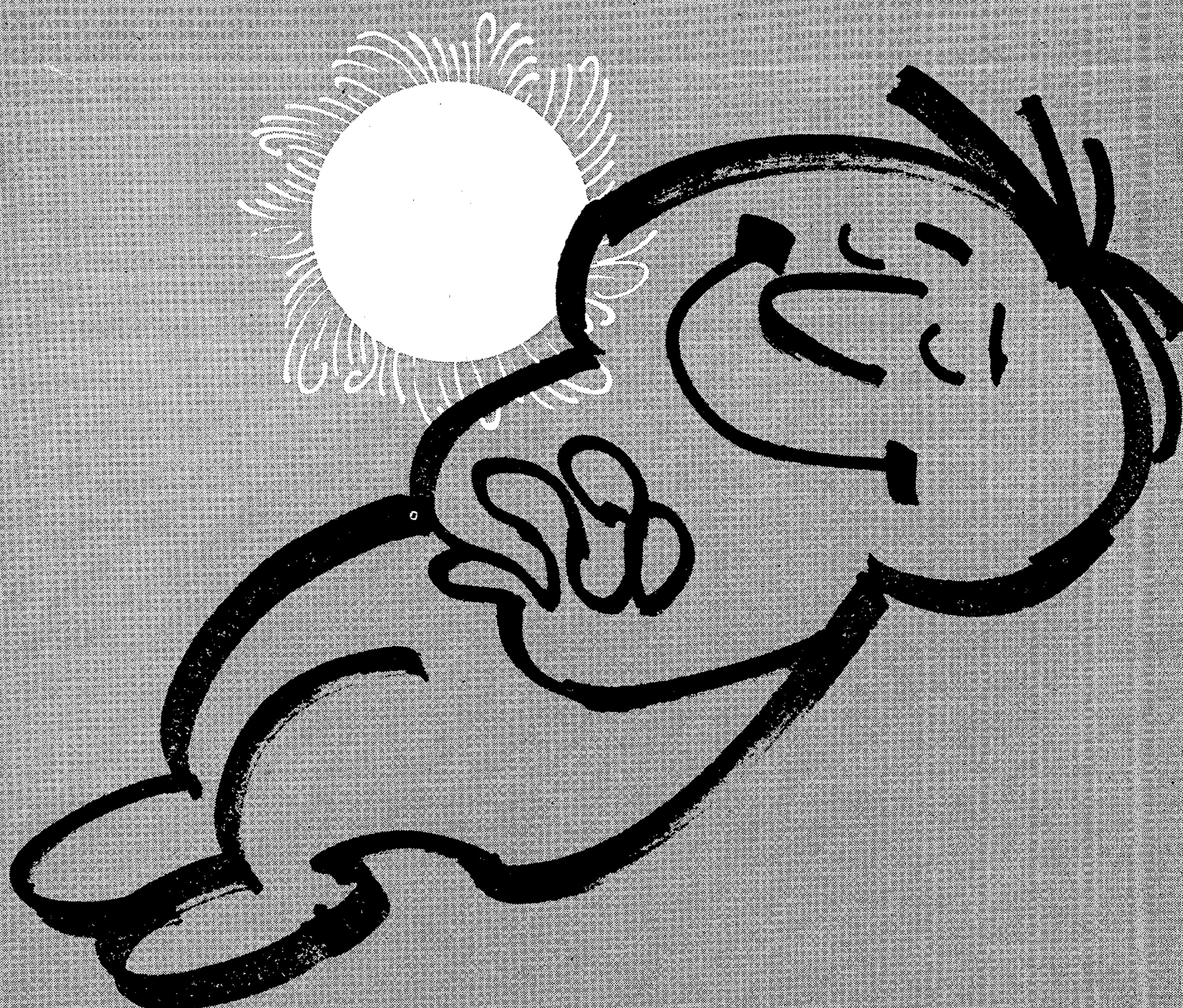
Heat Engines by John F. Sandfort $.95

The Origin of Radar
by Robert Morris Page $.95

The New Scientist, Essays on the Methods and Values of Modern Science
edited by Paul C. Obler and Herman A. Estrin $1.25

Count Rumford: Physicist Extraordinary
by Sanborn C. Brown $.95

Cloud Physics and Cloud Seeding: An Introduction to Applied Meteorology
by Louis J. Battan $.95



ENGINEERING AND SCIENCE
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Plain Talk About Nutrition

What is a "good" food? Will any single food substance supply all the essential nutrients? How many calories do you need? Some straight answers by an expert in the field of nutrition.

by Henry Borsook

One of the greatest biological discoveries of this century was the separating out of the essential from the accidental in food.

Today, as far as human nutrition is concerned, between 20 and 30 essential nutrients are recognized. The first of these is calories, which may be provided by protein, fat, or carbohydrates – the three main bulk constituents of our food. A deficiency of calories is as serious, and leads to as serious disease, as a deficiency of any other essential nutrient.

The next group of essential nutrients is in proteins. In animal protein, about half the weight consists of eight amino acids which animals are unable to make for themselves and so must get from their food. These are referred to as the indispensable amino acids in protein.

A protein may be compared to a great brick structure. It has about 20 different *kinds* of bricks, but there are hundreds of them, and they are arranged in a very special way in each protein. When this great chemical structure is eaten – by a baby, for example, whose chief source of protein is milk – the protein suffers a wrecking operation in the stomach and intestines and becomes like a pile of bricks. The bricks are then absorbed into the blood stream, and the liver, blood, hair, brain, muscle, and so on take out what bricks they need and rearrange them to make the proteins characteristic of the tissue. The chief difference, say, between skin and muscle isn't so much the kind of bricks, as their arrangement.

Of all these 20-odd kinds of bricks, there are the 8 we can't make for ourselves and which we have to get from our food. We have to get enough of them so that children will grow, and so that we will be free of nutritional disease. The nutritional quality of a protein is measured by how much of these eight amino acids is supplied by a reasonable serving.

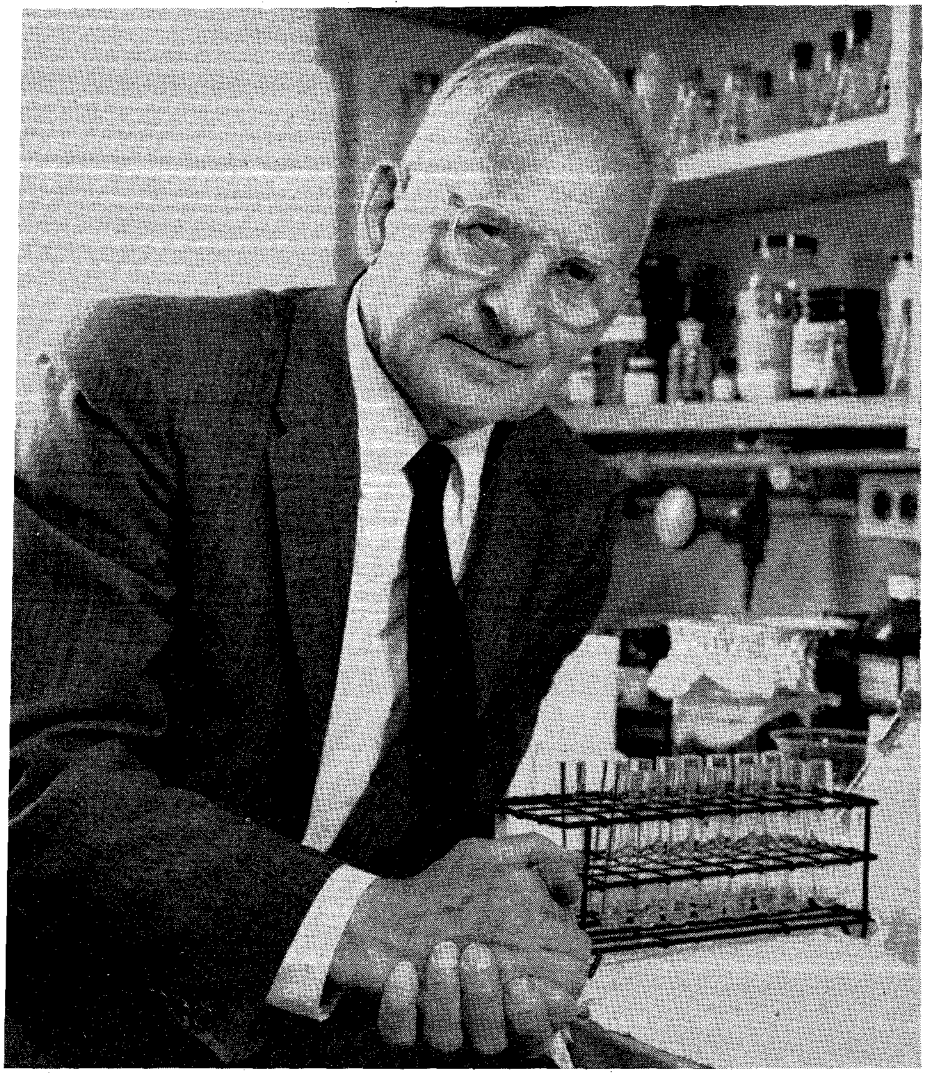
Then there are certain minerals. We probably need all the minerals that are known – most only in trace amounts – but there are really only three that we need to pay attention to: calcium, iron, and iodine. If we get enough to eat, we get all the rest.

Next there is the whole group of vitamins. They are all organic compounds; they all contain carbon, most also contain nitrogen, and two contain sulfur; we need only minute amounts of them. Ordinarily, we might eat a pound or a pound and a half of food a day – 700 grams dry weight. We need only about 1/15,000 of that amount of some vitamins, but without this minute amount there is disease. This is characteristic of vitamins in general: they are essential; we can't make them for ourselves; and though the quantity we need is actually very small, it is often hard to get this small quantity. Millions of people, in fact, don't.

Finally, in the last few years, attention has been focused on what are called poly-unsaturated fatty acids, which we can't make for ourselves and need to get from our diet.

Not all of the essential nutrients have to be provided in our food. Some animals are able to make some of them. (Vitamin C, for example, can be made by all animals except guinea pigs, monkeys, and humans – so these three species are the only ones known to be susceptible to scurvy.)

Some of the essential nutrients are provided for us by the bacteria in our intestines, such as vitamin K, which is required for the clotting of blood. Children are born without it, and during the first two or three days after birth they are more prone to cranial hemorrhages than later on. The milk that they drink, in spite of all the mother's care, is infected. The bacteria then take hold in their intestines and produce the vitamin K the children need.



Henry Borsook, professor of biochemistry at Caltech, and the man responsible for the development of Multi-Purpose Food.

Essential nutrients are all, in a platonic sense, essences. They are the realities of the diet, and, being essences, no one can replace another. A diet may be abundant in all 20-odd essential nutrients *but one,* and it is a disease-producing diet. There is one exception; the amino acid tryptophane, which we can't make for ourselves, is converted to a vitamin which we can't otherwise make for ourselves – nicotinic acid. But this is merely replacing one essential nutrient with another; the principle has not been invalidated.

This is how it comes about, for instance, that in the tropics young children are found dying with full stomachs. They get plenty to eat, but one or two essential nutrients are missing. If they are given as little as a third of an ounce a day of food containing the missing nutrients, then all the rest of the food is made good.

The next great discovery in this field, and it is *the* discovery from which all the future promise comes, was the proof that the source of an essential nutrient is immaterial. It may come from food which is grown, it may be mined, or it may come from a factory. For example, vitamins are the same whether we get them from wheat or meat or orange juice, or from Du Pont or Merck. I find a certain resistance to accepting this simple fact even among Caltech students, at first – that a substance is a substance, and it doesn't matter where it comes from.

As far as vitamins and minerals are concerned, it is easier, cheaper, and often more convenient to get them from sources *other* than food. In fact, the whole promise of coping with world food problems depends on our using industrial sources. For instance, one of the important reasons for eating milk and cheese is the calcium they contain, but the calcium of the chalk cliffs of Dover is just as good, cheaper, and easier to handle.

In southern California, if we went around without clothing most of the year we would probably pick up all the vitamin D we need from the sunlight. In England, rickets (a vitamin D-deficiency disease) used to be called "the poor man's disease," because the children of the well-to-do went to the country or the seashore in the summer, where they ran around with hardly any clothes on and the sunlight made enough vitamin D to carry them through the winter. The poor children stayed in the smoky city, where all the ultraviolet light which makes vitamin D was absorbed in the air, and so they got rickets.

We often hear talk of how some foods are good for us, and some are better than others. The definition of food is now a matter of arithmetic. It is simply this: Given a reasonable serving, a good food will supply a large measure of all the different essential nutrients that we need, and a poor food will not. No one food is perfect either; I don't know any single food substance where reasonable servings eaten three times a day will supply all the essential nutrients.

Most of the nutritional diseases that affect whole populations are in regions and countries where the people eat very few kinds of food. Nutritional safety is in variety. This needs to be borne in mind with the growing practice in the United States of reducing diets. It is important that a reducing diet be prescribed by a doctor who knows about nutrition. It is not an easy thing to do well, and an important principle is that no matter how calories are cut down, the protein mixture needs to be adequate in quality and quantity, and it should contain enough vitamins and minerals.

Safety in variety

The safety factor here is in variety. To restrict it is to court the danger of running into a shortage of one or more essential amino acids even if multivitamin pills are taken. In terms of the amount of the essential nutrients which are supplied, a quart of milk, a pound of "enriched" white bread, and a pound of meat are about a stand-off in nutritional quality. No one of them is perfect, but a combination of any two would do pretty well. Even in a reducing diet some calories are needed. The best source of calories for a reducing diet is enriched white bread. If I had to choose which of these three I would subsist on, I think I would do best with a pound of enriched white bread.

How many calories do we need? We don't know, really, because the standards for calorie requirements were set at the turn of the century by people living in cold climates, where they did much more physical work than we do now, and at a time when they didn't know much about vitamins – so, in order to get the minimum amounts of food needed to prevent certain specific deficiency diseases, they had to eat a lot. I am quite sure, for example, that people from middle age onwards, who are living the sort of sedentary lives most of us live nowadays, do better with less than the 2500 calories required in all the books on nutrition. I suspect the figure should be below 2000.

One of the most important medical developments I can think of would be the determination within reasonable limits of the proper caloric intake for middle-aged and elderly people. No matter how low these caloric requirements might turn out to be, there are certain facts that indicate we will never be able to get along on a few pills. The calculation runs like this: Let's say we need 2000 calories, which is 20 percent below the standard. Taking only the digestible material, and considering only its dry weight, for 2000 calories we need about 400 grams. That is about 9/10 of a pound. It is impossible to get 9/10 of a pound into a couple of pills. Furthermore, a deficiency of calories is noticed in a couple of days, whereas it wouldn't hurt anyone very much to live for a couple of weeks with a deficiency of minerals or vitamins. In any food planning for emergencies or for special circumstances, the first essential is calories.

One sure way of getting the indispensable amino acids we need is to eat meat; any animal food will do, because animals don't differ very much from each other in their basic chemical composition. The trouble is that animal protein is expensive. A cow returns in food only 3 percent of the food it eats, so beef is a luxury.

Vegetable proteins are cheap, but, in general, they tend to be short in one or two indispensable amino acids. Yet we have all known vegetarians who have done well. The largest animal in the world today, the elephant, is a vegetarian; and one of the most prolific, the rabbit, is also vegetarian.

Obviously, it is possible to do all right on a vegetarian diet. How is it done? By a mixture. For example, a mixture of beans and any cereal will provide a protein mixture which is as good as meat and a lot cheaper.

One of the most common diseases in the world today is a deficiency of one or two indispensable amino acids. It goes by various names, though the one generally used now is "kwashiorkor." It is very common throughout the tropics. Yet the world produces enough protein so that, if it were used sensibly, there would be no such disease as this.

Certain crops are grown for the sake of the oil; the meal that is left from the seed, in this country, goes mainly into petfoods. In other countries it is used for fertilizer or is thrown away. Without taking into account any of the proteins in meats and fish and dairy products, the world supply of oil seed cake protein *alone* provides enough protein, if used in a sensible mixture, to prevent protein deficiency disease in the world. It is a question of knowing how much we have and using it sensibly.

How much protein do we need?

How much protein do we really need, allowing a factor of two for safety? If all of our protein were meat, the most expensive source, it would be a surprisingly small amount – about two ounces. Most of us eat more than twice that. If only a fifth of the protein in our diet was meat and the rest was in a mixture of bread or beans, we would do very well.

The one mineral which all nutrition teaching says we don't get enough of is calcium. One of the important nutritional reasons for milk and cheese is the calcium they contain. The Recommended Daily Allowance (a technical term used by the National Research Council) is 800 mgs. per day. It takes about a pint and a half of milk to provide that much calcium. For young people this is probably too much milk; for old people it may not be enough calcium.

I sometimes say to nutritionists that if I were in charge of an orphan asylum (their food budget is always limited) I wouldn't serve the children any milk. I would provide the essential nutrients of milk — the protein, calcium, and vitamins — far more cheaply from other sources such as beans, powdered chalk, and vitamin concentrates. With the money saved I would give the kids some luxuries that they would get some fun out of.

Iron deficiency (anemia is a result of iron deficiency) used to be common in the United States. Today one sees it chiefly among the very poor and among the "faddy" eaters. It is easier to supply the iron as a mineral than as meat or any such common food source.

This was proven during the war when the British government, in order to save ship tonnage, since all the wheat had to be brought in by ship, made the British people eat whole wheat bread made of 85 percent extraction flour. Children soon began to show signs of calcium and iron deficiencies. This came about because of a material in the branny layers of the wheat berry which forms insoluble salts with calcium and iron; not only are the iron and calcium in the wheat berry not usable, but the berry robs iron and calcium from the other foods that are eaten.

The British government then added powdered chalk and an iron salt to the flour to make good the deficiencies that this noxious material in the branny layers had induced. If the British government could do something as drastic as this, my prescription for the replacement of milk isn't quite so wild.

Iodine deficiency, which shows up as goiter, used to be common in this country too, but iodized salt has done away with it. The amount of iodine required is very little.

Fruit and vegetables—unnecessary

There are certain vitamin deficiency diseases which are very difficult to treat by diet alone. The advent of pure synthetic vitamins, which can be given intravenously, has made possible their expeditious cure. It is chiefly for their vitamins that we eat the fruits and vegetables that nutritionists urge us to. Of course, many people eat fruits and vegetables because they like them, and that's fine. But, as far as vitamins are concerned, a good multivitamin pill makes the eating of vegetables and fresh fruit unnecessary, and it is a lot cheaper and easier. Yet I often find resistance to this convenient fact.

In the last decade, the medical profession has become interested in a relatively new essential nutrient —poly-unsaturated fatty acids. We know that poly-unsaturated fatty acids, the cholesterol level in the blood, and certain kinds of arterial disease are related in some way. The exact mechanism isn't clear, but I think everyone who has studied the subject is convinced that there is something in it. I take the conservative position and recommend that we play it safe. For this reason, all animal fats are advised against, and vegetable fats high in poly-unsaturated fatty acids, such as safflower oil or corn oil, are recommended. Cottonseed oil or olive oil are not quite as good, but are better than animal fats — of which butter is one, of course.

The information on this subject isn't quite as precise as one would like, but the recommendation now is about two tablespoons a day of safflower oil, which is the best and richest source. But it mustn't be cooked; these unsaturated acids are unstable *because* they are unsaturated, and cooking will wreck them.

Some potential benefits

I can probably best illustrate the potential benefits from the use of our scientific knowledge of nutrition by two examples. I am told that Mr. Clifford Clinton, founder of the Clifton Cafeterias, as a boy, lived in China and saw famine. As happens so often when we are children, we make certain resolves and these resolves are the ideals that govern us all our lives. In his case, his resolution was that if he could do anything about famine, he would. It was no accident, then, that when he grew up he went into the restaurant business.

When the depression hit southern California in 1930, Mr. Clinton let it be known publicly that whoever came to his restaurant at certain hours of the day would get a meal for nothing. After awhile I think he felt that this was being abused, and so he asked people to pay five cents for the meal, and this is still being done.

During the war, with his great experience of feeding large numbers of people quickly, it was inevitable that Mr. Clinton was asked to advise the government on the feeding of troops. It was toward the end of the war that he came to me and said that he would like to have a food made with roughly these specifications: not more than two ounces would supply one-third of the Recommended Daily Allowances of all the essential nutrients; it would cost no more than three cents per meal at the then prevailing prices; we were not to draw on foods that were customary in the American diet (there wasn't much danger at that price); it must keep well — in fact, indefinitely; it mustn't offend any religious taboo; it could be eaten with other foods; and it would be satisfying.

I said at once that the calories would have to come from some other food because two ounces would not supply one-third of the day's requirements of calories. I also thought it was inadvisable to attempt to supply the vitamin C, for it wouldn't keep when the food was cooked. But it would be quite feasible to do all the rest.

How could I say this so quickly? We knew already that we needn't worry about the vitamins and minerals. They were cheap and readily available; we

African children line up for their portions of Meals for Millions in the Congo Republic.

could add them to anything and they wouldn't affect the flavor or the way things were to be cooked. So all we had to be concerned with was the protein — with the quality of two ounces of protein which had to supply one-third of the day's requirements of essential amino acids. Animal proteins were too dear and would offend some religious taboos, but all I had to do was look up a book of tables on the amino acid composition of different vegetable proteins.

It was soon clear that the best protein nutritionally was soy bean protein. We were growing soy beans for the oil, and the meal left after the oil was extracted was largely thrown away at that time. After the war (and after we got started with our new food) the soy protein began to be used, as it is today, for pet foods.

It was simple, then, to meet Mr. Clinton's specifications. We made the two ounces in weight almost entirely of soy protein. The necessary vitamins and minerals were added from inexpensive concentrates or synthetic sources; the soy meal was a pretty good source of some of the vitamins and of iron and calcium. The vitamin C, if need be, could be added as a separate little pellet. Since there was a serious shortage of calories in two ounces of this food, our recommendation was to get the calories from any cereal. Happily, cereals are rich in the one indispensable amino acid (methionine) in which the soy bean protein is low. Then it became a nutritionally good diet, as good a diet as milk, eggs, meat, and vegetables —the customary American diet. And it was not difficult to do it for three cents a meal.

Mr. Clinton made a grant to Caltech to develop this food, and in the course of a year it was done. Indeed, most of the year was spent in learning how to cook the food so that we could tell people good ways of using it.

After that, this food was sent all over the world, where it was bought by many religious and philanthropic agencies who were concerned with near-famine. The reports began to come in — and are still coming in — of how a very small amount of this food did so much good. At first, I simply refused to believe these reports; I thought that they came from overenthusiastic users who just wanted more of the food. We know now that the reports were true and we know the reason why.

In the Pacific Islands, for example, they grow cassava because they can get the most food per acre from it, and it is easy to grow. After they are weaned, children on these islands are given little more than cassava to eat—which is little more than starch. The children get ill. Give them a very small amount of a good protein food such as Multi-Purpose Food—sometimes only one-third of an ounce, or even less — and they get well, because the indispensable amino acids they lack are supplied by the soy protein.

A foundation was then formed, under Mr. Clinton's leadership — the Meals for Millions Foundation — to raise money to make this food and give it away. After some years of operation, we thought we would like to know whether the good reports we were getting were true, so the secretary of the Foundation, Miss Florence Rose, was sent on a tour around the world. In India, she achieved an outstanding feat of statesmanship.

We had been sending American Multi-Purpose Food into India, but how could *any* quantity that we could send have any impact on the nutrition of 400 million people? Miss Rose realized that the Indians would have to learn to grow this food — or some food as good — for themselves, and they would have to make it and sell it themselves.

India doesn't have any soy beans and can't afford to buy them, so Miss Rose enlisted the support of an Indian nutritionist and food technologist and put it up to him to develop something from foodstuffs grown in India, but not used for human food, that was as nutritious as American Multi-Purpose Food. "If you need a little money to get your lab started," she said, "we can probably help you, but once you get started we will buy your whole production. Instead of sending American Multi-Purpose Food bought with American money over here, we will send you the dollars and buy your food for distribution in India."

Food from peanut meal

The scientist she enlisted, Dr. Subrahmanjan of Mysore, did a magnificent job. One of the food byproducts which wasn't being used in India at that time was peanut meal. Peanuts are grown there in great quantities for oil, which is exported, while the peanut meal was being wasted. So, after some analyses and trials, Dr. Subrahmanjan found that a mixture of peanut meal and chick pea meal, with some vitamins and minerals added, was nutritionally equivalent to the American Multi-Purpose Food. The food was first tested on rats in the standard way, and when that turned out all right, it was tried in orphanages and schools with striking results.

A year ago an Indian businessman put up his own money to build a plant which is now producing ten tons a day and the whole production is being bought by the state of Madras for their school lunch program. Each child gets about half an ounce a day and the results are so satisfactory that the Indian Minister of Agriculture is now trying to get the heads of governments of all Indian states to set up similar programs.

The Indian experiment was of great importance because it showed that it is perfectly easy to get a very good diet from vegetable sources alone. Not long ago the then head of the Food and Agriculture Organization (FAO) of the United Nations wrote a book in which he said that it was impossible to have a good diet without animal protein. This is not only wrong but harmful. It may be stated as a categorical fact that the two-thirds of the world which is now malnourished would remain so if they had to depend on even small amounts of animal protein. The whole problem can easily be solved from a technical point of view if people will use the vegetable proteins which are now being produced.

Food from grass

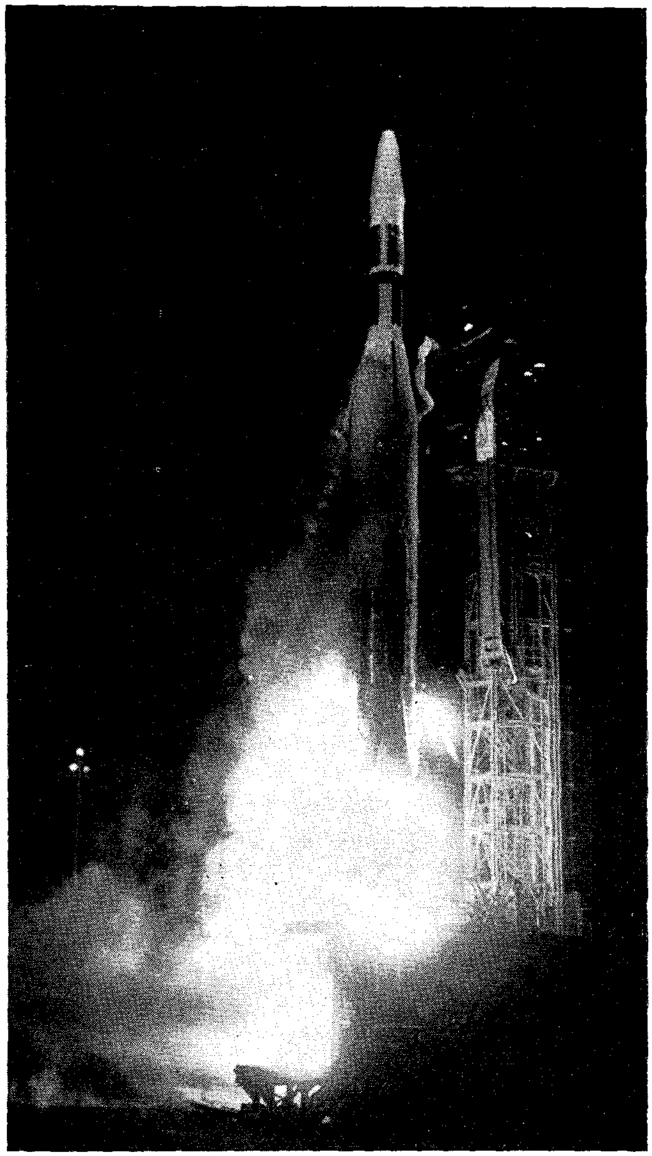
In every country in the world where malnutrition is endemic, one usually finds that the people are really growing enough for a pretty good diet if they would only use what they raise. Probably the largest source of potential food which isn't used at all is grass, leaves, and such uncultivated vegetation. A number of us at Caltech have been talking about building a portable machine that would go around and pick up grass and leaves and extract the soluble protein and vitamins. Grass would go in one end and a nice white powder, which would be highly nutritious in proteins, vitamins, and minerals, would come out the other.

This sounds fanciful, but we were all interested and pleased to read recently that an Englishman at the University of London had actually designed such a machine and it is now being tried out in British Guiana. The problem is one of engineering — to get fuel cheap enough and accessible enough. No one would have thought this was possible had it not been established that the source of an essential nutrient is immaterial. Synthetic vitamins or minerals can be added if necessary; they are so cheap and so abundant that even the poorest can afford them.

One of America's great interests as far as farm policy is concerned is assistance to underdeveloped countries. In many of these there is malnutrition. We can help these countries very quickly, with a very small capital outlay — and much more quickly than in the usual long-range agricultural programs — by applying a few basic nutritional principles. Good nutrition is the foundation of a sound industrial development. To provide these people with an adequate diet is not only the decent thing to do; it would also be good international politics.

MARINER II

A progress report on the spacecraft now heading for Venus



by Robert J. Parks
Director, JPL Planetary Program

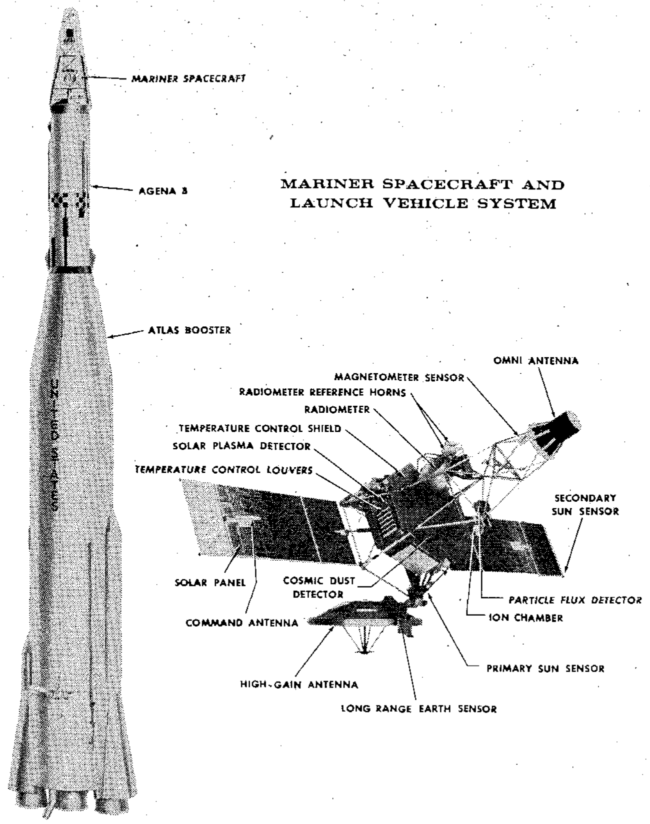
Mariner II was launched from Cape Canaveral on August 26, 1962. On December 14 the spacecraft will rendezvous with the plant Venus, and, if all equipment continues to operate, will report on actual measurements of the planet.

This is the first in what is planned to be an extended series of planetary exploration launches. The present primary objective of the Planetary Program is to conduct the initial unmanned spacecraft exploration of the planets and interplanetary space. An important secondary objective, however, is to develop the base for the eventual manned exploration phase.

Scientifically, our objective is to contribute information which will assist in answering two broad questions:

1) What, if any, life forms exist on the planets?
2) How was the solar system formed?

For two good reasons, we intended to concentrate at first on our two closest neighbors, Venus and Mars, and on the interplanetary space roughly within the ecliptic plane and between these two planets. Venus and Mars are probably most like the earth of any of the planets and therefore offer perhaps the most exciting fairly immediate rewards in terms of new information, and they are also the easiest to reach and explore.



MARINER SPACECRAFT AND LAUNCH VEHICLE SYSTEM

We have indications from earth measurements that these two planets have some characteristics quite different from earth. Venus, for example, being about the same size as the earth, would appear to have a much denser atmosphere – perhaps ten times as dense at the surface – to have very little oxygen or water vapor in its atmosphere, and to have a surface temperature perhaps as hot as 600° to 800° Fahrenheit. It has a cloud layer that precludes visual observation of the surface and, therefore, a visual measure of its rotation speed or axis. Radio reflection measurements would indicate that it has a relatively low rotation rate, perhaps keeping one face toward the sun.

Mars, on the other hand, not only is smaller than the earth, but has a much less dense atmosphere. It, too, would appear to have very little oxygen or water vapor in its atmosphere. Its surface can be seen, and it has a rotation rate close to that of the earth. Changes of surface characteristics, some of them cyclic with the Mars seasons, have been noted. These surface changes and infrared earth-based measurements both indicate the possibility that some sort of life forms do, in fact, exist on Mars.

Despite – or even, perhaps, because of – these differences, there has been over the years a great deal of curiosity, scientific and otherwise, about these planets. A great deal of new and valuable information can be obtained through closer observation by spacecraft to be launched to the vicinity of these two planets.

For any reasonable or efficient use of launch vehicle capability, launchings to the planets can be made only infrequently, of course. For Venus, opportunities occur approximately once every 19 months, and for Mars, once every 25 months. The period of these opportunities last for about three months or less, depending upon how much of the maximum launch vehicle performance capability one is willing to sacrifice. The travel time is about 3 to 4 months to Venus and 6 to 7 months to Mars. Incidentally, these laws of physics apply in Russia as they do in the United States.

On the average, a given launch vehicle can launch about the same payload to both Venus and Mars. The reason the travel time to Mars is about twice that to Venus is due largely to the fact that the spacecraft slows down if it moves away from the sun and speeds up if it moves toward the sun, due to its change in potential energy. From opportunity to opportunity at each of the planets, however, the energy requirements to reach the planet can vary by almost a factor of two. Depending on a number of factors involved, the payload capability could vary much more than this factor of two. This variation in energy requirements is approximately cyclic, with a period of about 8 years for Venus and 15 years for Mars.

The choice of Venus

The choice of Venus as opposed to Mars for the first mission resulted primarily from (1) the shorter flight times involved, (2) the shorter communication distances involved, and (3) the easier solar power collection problem at Venus-distance from the sun. (It requires about 2½ times as much solar panel area at Mars as at Venus). The Venus mission was therefore relatively more inexpensive and reliable.

Summers have been very significant in the history of the Mariner Project to date. In summer 1960, authorization was received for preparing a 1000-lb. spacecraft for launching in 1962. In summer 1961, it became necessary to redesign the spacecraft to a weight of 450 pounds within the capability of the Atlas-Agena launch vehicle. Summer 1962 was, of course, the launch period.

The extensive redesign about one year before launch required certain corners to be cut from the normal and otherwise desirable design and testing cycles. This rather remarkable feat would not have been possible without the extensive efforts and experience that was available from the Ranger Project as well as the early Mariner activities. Hardware from both activities was used, with some modifications.

The Mariner weighs 447 pounds and, in the launch position, is 5 feet in diameter at the base and 9 feet, 11 inches high. In the cruise position, with solar panels and high-gain antenna extended, it is 16.5 feet across in span and 11 feet, 11 inches high.

The design is a variation of the hexagonal concept used for the Ranger series. The hexagon framework base houses a liquid fuel rocket motor, for trajectory correction, and six modules containing the attitude control system, electronic circuitry for the scientific experiments, power supply, battery and charger, data encoder and command subsystem, digital computer and sequencer, and radio transmitter and receiver. Sun sensors and attitude control jets are mounted on the exterior of the base hexagon.

A tubular superstructure extends upward from the base hexagon. Scientific experiments are attached to this framework. An omnidirectional antenna is mounted at the peak of the superstructure. A parabolic, high-gain antenna is hinge-mounted below the base hexagon. Two solar panels are also hinged to the base hexagon. They fold up alongside the spacecraft during launch, parking orbit, and injection and are folded down, like butterfly wings, when the craft is in space. A command antenna for receiving transmissions from earth is mounted on one of the panels.

The solar panels contain 9800 solar cells in 27 square feet of area. They will collect energy from the sun and convert it into electrical power at a minimum of 148 watts and a maximum of 222 watts. The amount of power available from the panels is expected to increase slightly during the mission, due to the increased intensity of the sun. Each solar cell has a protective glass filter that reduces the amount of heat absorbed from the sun, but does not interfere with the energy conversion process. The glass covers filter out the sun's ultraviolet and infrared radiation that would produce heat but not electrical energy.

Prior to the time that the solar panels were pointed toward the sun, power was supplied by a 33.3-pound silver-zinc rechargable battery with a capacity of 1000 watt hours. The recharge capability is used to meet the long-term power requirements of the Venus Mission. The battery supplies power directly for switching and possibly sharing peak-loads with the solar panels and also during trajectory correction when the panels are not directed at the sun.

The power subsystem converts electricity from the solar panels and battery to 50 volt, 2400 cycles per second; 26 volt, 400 cps; and 25.8 to 33.3 volt DC.

Two-way communication

Two-way communication aboard the Mariner is supplied by the receiver/transmitter, two transmitting antennas – the omnidirectional and high-gain antenna, and the command antenna for receiving instructions from earth. Transmitting power is 3 watts.

The high-gain antenna is hinged and equipped with a drive mechanism allowing it to be pointed at the earth on command. An earth sensor is mounted on the antenna yoke near the rim of the high-gain dish-shaped antenna to search for and keep the antenna pointed at the earth.

Stabilization of the spacecraft for yaw, pitch, and roll, is provided by ten cold gas jets, mounted in four locations (3, 3, 2, 2,), fed by two titanium bottles containing 4.3 pounds of nitrogen gas pressurized to 3500 pounds per square inch. The jets are linked by logic circuitry to three gyros in the attitude control subsystem, to the earth sensor on the parabolic antenna, and to six sun sensors mounted on the spacecraft frame and on the back of the two solar panels.

The four primary sun sensors are mounted on four of the six legs of the hexagon, and the two secondary sensors on the backs of the solar panels. These are light-sensitive diodes which inform the attitude control system – gas jets and gyros – when they see the sun. The attitude control system responds to these signals by turning the spacecraft and pointing the longitudinal or roll axis toward the sun. Torquing of the spacecraft for these maneuvers is provided by the cold gas jets fed by the nitrogen gas regulated to 15 pounds per square inch pressure. There is calculated to be enough nitrogen to operate the gas jets to maintain attitude control for a minimum of 200 days.

Central Computer and Sequencer

Computation for the subsystems and the issuance of commands is a function of the digital Central Computer and Sequencer (CC&S). All events of the spacecraft and contained in three CC&S sequences. The launch sequence controls events from launch through the cruise mode. The midcourse propulsion sequence controls the midcourse trajectory correction maneuver. The encounter sequence provides required commands for data collection in the vicinity of Venus.

The CC&S provides the basic timing for the spacecraft subsystems. This time base is supplied by a crystal control oscillator in the CC&S operating at 307.2 kilocycles (kc). This is divided down to 38.4 kc for timing in the power subsystem and divided down again to 2400 and 400 cps for use by various subsystems. The control oscillator provides the basic "counting" rate for the CC&S to determine issuance of commands at the right time in the three CC&S sequences.

The subsystems clustered around the base of the spacecraft are insulated from the sun's heat by a shield covered with layers of aluminum-coated plastic film. At the bottom of the spacecraft, just below the subsystem modules, is a second temperature control shield. It prevents too rapid loss of heat into space, which would make the establishment of required temperatures difficult to maintain. The two shields form a sandwich that helps to minimize the heat control problem.

Temperature control of the attitude control subsystem is provided by louvers actuated by coiled bimetallic strips. The strips act as coil springs that expand and contract as they heat and cool. This mechanical action opens and closes the louvers. The louvers are vertical on the face of the attitude control box and regulate the amount of heat flowing into space. This is a critical area as some of the equipment may not function properly above 130°F.

Paint patterns, aluminum sheet, thin gold plate, and polished aluminum surfaces are used on the Mariner for passive control of internal temperatures. These surfaces control both the amount of internal heat dissipated into space and the amount of solar heat reflected away, allowing the establishment of temperature limits. The patterns were determined from testing of a Temperature Control Model (TCM).

The TCM was subjected to the variations of temperature anticipated in the Venus Mission in a space simulation chamber at JPL.

Communication with the spacecraft is in digital form. The command subsystem aboard the Mariner decodes incoming digital commands and sends them to the designated subsystems. Data from engineering and scientific sources are encoded to digital form for transmission to earth.

Synchronizing pulses are spaced at regular intervals between the data signals from Mariner. Ground-based receiving equipment generates identical pulses and matches them with the pulses from the spacecraft. This provides a reference to determine the location of the data signals allowing receiving equipment to separate data signals from noise.

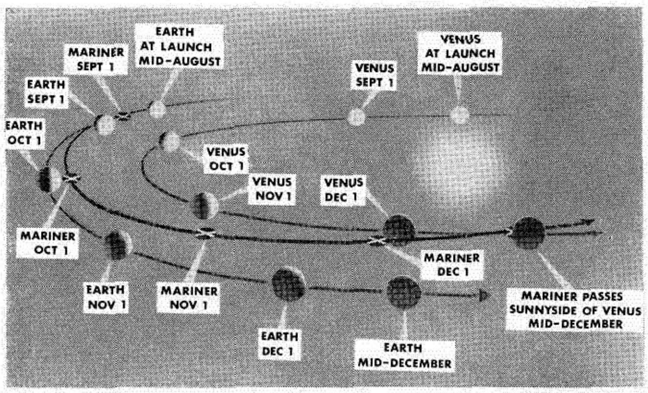
Six scientific experiments are carried aboard the Mariner. Four of these are designed to collect information in space and in the vicinity of Venus. The other two will provide information solely on Venus and will operate only as Mariner passes the planet.

The experiments are:

1) Microwave radiometer experiment to measure temperature distribution on the planet's surface.

2) Infrared radiometer experiment to provide information on the distribution of thermal energy in the planet's atmosphere.

3) Magnetometer experiment to determine the three mutually perpendicular components of the magnetic field in the interplanetary space between earth and Venus, and in the vicinity of Venus at planetary encounter.



Mariner II trajectory. When the spacecraft encounters Venus in mid-December, the distance between the earth and Venus will be about 36 million miles.

4) Charged particle experiment to detect the distribution, variations, and energies of electrically charged particles in space and in the vicinity of Venus, and the rate at which charged particles lose energy.

5) Plasma experiment to obtain information on the extent of, variations in, and mechanism of the solar corona.

6) Micrometeorite experiment to measure the density of cosmic dust particles which exist in interplanetary space and in the vicinity of Venus.

The microwave radiometer is mechanized so it can scan Venus during the fly-by. Initially, it is designed to go into a fast scan search. When it detects the planet, the radiometer will adopt a slow scan mode. The infrared experiment is attached to the rim of the dish-shaped microwave device and will scan with the larger instrument.

Launching Mariner II

Mariner II was launched at 11:53 p.m. PDT on August 26, 1962, after several delays. The launch vehicle injected the spacecraft properly into a trajectory that was within the expected accuracy of the launch vehicle and within the correction capability of the trajectory correction maneuver built into the spacecraft.

Spacecraft telemetry and tracking data is received at the three Deep Space Instrumentation Facility (DSIF) sites located in California, South Africa, and Australia. This information is relayed in near real time by teletype lines to the Jet Propulsion Laboratory. The spacecraft was first picked up by the South Africa station and then shortly thereafter by the Australian station.

It was with considerable satisfaction that we received the report from the JPL specialists assigned to monitor the telemetry data — not long after the events actually occurred — that the solar panels had opened, that the spacecraft had acquired the sun, that the gyros which are used only for acquisition and maneuvers had turned off, and that the battery was being charged by the energy from the solar panels.

Approximately 57 hours after launch, when it was established that the spacecraft was performing in a completely satisfactory fashion, the cruise (interplanetary) science experiments were turned on by ground command from the South Africa DSIF site. All experiments did turn on, are working properly, and have been collecting valuable data almost continuously except for the trajectory correction maneuver period.

During the first week of flight, the roll axis control system was purposely not turned on. During this period, the spacecraft was too close to the earth for the earth sensor to operate properly. About seven days out, the on-board programmer caused the roll control system to be activated and the high-gain antenna to be pointed toward the earth.

There was some question at first whether the earth sensor had acquired the earth or the moon, since either one would have caused the high-gain antenna coverage to include the earth. The correction maneuver could be made regardless of which had been acquired, but it was desirable to know which body had been acquired. Therefore, the maneuver was postponed for one day to see how signals varied during that period, and thus determine which object had been acquired. After the extra day, it was determined that the earth had been acquired, and we were ready to proceed with the maneuver.

The three quantitative numbers needed for the command, the roll turn, the pitch turn, and the velocity increment had been calculated on the computer at JPL from previous tracking data and from considerations of the desired target point. These commands had been relayed to the DSIF station at Goldstone, California, in the form of command tapes. These tapes were duly used to transmit this information to the spacecraft some 1.5 million miles out in space. After assurance that these quantitative commands had been properly transmitted, the execute command was initiated.

The gyros were turned on and warmed up for an hour. The spacecraft rolled and then pitched as commanded. During the course of this maneuver, the spacecraft went through a deep null in the low-gain antenna pattern and, for a short period, the signals went below the receiver threshold. By completion of the maneuver, the signal strength was back up and the receivers were back in lock.

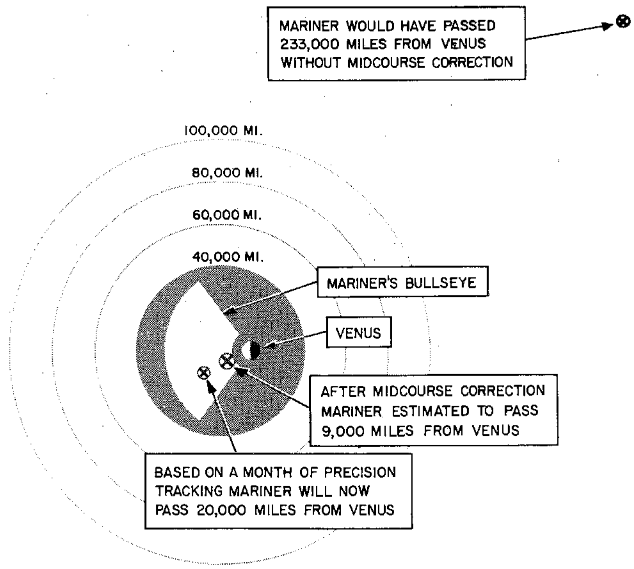
At the precise instant that the rocket motor was programmed to fire, the Goldstone tracking station noted a change in Doppler frequency, indicating that the motor had indeed fired. This Doppler shift lasted burn and then ceased. The spacecraft then proceeded burn and then ceased. The spacecraft then proceeded as planned to reacquire the sun and, some time later, the earth.

Hitting the bull's eye

This midcourse correction maneuver was designed to correct a trajectory that would have taken the spacecraft some 233,000 miles from Venus.

Shortly after the maneuver, it was predicted that Mariner II would pass about 9,000 miles from the surface of the planet. After almost five weeks of more precise tracking, however, it was determined that the small midcourse correction rocket had given the spacecraft slightly more velocity than planned. The velocity change required was an addition of 45 miles an hour to the 60,117 miles an hour the spacecraft was traveling in relation to the sun. Instead (for reasons not yet determined) the small rocket imparted an additional velocity of 47 miles an hour.

At interplanetary distances, this overcorrection of two miles an hour was enough to alter the course of the spacecraft by more than 10,000 miles. The latest estimated miss distance, therefore, is 20,900 miles—which may be off by as much as 3,000 miles. This is because of uncertainty about the exact location of tracking stations on earth, the distance of the astronomical unit (the distance between the earth and sun), and uncertainty about how the pressure of sunlight may affect the spacecraft.



Mariner II is now scheduled to pass within 20,900 miles of Venus — still in the bull's eye it is aiming for.

Even with the wider miss, Mariner II will still pass within the planned bull's eye — a pie-shaped target area extending from about 4,000 to 40,000 miles above Venus on the sunlit side of the planet—in which scientific planetary experiments will still be effective.

Mariner II has already discovered a steady wind of charged particles blowing off the boiling surface of the sun into interplanetary space. The existence of this solar wind provides a new insight into interplanetary weather and the manner in which some solar energy is transported to earth.

Apparently the solar plasma takes the form of a continuous wind, which at times reaches hurricane force with outbursts, such as solar flares, on the sun. Even though this gas is exceedingly tenuous under any terrestrial scale, it is definitely dense enough, and is moving fast enough, to be able to push the interplanetary magnetic field around as it sees fit.

Another finding made by Mariner II is that the density of cosmic dust — microscopic particles weighing as little as five one-trillionths of a pound — was only a thousandth of that observed by satellites in the environs of the earth. Through some mechanism not yet understood, the earth apparently traps the dust in its vicinity.

From an accumulation of such scientific data as this, we hope to develop a base for the eventual manned exploration of space.

The Summer at Caltech

Proposition 13

Caltech's President L. A. DuBridge has joined with the heads of 36 other private colleges and universities in California to enlist support in favor of a "yes" vote on Proposition 13 in the November election.

Proposition 13 removes the long-outdated 100-acre limitation on tax-exempt property of private non-profit colleges and universities, provided such property is used exclusively for the purposes of education.

"At the present time," says President DuBridge, "Caltech is not quite up to the 100-acre limit, but we soon will be well beyond it. Many independent colleges are already being taxed on their educational property in excess of 100 acres. Naturally, this is not only a financial burden, but discourages expansion of the private colleges. Yet such expansion during the next ten years is essential to take care of the growing California student population. Any students not taken care of by the private colleges must of necessity go to the public colleges, at a cost to the taxpayer far greater than the relatively small tax relief which the passage of Proposition 13 would involve. Furthermore, experience shows that on the average a college spends $31 in the local community for every $1 of tax exemption which it receives. It is obviously good business for the taxpayers to encourage the growth of the private colleges.

"The important part which Caltech plays in the Pasadena community is well known. Many millions of dollars are brought into this community each year, both directly and indirectly. This is overwhelmingly greater than the tax exemption which we now receive or the larger one we would receive in future years. Yet these tax costs would be a large item in our own budget.

"Though there is no formal opposition to Proposition 13, there is a strong possibility that it may fail to pass for lack of understanding and interest. I hope, therefore, that Caltech's faculty, students, alumni, and friends will not only support Proposition 13, but will also urge others to do so."

Professor Emeritus

William N. Lacey retired last month as dean of the faculty and has been named professor of chemical engineering, emeritus. He has been a member of the Caltech faculty for 46 years, and served as dean of graduate studies from 1946 to 1956.

Dr. Lacey has won wide recognition for his research on the properties and behavior of hydrocarbons. He has served as a consultant on many government and industrial research projects, and is the author or co-author of six books and nearly 150 scientific papers.

Among the honors he has received are the Hanlon Award of the Natural Gasoline Association of America, the Lucas Medal of the American Institute of Mining and Metallurgical Engineers, and the Certificate of Appreciation of the American Petroleum Institute.

During World War II, Dr. Lacey served with the National Defense Research Committee as a supervisor of research and development of artillery rocket ammunition at Caltech, and was awarded the Presidential Certificate of Merit in 1948.

In June 1960 he was appointed a member of the California State Board of Registration for Civil and Professional Engineers.

William N. Lacey

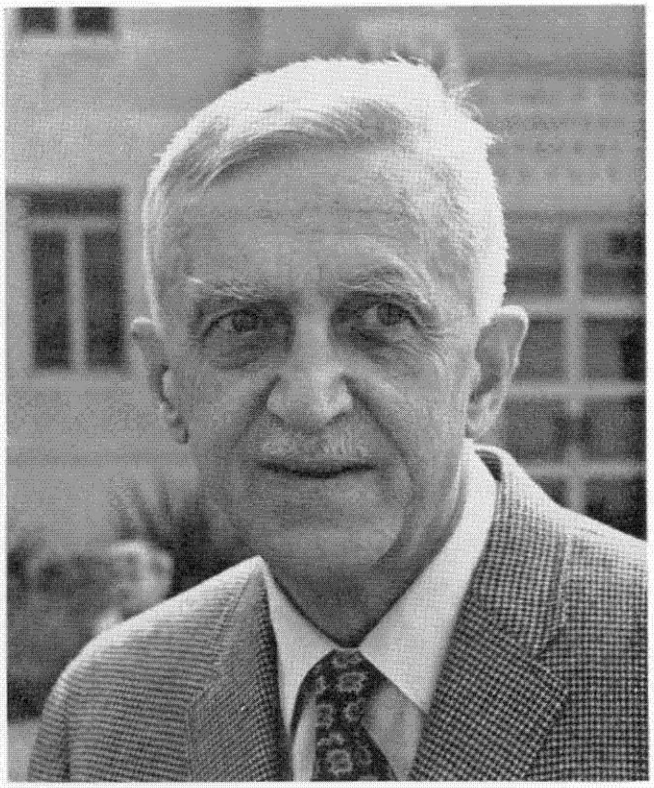
Retiring Professor

Gennaday W. Potapenko, associate professor of geophysics, is retiring after 32 years of teaching and research at Caltech. A native of Russia, Dr. Potapenko received his degrees from the University of Moscow, and, for a time, did research work on short radio waves there and at the University of Berlin. He also taught the technique for generating such waves at the University of Goettingen.

In 1930 he came to Caltech on a Rockefeller Fellowship, and became active in many fields of research. During World War II he invented the first ultra short wave radar, which increased the precision of the radar picture and improved the instrument as a distance indicator. He also designed a cooler for superchargers that enabled bombers to reach greater heights.

For the past six years Dr. Potapenko has worked on a new device designed to protect patients from germs during long operations. His patented invention, the Aseptic Air System, destroys more than 99.99 percent of the microorganisms present in the air. To date more than 20,000 operations have been performed using this system. The results show that it reduces the rate of infection to below 0.1 percent from the customary 5 percent or higher.

Dr. Potapenko is a member of the American Physical Society, the American Geophysical Union, the American Association for the Advancement of Science, and the Society of Exploration Geophysicists.



Gennaday W. Potapenko

James R. Page, 1884-1962

James R. Page, former chairman of Caltech's Board of Trustees, died on July 20 of injuries received in an automobile accident in April. He was 78 years old.

Mr. Page was one of the 100 original members of the California Institute Associates when they organized in 1926. He was elected their president in 1931. In that same year he became a trustee of the Institute, and in 1943 he succeeded the late Allan C. Balch as chairman of the board. He retired as chairman in 1954 but continued to serve as chairman of the board's finance committee until his death.

A native of Memphis, Tennessee, Mr. Page came to California in his youth and for more than 60 years was active in the business, cultural, civic, and religious affairs of the Los Angeles community.

He was a director of the I. N. Van Nuys Building Company, the Gladding McBean Company, the Southern California Edison Company, the First Safe Deposit Company, honorary director of the Union Oil Company of California, and a trustee and treasurer of the Henry E. Huntington Library and Art Gallery.

For five years he was president of the California Bank. He served four terms as president of the All-Year Club of Southern California. From 1923 to 1929 he was secretary of the Greater Los Angeles Harbor Committee of 200.

Mr. Page was a leading figure in the Community Chest and the Episcopal Church, and he was a trustee of the Good Samaritan Hospital, the Barlow Sanitarium and the Cate School in Carpinteria.

James R. Page

GEORGE W. GREEN

1914 - 1962

George W. Green, Caltech's vice president for business affairs, died on July 21, of complications from a thrombosis of the internal carotid artery.

Mr. Green came to Caltech in 1947 as manager of the accounting office. He was made business manager in 1948, comptroller in 1952, and vice president for business affairs in 1956.

He was born in Batavia, Illinois, in 1914. He received his BS in Business Administration at UCLA in 1937, and became a Certified Public Accountant, State of California, in 1941. He worked with the accounting firm of Price, Waterhouse & Co., from 1937 until 1947, except for three years during World War II when he served as an officer in the U.S. Naval Reserve.

At a memorial service in honor of George Green, held at the Westminister Presbyterian Church in Pasadena on July 26, President DuBridge said:

"To those of us who worked closely with him, George Green's prime characteristics were enthusiasm, devotion, and integrity . . . He took special pleasure in dealing with tough problems, and when they turned out successfully – as they usually did – he literally radiated his pleasure . . . He believed deeply in the California Institute of Technology. He was devoted to its principles and its objectives. And he spent the past 15 years selflessly promoting these objectives.

"But he was far more than a local campus figure. He became active in national organizations of university business officers; he worked devotedly to learn from others, to help others, and to lead these organizations to work together on national problems—problems common to all universities.

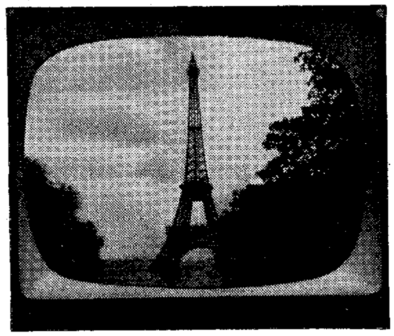
"Because of Caltech's situation, he was of course interested in the relations between universities and the federal government, and he did much to promote agreement and unity among universities on problems of government contracts, taxation, federal aid to higher education, and others. He was widely regarded as one of the best and most valued and most respected university business officers in the nation. And he did much to bring to government circles a better understanding of university problems.

"But it is still not only for these reasons that we shall miss George. We shall miss him because of the kind of man he was – friendly, unselfish, warmhearted, anxious to be of service, always honest, always loyal to friends and associates. We shall miss him more and more as the days go by – and we come to realize what it means not to have George to turn to for friendly, thoughtful help in difficult problems and for confident, intelligent leadership.

"We have lost a great citizen, an able leader – and an irreplaceable friend. We can only be thankful that, though he is gone, the work he has done will live for a long time, and his influence and inspiration will continue to guide us for years to come."

George Green served on many organizations. He was a member of the Advisory Committee of the National Science Foundation's Institutional Grant Committee, and of the U.S. Public Health Service General Medical Research Program-Project Committee. He was a former trustee of the Institute for Defense Analyses, and was former Secretary-Treasurer of the National Federation of College and University Business Officers Association. He held membership in the Controllers Institute of America and the California Society of Certified Public Accountants.

He was past secretary and a director of the Pasadena Chamber of Commerce, a trustee of the Huntington Memorial Hospital, a director of the Atlas Federal Savings & Loan Association of Pasadena, a member of the Advisory Board of the Pasadena Salvation Army, a member of the Pasadena Kiwanis Club, and of the Association of Independent California Colleges and Universities.



Faculty Changes

Promotions

To Professor:

Tom M. Apostol—Mathematics
Charles A. Barnes—Physics
Norman H. Brooks—Civil Engineering
Thomas K. Caughey—Applied Mechanics
Roy W. Gould—Engineering and Physics
W. Barclay Kamb—Geology
W. A. J. Luxemburg—Mathematics
Julius Miklowitz—Applied Mechanics
Anatol Roshko—Aeronautics
Cushing Strout—History
A. V. Tollestrup—Physics
Ward Whaling—Physics
G. B. Whitham—Aeronautics and Mathematics

To Associate Professor:

Fred C. Anson—Analytical Chemistry
Derek H. Fender—Biology and Electrical Engineering
A. M. Garsia—Mathematics
Oscar Mandel—English
Jon J. Mathews—Theoretical Physics
Carver A. Mead—Electrical Engineering
Ronald F. Scott—Civil Engineering
Leon T. Silver—Geology
Frederic Zachariasen—Theoretical Physics

To Senior Research Fellow:

Hao-Wen Liu—Aeronautics

To Assistant Professor:

Paul R. Baker—History
Everett C. Dade—Mathematics
Kenneth Lock—Electrical Engineering
William P. Schaefer—Chemistry
Bradford Sturtevant—Aeronautics
Robert D. Wayne—German

New Faculty Members

F. H. Abernathy, visiting associate in aeronautics, from Harvard University, where he is assistant professor in the division of engineering and applied physics.

Keiiti Aki, visiting associate in seismology, from the Earthquake Research Institute at Tokyo University, where he is associate professor.

John R. Atkins, instructor in psychology and anthropology, from the University of Pittsburgh, where he was research associate in anthropology.

T. R. Anantharaman, senior research fellow in materials science, from the Indian Institute of Science in Bangalore, where he is assistant professor of metallurgy.

Sherwin P. Avann, senior research fellow in mathematics, from the University of Washington, where he is associate professor of mathematics.

B. J. S. Barnard, senior research fellow in applied mechanics, from Cambridge University, where he received his PhD this year.

Richard Barnes, visiting associate in physics, from Iowa State University, where he is professor of physics and senior physicist at the Ames Laboratory.

Henry E. Baumgarten, visiting associate in chemistry, from the University of Nebraska, where he is professor of chemistry.

Herbert Booth, instructor in speech and director of forensics, from Cerritos College, where he was instructor in speech and assistant director of forensics.

Bille C. Carlson, senior research fellow in mathematics, from the University of California, where he received his PhD this year.

William Chester, visiting professor of aeronautics, from Bristol University in England, where he is a reader in the mathematics department.

Steven C. Frautschi, assistant professor of theoretical physics, from Cornell University, where he was assistant professor of physics.

Melvin Gerstein, senior lecturer in engineering (part-time), from Dynamic Science Corporation in South Pasadena, where he is vice president and technical director.

Gvirol Goldring, senior research fellow in physics, from the Weizmann Institute in Israel, where he is associate professor of physics.

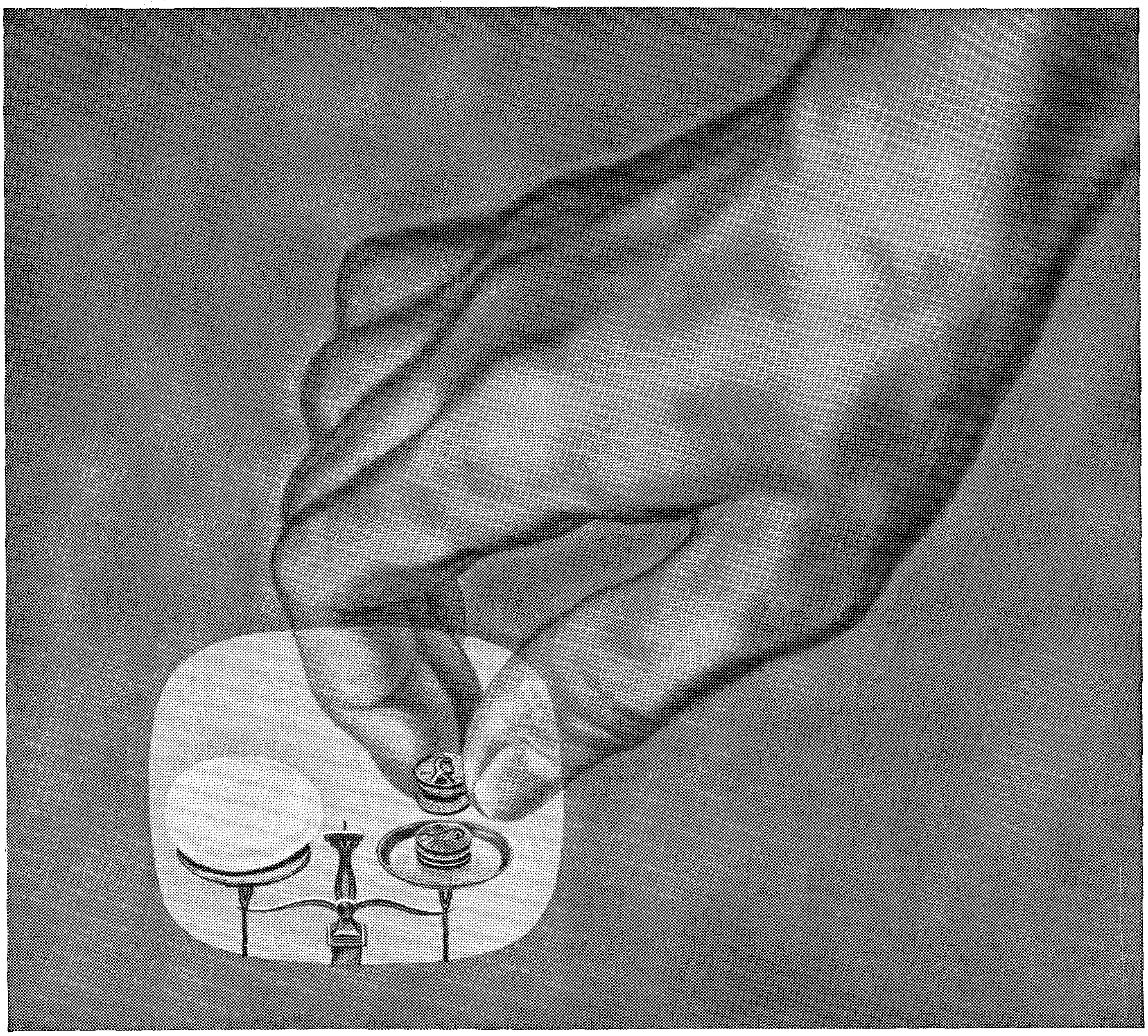
Thomas Grettenberg, assistant professor of electrical engineering, from Stanford University, where he received his PhD this year.

George Griffiths, senior research fellow in physics, from the University of British Columbia, where he is associate professor of physics.

James Halpern, Bateman Research Fellow in mathematics, from the University of California, where he received his PhD this year.

Donald R. F. Harleman, visiting associate professor of hydraulics, from MIT, where he is associate professor of hydrodynamics.

continued on page 28



John Holum, visiting associate in chemistry, from Augsburg College in Minneapolis, where he is associate professor of chemistry.

Keith Jensen, freshman coach of football, basketball, and baseball, from UCLA, where he received his BS in June.

Leon Knopoff, professor of geophysics, from UCLA, where he was professor of geophysics and physics.

George D. Langdon, assistant professor of history, from Yale University, where he received his PhD in 1961.

Peter Lissaman, MS '55, assistant professor of aeronautics, from the U. S. Naval Postgraduate School in Monterey, where he was assistant professor of aeronautics.

Raymond E. Miller, senior research fellow in electrical engineering, from the Research Center of the International Business Machines Corporation, where he is a staff member.

Bertram Morris, visiting professor of philosophy, from the University of Colorado, where he is professor and chairman of the department of philosophy.

Gerry Neugebauer, PhD '60, assistant professor of physics, from JPL, where he was a specialist scientist.

Roman Novins, lecturer in Russian, from Sequoia University in Los Angeles, where he taught in the Slavic studies department.

Fredric Raichlen, assistant professor of civil engineering, from MIT, where he received his ScD this year.

Donald W. Robinson, senior research fellow in mathematics, from Brigham Young University, where he is associate professor of mathematics.

Donald M. Rockwell, visiting associate in chemistry, from Juniata College in Huntington, Pa., where he is professor and head of the department of chemistry.

Stanley K. Runcorn, visiting associate in geophysics, from King's College, Durham University, in England, where he is professor and director of the department of physics.

Eleanor Searle, lecturer in history, who spent last year on a postdoctoral fellowship from the American Association of University Women to do research on the Battle Abbey at the Huntington Library.

Scott Searles, visiting associate in chemistry, from Kansas State University, where he is associate professor of chemistry.

Howard J. Sherman, assistant professor of economics, from Wayne State University in Detroit, where he was assistant professor of economics.

Robert A. Sigafoos, senior research fellow in economics, from the Stanford Research Institute, where he was head of urban studies and a member of the economics staff.

Merrill P. Spencer, MD, visiting associate in engineering, from the Bowman Gray School of Medicine of Wake Forest College in Winston-Salem, North Carolina, where he is associate professor of physiology and pharmacology.

Thomas E. Stelson, visiting associate in civil engineering, from the Carnegie Institute of Technology, where he is ALCOA professor and head of the department of civil engineering.

Hugh P. Taylor, BS '54, PhD '59, assistant professor of geology, from Pennsylvania State University, where he was assistant professor of geology.

Rochus Vogt, assistant professor of physics, from the Fermi Institute for Nuclear Studies at the University of Chicago, where he was a research associate in physics.

James D. Von Putten, assistant professor of physics, from the Cern Laboratory in Geneva, Switzerland, where he was NATO postdoctoral fellow.

Harold H. Warren, visiting associate in chemistry, from Williams College, where he is associate professor of chemistry.

E-an Zen, visiting associate professor of geology, from Washington, D.C., where he is a geologist with the U.S. Geological Survey.

John Zeigel, part-time instructor in English, from Claremont College, where he is studying for his PhD.

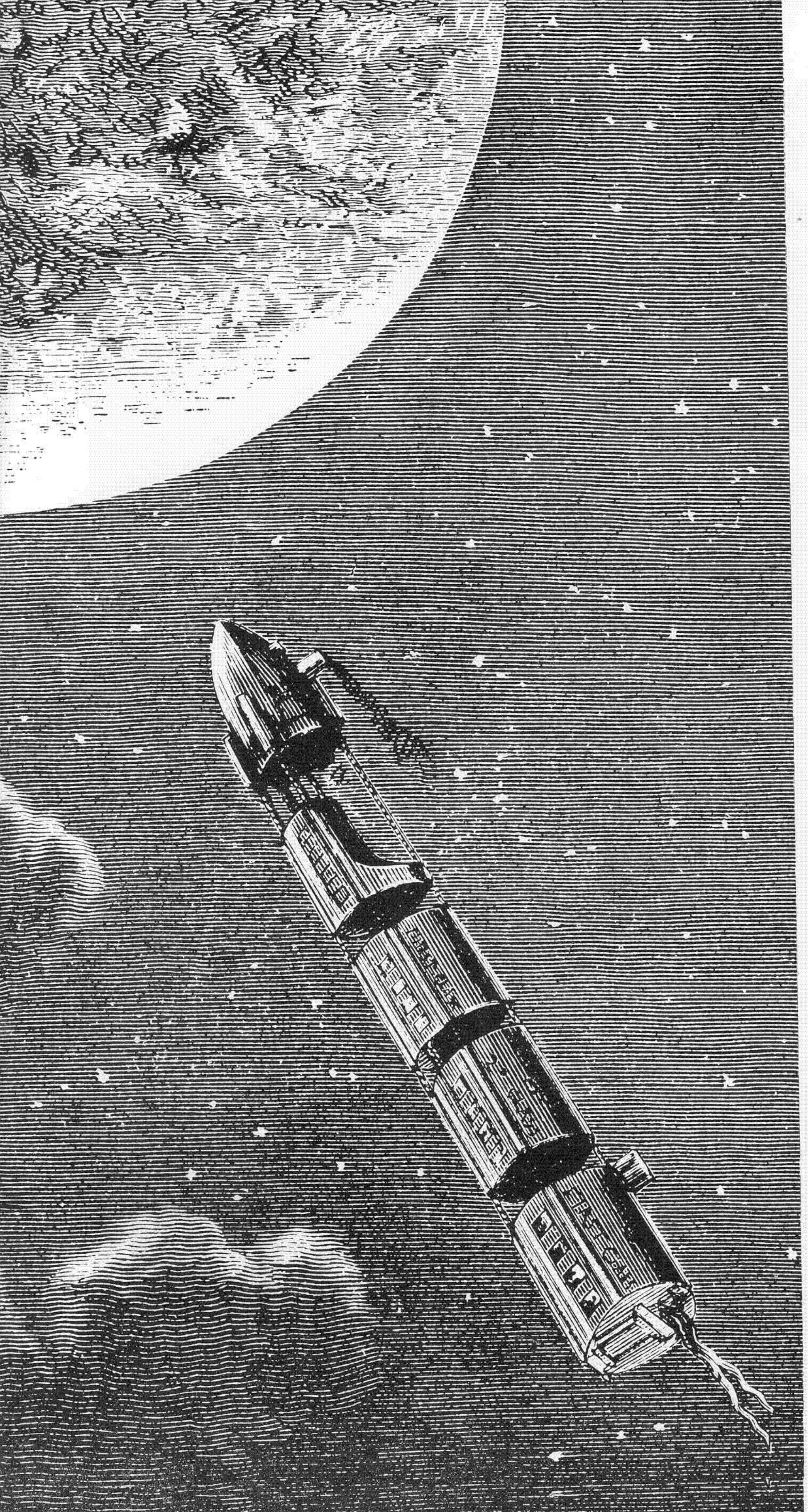
On Leave of Absence, 1962-63

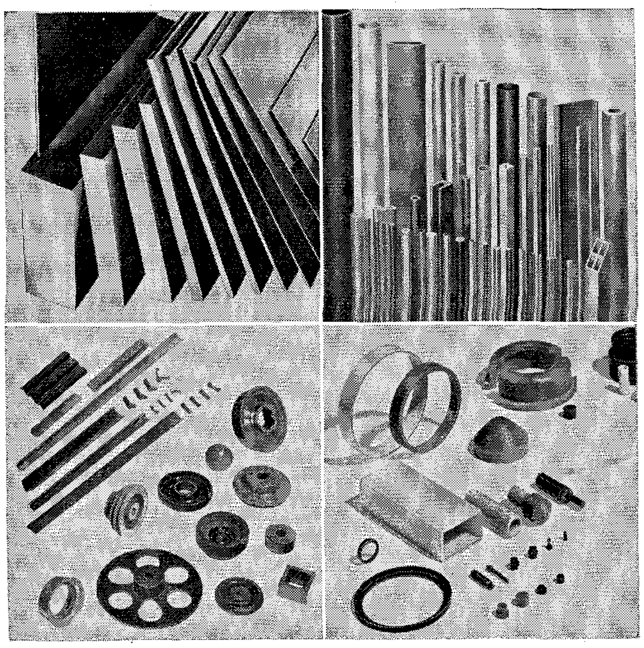
Robert A. Huttenback, assistant professor of history and master of the Student Houses, to Pretoria, South Africa, where he is writing a history of the Indians in South and Central Africa, and completing a history of Kashmir.

Charles R. DePrima, professor of applied mechanics, to serve as a staff member at the Courant Institute of Mathematical Sciences at New York University.

Cushing Strout, professor of history, to Cornell University in Ithaca, N.Y., as Whiton Visiting Professor in American History.

Charles Barnes, professor of physics, to the Research Institute for Theoretical Physics in Copenhagen on a National Science Foundation Fellowship.





Alumni News

A Word With the President

Your Alumni Association will continue to move forward this year.

Membership is growing. Annual paid members, life members, and percent of eligible are all at new highs, indicating either increasing interest in Association work or exceptional salesmanship on the part of Membership Directors. During the coming year, a new directory will be published.

The Seminar will be held in May 1963. This traditional day is probably the most important single alumni function. For the last few years, nearly the maximum number which can be accommodated have attended. If you have not come, you have missed the opportunity to see the new campus, to hear old and new teachers, to meet old and new friends.

The Interhouse is a new tradition. At the invitation of the Student Houses, alumni and their guests have viewed the imaginative displays set up in the House courts, and have joined, now and then, in the dancing.

Other social events will be limited this year to outstanding speakers on outstanding subjects, or meetings of exceptional educational value.

Again (and often) you will be asked to contribute to the Institute. Last year, 1708 alumni gifts totalled over $63,000, and an additional $51,000 was contributed for trusts and specific equipment – a splendid showing.

Your Association is contributing $1000 to the student body for the support of a new series of programs to include musical events and newsworthy speakers. These programs will be reported in *Engineering & Science.*

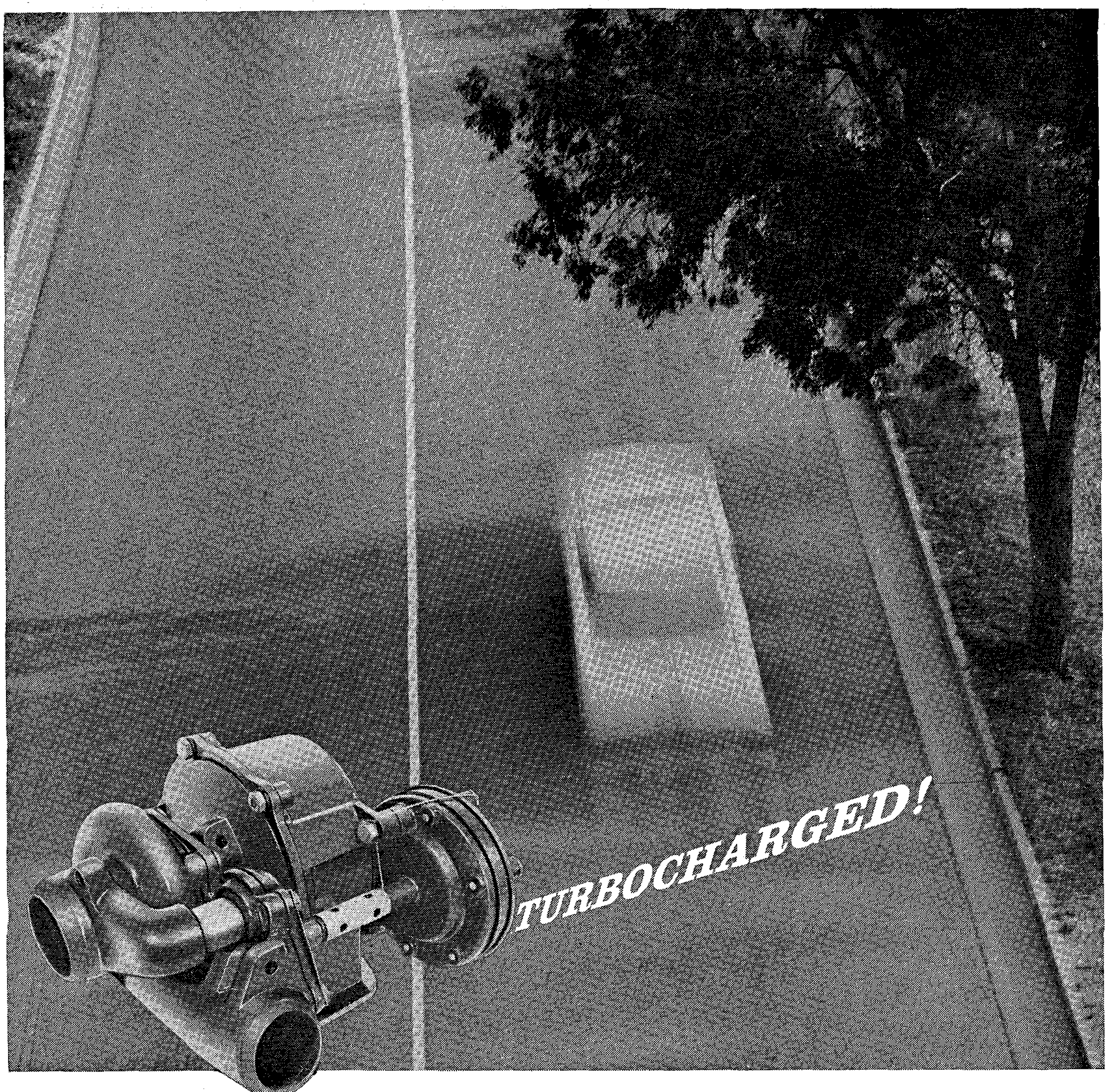
The Association is continuing its support of four exceptional undergraduate students, one in each class, through the Alumni Scholarships, which pay full tuition.

Your comments on our activities will be welcome.

– *W. L. Holladay '24*
president,
Caltech Alumni Association

Aerospace Men of the Year

John R. Pierce (BS '33, MS '34, PhD '36), director of communications research at the Bell Telephone Laboratories, is one of two men named "Aerospace Men of the Year" by the Air Force Association. With Alton C. Dickieson, also of Bell Telephone Laboratories, Pierce has received the Air Force Association's highest award, the Gen. H. H. Arnold Trophy, for his leading role in developing the Telstar communications satellite.



Small car economy with big car performance

Breakaway acceleration from 0 to 60 mph in just a fraction over 8 seconds. That is the unheard of big car performance achieved with small car economy by a popular 1962 automobile turbocharged by Garrett-AiResearch.

The Garrett turbocharger is the first controlled for optimum performance at all driving speeds. No matter how fast or slow you may be traveling, sudden acceleration and extra pulling power are there instantly and smoothly when you need them—on any grade at *any* altitude.

How is it possible? The Garrett turbocharger, driven entirely by the engine's waste exhaust gases, sucks in larger amounts of outside air and forces maximum fuel-air charges into the cylinders. This means better combustion, more power.

Other areas of concentration at Garrett include: space life support systems, solar and nuclear power systems, electronic systems, air conditioning and pressurization systems, computer systems and small gas turbines for both military and industrial uses.

For further information about a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles. *Garrett is an equal opportunity employer.*

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THE GARRETT CORPORATION • AiResearch Manufacturing Divisions • Los Angeles 9, California • Phoenix, Arizona • other divisions and subsidiaries: Airsupply-Aero Engineering • AiResearch Aviation Service • Garrett Supply • Air Cruisers • AiResearch Industrial • Garrett Manufacturing Limited • Garrett International S. A. • Garrett (Japan) Limited

Personals

1915

Herbert B. Holt died of a stroke on August 31 at the age of 70 in Pasadena. He was vice-chairman of the board of directors of the Bekins Van & Storage Company.

A native of Waterloo, Iowa, he came to California in 1906. He married Ruth Bekins in 1920 and, two years later, joined the Bekins company as a clerk. Mr. Holt was a life member of the Caltech Alumni Association and in 1941-2 served as secretary, membership chairman, and chairman of the committee on placement and campus relations.

1918

Noel Pike writes that he has been electric power advisor with the U.S. Operations Mission, which is the local agency of A.I.D. in Saigon, Vietnam, since August 1961. He retired in April 1961 as managing director of the Colombian electric properties of the American and Foreign Power Company. Noel is due to stay in Vietnam until August 1963; after that he talks of settling on the Mediterranean coast of Spain, or perhaps building a boat and having it shipped back to the Pacific Northwest or Canada. Noel's daughter is married to a captain on Continental Airlines and they live in El Paso with their three children. He also has a married son who is a lawyer in Mexico City.

1920

George O. Suman retired on May 31 from the Tidewater Oil Company in Los Angeles after nearly 42 years of service. He was San Joaquin Valley district production manager. The Sumans live in Kern City with their five children: Robert, 16; Dorothy, 15; Clinton, 14; Karyn Lee, 11; and Anne, 9.

Howard D. Hoenshel, MS, retired last spring as product manager for nylon intermediates in Du Pont's polychemicals department in Wilmington, Delaware. He had been with the company since 1926.

1929

Dallas E. Cole is now chief engineer of the Colorado River Board. He was formerly assistant. The Coles', who live in San Gabriel, have twin daughters—one of whom is married to *Ronald Dettling '57*.

1931

George Langsner, assistant state highway engineer for the California Division of Highways in Sacramento, has been appointed a member of the executive committee of the Highway Division, American Society of Civil Engineers. His son, Robert, graduated from Caltech last June.

1937

At the 25th anniversary of the Class of 1937 in June of 1962, the alumni present furnished the following personal information:

Walter L. Moore, chairman of the department of civil engineering at the University of Texas, was unable to attend the 25th reunion but wrote:

"Since 1947 I have been teaching at the University of Texas and have raised one native Californian and three native Texans. The native Californian is a girl and will be ready to enter college a year from this September. We have two girl Texans, ages 15 and 8½, and one boy Texan, age 7. The three girls, at least, are showing up with excellent scholastic records, but the boy, who is now in the first grade, has not yet determined his academic bent. He is, however, doing a lot of reading and may tune-up his academic abilities.

"We have enjoyed a few brief contacts with the LeVan Griffises since they moved to Houston, with Bob Mahoney during visits to New York, and with some of the Californians during our visits there. I would like to have a chance to visit the other CIT'ers of the '37 vintage, and invite any who are passing through Austin to stop by for a visit."

George Mann has three girls and one boy, ages 1 to 18 years. He is now teaching mechanical engineering at Los Angeles State College. His first job out of school was at Lockheed, after which he started a small company in which he is still active.

W. Gordon Wylie has been with the U.S. Weather Bureau since September 1937. The last 3½ years he has spent in Wichita, Kansas. Previous assignments were in Fresno, Burbank, at UCLA for graduate work in meteorology, Seattle, and Honolulu. Gordon has a son Bruce, 22, a daughter Karen, 19, both in Kansas State University. He also has two other daughters, Joanne, 14 and Anita, 10.

Hugh Warner is married and has two children, one of each. He is production manager of the Data Processing Systems Branch of Librascope Division, General Precisions, Inc., in Glendale, California.

Jim Seaman has been engaged in electrical engineering for the Southern California Edison Company for 25 years. He has a 21-year-old son in the Navy at Pearl Harbor, serving as an electronics technician with hopes of being admitted to Caltech. His daughter is starting San Marino High. His wife is president of the Oxy Alpha Sorority Alumni Association.

Ted Fahrner graduated in electrical engineering but has worked principally in mechanical engineering. He is now a nuclear engineer with E. H. Plesset Associates in Los Angeles. Ted has been married for 20 years and boasts 5 children; 3 boys and 2 girls, ages 18 to 5.

R. Bruce Lockwood is engaged as a geologist in consulting engineering work.

Mac McSparran attended Harvard Business School from 1937 to 1939. He has been with ALCOA since 1939, starting with the ALCOA Vernon Works, where he spent 6 years in industrial engineering and production control. Since 1945 he has been engaged in sales. Mac's wife, Lora, of Glendora, is a native Californian. They have three children.

Thomas Davis, ex 37, is the southern California engineering representative for the Boeing Company. Tom lives in Altadena, and is married to Mildred Anna Edmonson from Akron, Colorado. The Davises have a daughter, Margaret, age 8, sons Thomas, 4 and James, 17 months. The latter is a third generation Californian.

Martin H. Webster is a partner in the law firm of Webster and Abbot, in Beverly Hills. Familial encumbrances include a wife and 2 children, ages 13 and 11.

Dan Gerlough, after many years on the faculty at UCLA, joined Ramo-Wooldridge in 1959. Dan is in charge of group study applications of computers for traffic control. He is married and has one daughter.

Chuck Woolsey is married with two children, a boy, 20, and a girl, 14. He is an applied chemist turned metallurgist. When he first got out of school, he helped General Electric develop and build flatirons in Ontario. During the war he was engaged in project work at Tech. He was with Food Machinery Corporation on the Watt Buffalo job for awhile. For six years after the war he was at NOTS. Chuck is now with Atomics International as Assistant to the Director of the Fuels and Materials Department.

Virgil Erickson is in the manufacturing business. He is married and has five children, one in college this fall, 2 boys and 3 girls.

John P. Selberg is married and has three children, a daughter 16, starting college in 1962. John's son is 15, a 6-footer, and wants to go to Tech. The 12-year-old son is in junior high. John is working for Standard Steel Corporation.

Joe Axelrod is with Lear, Inc., in Santa Monica. Joe was formerly at Hughes in x-ray diffraction, and earlier with the U.S. Geological Survey working on the physics and chemistry of minerals. Joe is presently engaged in growing crystalline thin films of semi-conductors.

Carl Johnson is a consulting structural

continued on page 36

High Voltage Engineering Corporation . . .

"CHARGED PARTICLES"

High Energy Hardware

The Van de Graaff long ago earned its place in the nuclear physics laboratory. The electrostatic accelerator had apparent voltage limitations, and the Company that came to build them for research appeared to accept these limitations and settled down happily in the field of low energy physics. Perseverance in technology and the Tandem principle of charge-exchange tend to make these limitations less apparent today, but we still speak mainly of low energy or "nuclear structure" physics research.

Injection

What about our interest in high energy physics? Visible accomplishments of High Voltage Engineering include the design and delivery of thirteen injectors to accelerators in the Gev range, mostly electron and proton synchrotrons. These are listed at right. The results are gratifying. For instance, the installations of new ARCO 10-Mev Linac injectors have increased the electron beam intensity of two synchrotrons by several orders of magnitude, significantly improving their usefulness. The Cambridge Electron Accelerator went into operation successfully last month with an ARCO 20-Mev S-Band Linac as injector. Three Van de Graaffs are getting protons off to a good start at Brookhaven National Laboratory, Saclay in France and Princeton University.

High Voltage d-c

On the output end of orbital accelerators, the 600-kilovolt, 8 milliampere ICT* d-c power supply is being used to develop a stable electric field for high energy beam separators or velocity selectors, presently for Brookhaven and Argonne National Laboratories.

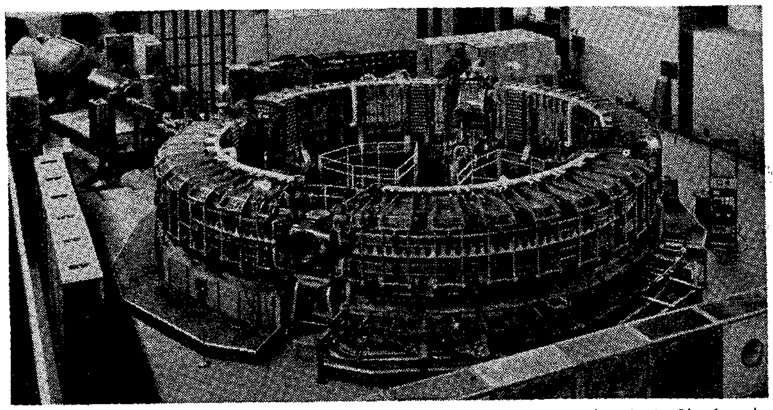
High Voltage is our business — for example, sophisticated studies of vacuum as a high-voltage insulating medium are being carried out. We are developing high voltage transfer systems which will support 750 kv d-c into 10^{-6} Torr vacuum from atmosphere.

Ion Guns

In the development of more intense ion sources, there has been steady progress over the years. One-hundred milliampere guns are being used in our own research programs. Ion-optics problems are the subject of constant development with an eye toward higher intensity and better efficiency. Much of this work is a necessary part of our Tandem Van de Graaff program and sheds light on problems we share with designers of high energy accelerator systems.

We welcome the opportunity to evaluate these capabilities in terms of your requirements.

**Insulating-Core Transformer*



3 Mev Van de Graaff pulsed electron injector to synchrotron — Instituto Nazionale di Fisica Nucleare, Frascati, Italy.

INJECTORS FOR HIGH ENERGY ACCELERATOR INSTALLATIONS

		SYNCHROTRON
University of Purdue	1 Mev Van de Graaff	340-Mev Electron
Massachusetts Institute of Technology	1 Mev Van de Graaff	350-Mev Electron
CERN	1.5 Mev Van de Graaff	Electron Analog to Storage Ring
Cornell University	2 Mev Van de Graaff (replaced by 10-Mev Linac)	1.1 Gev Electron
Brookhaven National Laboratory	2 Mev Van de Graaff	Analog to 30-Gev Proton
Instituto Nazionali di Fisica Nucleare de Frascati, Italy	3 Mev Van de Graaff	1.5-Gev Electron
University of Bonn	3 Mev Van de Graaff	416-Mev Electron
Princeton University	3 Mev Van de Graaff	3-Gev Proton
Brookhaven National Laboratory	4 Mev Van de Graaff	3-Gev Proton
Centre d'Etudes Nucleaires de Saclay	4 Mev Van de Graaff	3-Gev Proton
Cornell University	10 Mev Linac	1.1-Gev Electron
California Institute of Technology	10 Mev Linac	1.5-Gev Electron
Cambridge Electron Accelerator	20 Mev Linac	6-Gev Electron

HIGH VOLTAGE ENGINEERING

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HIGH VOLTAGE ENGINEERING (EUROPA) N.V.

CALTECH CALENDAR

ALUMNI EVENTS

November 17 Interhouse Dinner Dance

FRIDAY EVENING DEMONSTRATION LECTURES

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

October 26

The Electron Microscope—Its Present Possibilities and Future Prospects
—Alan Hodge

November 2

Searching for Earthquake Faults Around the Borders of the Pacific
—Clarence R. Allen

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Meetings: 13th Floor, Engineers Club, 206 Sansome St., San Francisco
Informal luncheons every Thursday at 11:45 A.M. Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

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Meetings: University Club, 1319 "K" Street
Luncheon first Friday of each month
Visiting alumni cordially invited—no reservation

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3040 Udal Street

Secretary Frank J. Dore, '45
Astronautics Div., Convair

Program Chairman Herman S. Englander, '39
U. S. Navy Electronics Laboratory

Personals . . . *continued*

engineer in the firm of Johnson and Nielson, Los Angeles and Riverside. Carl and his wife, Margaret, have three children, David, 12, Christine, 16, and Ann, 21, who graduated from Occidental College in June.

Wendell B. Miller is college relations supervisor for the Pacific Telephone Company. Wendell lives in Arcadia, is married and has four children, 2 boys and 2 girls. He has worked for Pacific Telephone since graduation and has lived in Arcadia since 1941.

George Carroll operates a "1½-man" structural engineering office. George lives in Pasadena and is married, with one 9-year-old daughter.

Irv Ashkenas is vice president of Systems Technology, Inc., in Inglewood. Irv has three boys and lives in Beverly Hills.

Bob Campbell has been with Southern California Edison since graduation. He lives in Arcadia with his wife Barbara. His daughter Barbara is at the University of California at Riverside, and Bonnie is a senior at Arcadia High.

Carl "Swede" Larson is projects manager for Emil R. Wohl Construction Company. Carl has been married for 23 years and has three boys, Carl, 21, Robert, 9, and James 7, and two girls, Mary K, 16 and Kristine, 14.

Ed Price received his PhD from the University of California at Berkeley in 1950. He married Margaret Muckleston in 1942. Margaret and Ed have five children. Ed's present position is professor of geography at Los Angeles State College.

Wilbur F. Snelling lives in Portuguese Bend, California, with his wife Theodora. His son, John, is at Claremont Mens College and his daughter Sally at Chadwick School. Wilbur is executive vice president of North American Aviation, Inc., Los Angeles Division. He reports that he took up skiing at age 45—one broken leg. He took up tennis at age 46 – no casualty as yet.

Al Zimmerman is living in San Gabriel and working for American Pipe and Construction Co. Al has been married for 20 years, has one daughter, age 18, who graduated from high school in June.

Paul Schaffner is assistant vice president of the insurance brokerage firm of Marsh & McLennan-Cosgrove & Company of Los Angeles. After graduation he was with the Board of Fire Underwriters for the Pacific for one year, and has been with his present employer since then. Paul and his wife Eunice live in La Canada and have two daughters, Vicky, 16, and Diana, 13.

Walton A. Wickett lives in Atherton, California, and is with the Menlo School and College in Menlo Park.

—Paul C. Schaffner
1937 Class Secretary

1941

R. Carroll Maninger is now on the staff of the electronics engineering department of the University of California's Radiation Laboratory in Livermore. The Maningers, who live in Palo Alto, have three children.

1948

Jesse R. Singleton, PhD, died of cancer on July 7 in a New York hospital. He was teaching in the department of biological sciences at Purdue University in Lafayette, Indiana, where he had been for eight years. A short time before his illness and death, he had received a large grant from the National Science Foundation to develop an institute at Purdue where his new method of teaching biology would be used on graduate students.

Jesse leaves his wife, Dr. Katerina Singleton, who teaches Russian at Purdue; his son John, 9; his mother, a brother and two sisters.

ALUMNI FUND: Performing its Task

The second year of Alumni Fund solicitation for endowment principal is now underway. Before we set forth our goals for this year, let us look at what we have already accomplished.

In 1960-61, a year of non-solicitation, we received some $6000, all designated for the new Fund purpose of increasing the Institute's endowment principal.

Then in 1961-62 1700 alumni gave $47,000 to endowment principal plus an additional $18,000 restricted for other campus purposes. The Alumni Fund endowment principal now totals more than $53,000. Two years ago when the alumni turned their efforts toward increasing endowment, President DuBridge stated that there is a "substantial need" for a larger endowment. This was not just a casual remark. Endowment income which formerly provided 32 percent of on-campus expenditures now accounts for only 20 percent.

Alumni are helping to increase endowment principal through their Alumni Fund gifts as reported above. But equally important is the fact that alumni interest is stimulating others to give also.

Before our endowment fund campaign was announced, Caltech's friends averaged only $38,000 over a two-year period in new endowment gifts. In the next two years *after* our purpose was announced, gifts to endowment averaged more than $90,000 each year. The largest gift received (now in six figures) was given as a *direct result* of the alumni effort toward this same end.

The growth of endowment contributions from Caltech's friends is an extremely important trend, one which alumni alone have created. We hope this trend will be continued and accelerated by alumni interest and support.

So much for the past. We must do more in the future. First, we look for continued support from those who gave last year. Secondly, we want to add to this support from the rather large number of alumni who give sporadically or not at all.

Finally, we hope all of you will consider the size of your gift. Make it as large as you can afford, for it will take thoughtful giving by each of you to reach the goal we have set for ourselves this year.

—G. Russell Nance and William H. Saylor
Directors of the Caltech Alumni Fund, 1962-63

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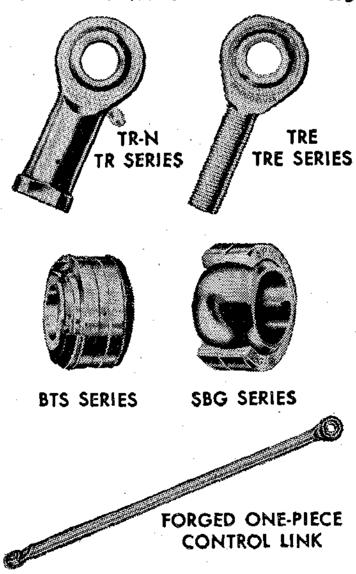
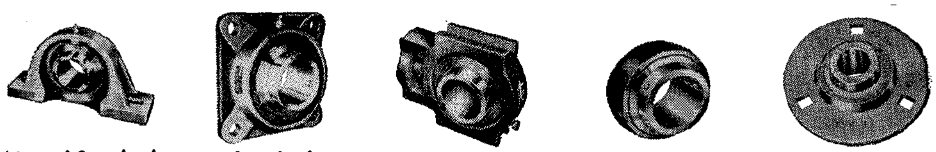
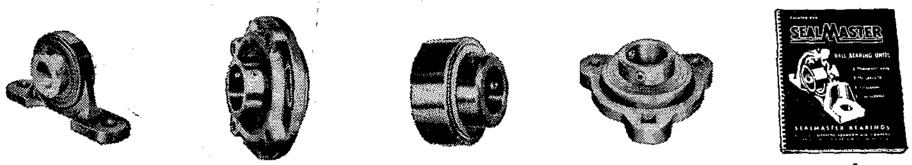




Normal-Standard Medium Duty PILLOW BLOCKS — Standard Medium Duty FLANGE UNITS — TAKE-UP UNIT — L BEARING — Stamped Steel FLANGE UNITS



LP PILLOW BLOCK — FLANGE CARTRIDGE UNIT — SL BEARING — LF FLANGE UNIT — Write for Bulletin 454

SEALMASTER

SEALMASTER BEARINGS

A Division of STEPHENS-ADAMSON MFG. CO.
49 Ridgeway Avenue • Aurora, Illinois

PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI • BELLEVILLE, ONTARIO • • MEXICO DF •

ALUMNI ASSOCIATION
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

BALANCE SHEET
June 30, 1962

ASSETS			
Cash in Bank			$ 1,478.69
Investments:			
Share in C.I.T. Consolidated Portfolio		$ 72,710.36	
Deposits in Savings Accounts		21,454.05	94,164.41
Investment Income Receivable from C.I.T.			4,032.22
Postage Deposit, etc.			184.04
Furniture and Fixtures, at nominal value			1.00
Total Assets			$ 99,860.36
LIABILITIES, RESERVES AND SURPLUS			
Accounts Payable			$ 1,017.75
Deferred Income:			
Membership Dues for 1962-63 paid in advance		$ 9,403.50	
Investment Income for 1962-63 from C.I.T. Consolidated Portfolio (earned during 1961-62)		4,032.22	13,435.72
Life Membership Reserve			59,000.00
Reserve for Directory:			
Balance, July 1, 1961	$ 2,084.90		
1961-62 Appropriation	2,000.00	$ 4,084.90	
1961-62 Directory Expense		153.37	3,931.53
Surplus:			
Balance, July 1, 1961		$ 19,064.12	
Share of Profit on Disposal of Investments of C.I.T. Consolidated Portfolio for 1961-62		3,771.97	
Excess of Expenses over Income for 1961-62		(360.73)	22,475.36
Total Liabilities, Reserves and Surplus			$ 99,860.36

STATEMENT OF INCOME AND EXPENSES
For the Year Ended June 30, 1962

INCOME		
Dues for Annual Members		$ 17,427.75
Investment Income:		
Share from C.I.T. Consolidated Portfolio	$ 3,786.76	
Interest on Deposits in Savings Accounts	1,113.62	4,900.38
Annual Seminar		4,634.60
Program and Social Functions		3,419.10
Miscellaneous		42.18
Total Income		$ 30,424.01
EXPENSES		
Subscriptions to Engineering and Science Magazine:		
Annual Members	$ 12,195.75	
Life Members	2,996.00	$ 15,191.75
Annual Seminar		4,550.50
Program and Social Functions		3,815.53
Administration:		
Directors' Expenses	$ 236.35	
Postage	711.22	
Printing	275.81	
Supplies	827.75	
Miscellaneous	220.15	2,271.28
Fund Solicitation Committee		2,100.85
Directory Appropriation		2,000.00
Membership Committee		454.83
ASCIT Assistance		400.00
Total Expenses		$ 30,784.74
Excess of Expenses over Income		$ 360.73

AUDITOR'S REPORT

Board of Directors, Alumni Association, California Institute of Technology
Pasadena, California

I have examined the Balance Sheet of the Alumni Association, California Institute of Technology as of June 30, 1962 and the related Statement of Income and Expenses for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

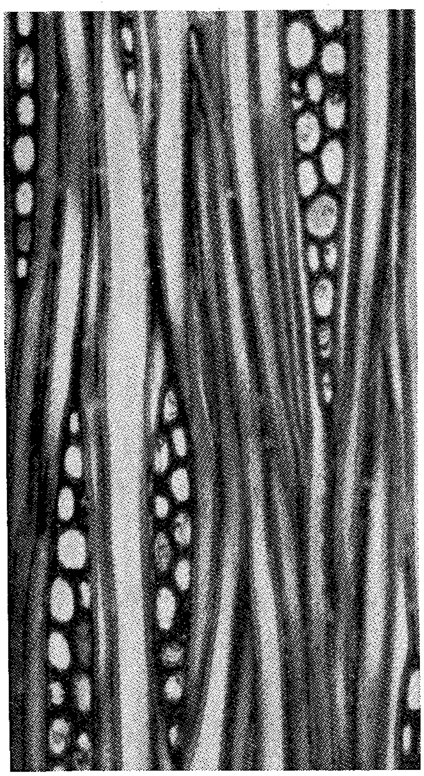
In my opinion, the accompanying Balance Sheet and Statement of Income and Expenses present fairly the financial position of the Alumni Association, California Institute of Technology at June 30, 1962, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

CALVIN A. AMES, Certified Public Accountant
1602 West Thelborn St., West Covina, California

September 25, 1962

Kodak beyond the snapshot...
(random notes)

What makes hickory the way it is



This photomicrograph shows the basic structure of hickory wood. It was taken on a plain, ordinary microscope with a BROWNIE Camera. For details on this use of BROWNIE Cameras, request a copy of "Photomicrography with Simple Cameras" from Eastman Kodak Company, Sales Service Division, Rochester 4, N.Y. Everybody knows what a BROWNIE Camera is.

Huntley with rope

May we please plant a little spore in the brain intended to grow into a career not previously contemplated?

Sound, businesslike outfits need well-grounded engineers to run their photographic operations. This doesn't necessarily mean making the candid shots at the boss's daughter's wedding.

We have made a 42-minute movie called "Photography at work . . . a progress report." (To show it, write Eastman Kodak Company, Professional Photographic Sales Division, Rochester 4, N.Y.)

Mr. Chet Huntley narrates. We take you inside a cake being baked in Dayton. We puzzle you with a monstrous camera intended to take pictures in Cincinnati without perspective. We show you how they test a new hydrofoil on Lake Washington and what nooks and crannies a camera can explore when fitted with fiber optics. We take you to lots of places, starting on a classy note with the hunt for anti-matter at Brookhaven.

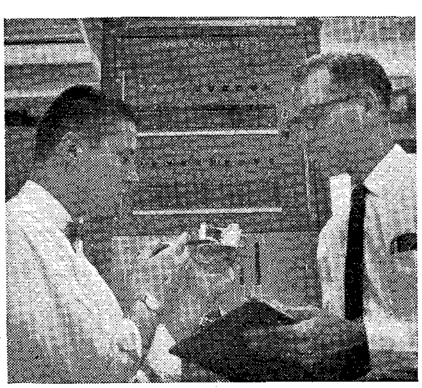
If we create the impression that the great linear accelerator there is nothing but another camera accessory, do not conclude that perspective is being shunned in Rochester as well as in Cincinnati. There is a "low technology" that civilizations evolve over the millennia for hewing the wood and drawing the water of everyday life and a "high technology" that is called into existence by the demands of pure science and then very kindly lowers a rope to haul up the "low technology". Maybe 1520 feet of movie film is better than rope.

The improvement of capacitors

Our polyester is different from other polyester. We add a cyclohexane ring to the unit structure, whereas other polyester is just poly(ethylene terephthalate). The added ring protects against moisture, raises the melting point, and gives customers some reasons of self-interest to seek out the trademarks KODEL on polyester fiber and TENITE on polyester molding granules.

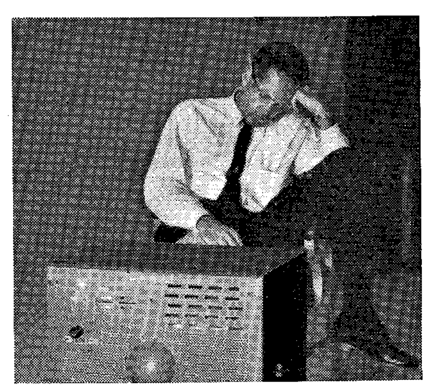
When the president of Kodak visited the lab where, in addition, its electrical advantages were discovered, we set up ten .05-μfd 200-v polyester capacitors for him, identical except that five had the ring and five didn't. We put them all in an oven at 185°C and applied 700 volts of dc across them. Within 3 minutes all five of the p(e t)'s had shorted out. This was the logical moment for the president to leave, but realism is company policy. The president wanted to watch the first of ours fail. It took 10 minutes. That was four years ago.

We then replaced 15 of the regular capacitors in a TV set with our kind and set it to running 9 hours a day, 7 days a week. All other components that failed we replaced. For the Electrical Insulation Show early this year, we removed the set from the room where the lab manager hides it and took it to Washington. It was the hit of the show. The coincidence that it happened to be the only TV set in the hall on the day when the first American was orbiting the earth might have helped focus attention on it. It would not have been a good place for a capacitor to blow.



MAKING CHEAP THINGS WORK WELL IS A GOOD LIFE.

SOPHISTICATED TECHNICAL PERSUASION IS A GOOD LIFE.



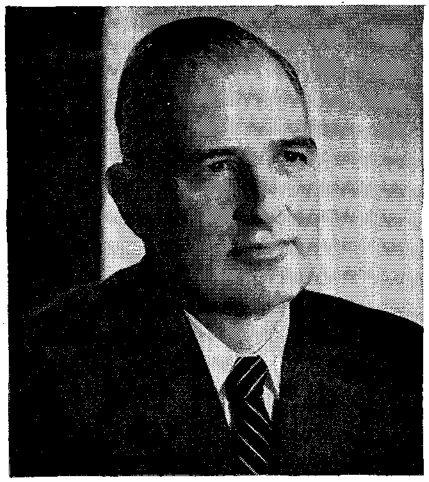
THE GOOD LIFE IS NOT ALWAYS FILLED WITH TENSION.

Plenty of lively work at Kodak researching, engineering, producing, and marketing all sorts of things.

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

An interview with General Electric's W. Scott Hill

One of a series...



Manager—Engineering Recruiting

How to Make the Most of Your First Five Years

MR. HILL has managerial responsibility for General Electric's college recruiting activities for engineers, scientists, PhD's and technicians for the engineering function of the Company. Long active in technical personnel development within General Electric, he also serves as vice president of the Engineers' Council for Professional Development, board member of the Engineering Manpower Commission, director of the Engineering Societies Personnel Service and as an officer or member of a variety of technical societies.

Q. Mr. Hill, I've heard that my first five years in industry may be the most critical of my career. Do you agree?

A. Definitely. It is during this stage that you'll be sharpening your career objectives, broadening your knowledge and experience, finding your place in professional practice and developing work and study habits that you may follow throughout your career. It's a period fraught with challenge and opportunity—and possible pitfalls.

Recognizing the importance of this period, the Engineers' Council for Professional Development has published an excellent kit of material for young engineers. It is titled "Your First 5 Years." I would strongly recommend you obtain a copy.*

Q. What can I do to make best use of these important years?

A. First of all, be sure that the company you join provides ample opportunity for professional development during this critical phase of your career.

Then, develop a planned, organized personal development program—tailored to your own strengths, weaknesses and aspirations—to make the most of these opportunities. This, of course, calls for a critical self appraisal, and periodic reappraisals. You will find an extremely useful guide for this purpose in the "First 5 Years" kit I just mentioned.

Q. How does General Electric encourage self development during this period?

A. In many ways. Because we recognize professional self-development as a never-ending process, we encourage technical employees to continue their education not only during their early years but throughout their careers.

We do this through a variety of programs and incentives. General Electric's Tuition Refund Program, for example, provides up to 100% reimbursement for tuition and fees incurred for graduate study. Another enables the selected graduate with proper qualifications to obtain a master's degree, tuition free, while earning up to 75% of his full-time salary. These programs are supplemented by a wide range of technical and nontechnical in-plant courses conducted at the graduate level by recognized Company experts.

Frequent personal appraisals and encouragement for participation in professional societies are still other ways in which G.E. assists professional employees to develop their full potential.

Q. What about training programs? Just how valuable are they to the young engineer?

A. Quite valuable, generally. But there are exceptions. Many seniors and graduate students, for example, already have clearly defined career goals and professional interests and demonstrated abilities in a specific field. In such cases, direct placement in a specific position may be the better alternative.

Training programs, on the other hand, provide the opportunity to gain valuable on-the-job experience in several fields while broadening your base of knowledge through related course study. This kind of training enables you to bring your career objectives into sharp focus and provides a solid foundation for your development, whether your interests tend toward specialization or management. This is particularly true in a highly diversified company like General Electric where young technical graduates are exposed to many facets of engineering and to a variety of product areas.

Q. What types of training programs does your company offer, Mr. Hill?

A. General Electric conducts a number of them. Those attracting the majority of technical graduates are the Engineering and Science, Technical Marketing and Manufacturing Training Programs. Each includes on-the-job experience on full-time rotating assignments supplemented by a formal study curriculum.

Q. You mentioned professional societies. Do you feel there is any advantage in joining early in your career?

A. I do indeed. In fact, I would recommend you join a student chapter on your campus now if you haven't already done so.

Professional societies offer the young engineer many opportunities to expand his fund of knowledge through association with leaders in his profession, to gain recognition in his field, and to make a real contribution to his profession. Because General Electric benefits directly, the Company often helps defray expenses incurred by professional employees engaged in the activities of these organizations.

Q. Is there anything I can do now to better prepare myself for the transition from college campus to industry?

A. There are many things, naturally, most of which you are already doing in the course of your education.

But there is one important area you may be overlooking. I would suggest you recognize now that your job—whatever it is—is going to be made easier by the ability to communicate . . . effectively. Learn to sell yourself and your ideas. Our own experience at General Electric—and industry-wide surveys as well—indicates that the lack of this ability can be one of the major shortcomings of young technical graduates.

**The kit "Your First 5 Years," published by the Engineers' Council for Professional Development, normally sells for $2.00. While our limited supply lasts, however, you may obtain a copy by simply writing General Electric Company, Section 699-04, Schenectady, New York.*

(An equal opportunity employer.)

Progress Is Our Most Important Product

GENERAL ELECTRIC