ENGINEERING | AND | SCIENCE

November 1959

Student Houses . . . page 30

Published at the California Institute of Technology


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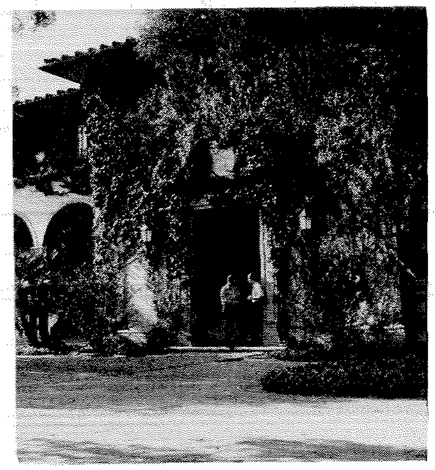

On Our Cover

an idyllic view of one of Caltech's Student Houses (Fleming, to be specific). On page 30, a more acid view of the Student Houses by an undergraduate, Douglas W. Shakel '60.

James A. Lockhart

research fellow in biology, received his BA from the University of Wisconsin in 1944, then went to Michigan State for his BS in 1946 and his MS in 1949. He came to Caltech to do plant research after receiving his PhD in plant physiology from the University of California in 1954. In his research, he has concentrated on the plant hormone, gibberellin, and the relationship between this remarkable plant-growing substance and the effects of light. He writes about this interesting relationship in his article, "Gibberellin – A New Plant Hormone," on page 15 – and about the colorful history and background of the hormone which may someday help agriculture to new highs of productivity.

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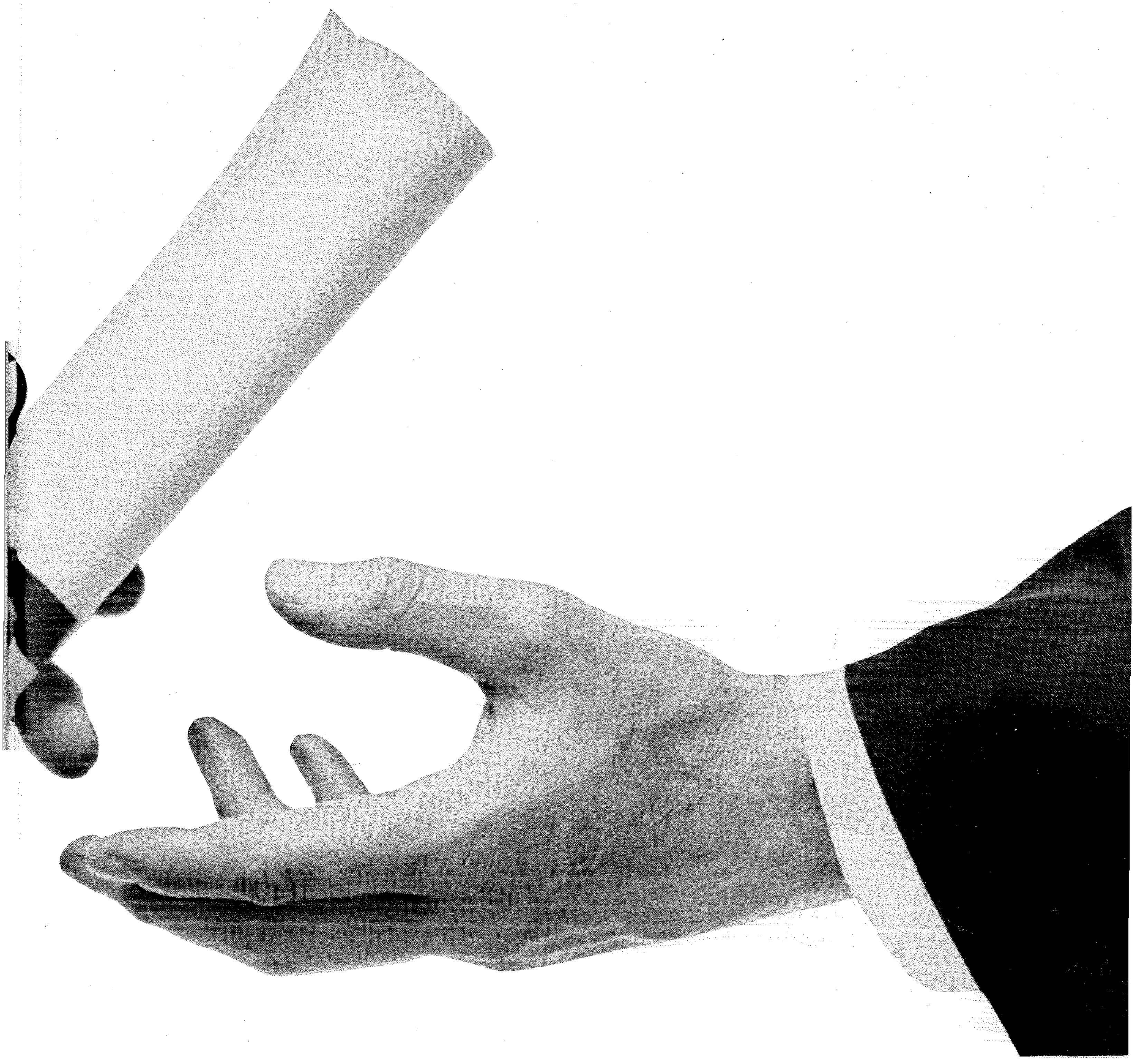


Books

Magnets
Soap Bubbles
The Neutron Story
How Old is the Earth?
Echoes of Bats and Men

Doubleday-Anchor Books . . 95c each

These are the first five paperbacks to be published in a new Science Study Series, "designed to bridge the gap between scientists and laymen." The series is one of the by-products of the work of the Physical Science Study Committee, set up at MIT in 1956 to revise the teaching and study of high-school physics. The committee is writing a new physics textbook, producing a library of classroom films, and designing simple apparatus that can be constructed by teachers and students. The Science Study Series has been conceived as supplementary reading to this program, and about 15 titles will be published every year.

The books are designed for both students and the general public. High school pupils who have these paperbacks forced on them are going to be delighted with most of the books. But the general public, unless it is encouraged to seek them out, is likely to avoid the books because their straightforward titles promise only dry accounts of specialized (even esoteric) fields. But this is far from the fact. *Magnets* and *Soap Bubbles*, in particular, are little masterpieces of popular science writing. *Magnets*, as it turns out, is the absorbing autobiography of a physicist, Francis Bitter. (Now professor of physics at MIT, he was at Caltech on a National Research Fellowship in the late '20s, working under R. A. Millikan on the magnetic properties of gases). *Soap Bubbles* is a charming, and famous, series of talks given by Sir Charles Vernon Boys to an audience of children at the London Institution in 1889 and 1890.

Of the other books, *The Neutron Story* is perhaps the most "difficult." Its author, Donald J. Hughes, is a senior physicist at the Brookhaven National Laboratory. Patrick H. Hurley, author of *How Old is the Earth?*, is a geophysicist at MIT. Donald R. Griffin, who wrote *Echoes of Bats and Men*, has spent most of his scientific career investigating the navigating techniques of animals. He is professor of zoology at Harvard.

Forthcoming titles in this new Science Study Series (in 1960) include *The Physics of Television, Galileo, Crystals and Crystal Growing, Radio Astronomy, The Birth of a New Physics*, and *Waves and the Ear.*

Men and Atoms

by William L. Laurence

Simon & Schuster $4.50

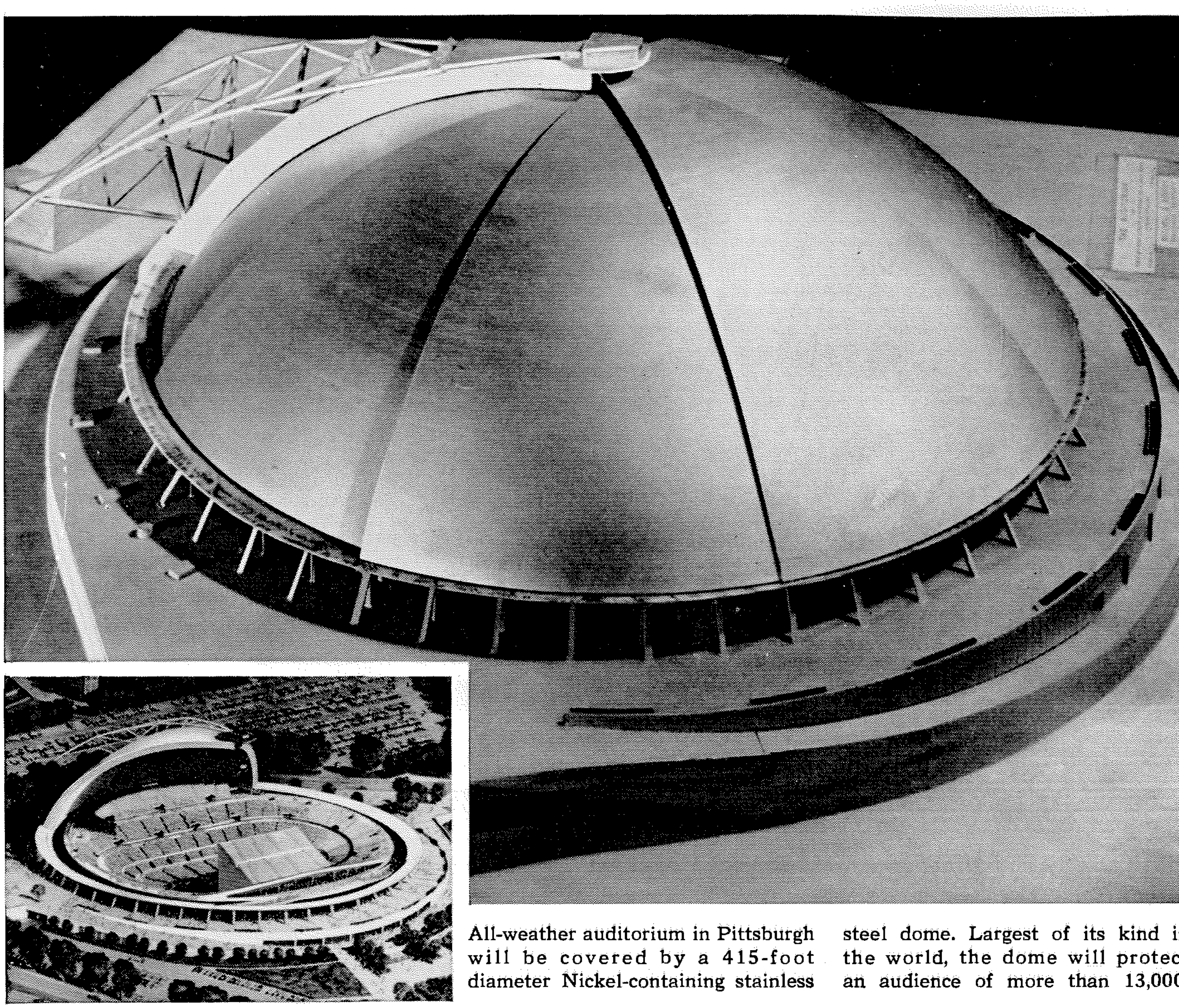
Reviewed by Robert F. Christy, professor of theoretical physics

Mr. William L. Laurence has had almost unparalleled opportunities as a writer in the field of atomic energy. Through his position as science editor of the New York *Times*, he was acquainted with the beginnings of fission work in this country in the New York area. Later, he was chosen as official correspondent in the last stages of the atom bomb project. Since then he has witnessed tests and followed the developments in atomic energy with a tremendous advantage over other writers.

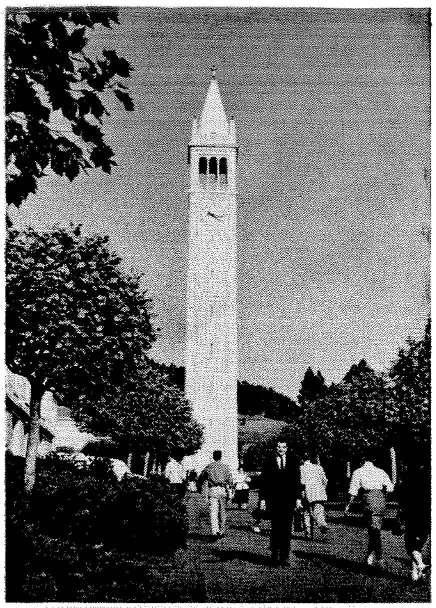
This book, *Men and Atoms*, covers the field of atomic energy from its inception with the discovery of radioactivity by Becquerel, through the discovery of fission by Hahn and Strassman, to the explosion of an H-bomb, and then to a discussion of the aging process in man and the bearing thereon of isotope research. Parts of this wide-ranging story are fascinating, but the book lacks the underlying unity that might tie together what ends up as a strange collection of essays.

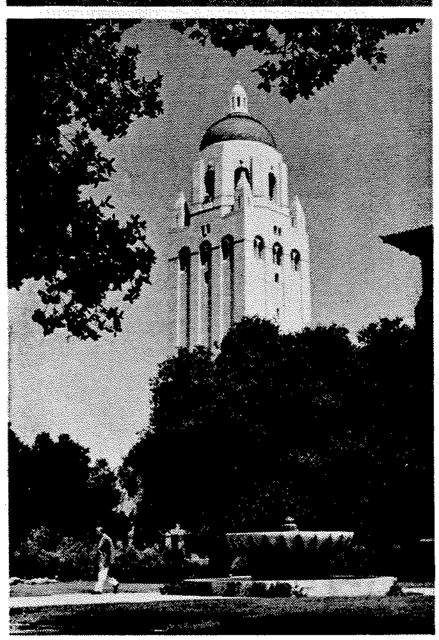
The book starts with the remarkable story of the discovery of fission and the spread of that knowledge around the world. It is on the whole well told and is indeed one of the classic episodes of physics discovery. It tells how Hahn and Strassman tried for years to understand the radioactivities associated with the capture of neutrons by uranium, until they

continued on page 10



An Announcement of Importance to Engineering and Physical Science Majors





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PROJECTS – Current major projects include the Navy POLARIS Fleet Ballistic Missile; the DISCOVERER program; MIDAS and SAMOS; Air Force Q-5 and X-7 and the Army KINGFISHER. PROJECT MIDAS is an early warning infrared system against ballistic missile attacks, based on the use of satellites. PROJECT SAMOS is designed for the development of an advanced satellite reconnaissance system. DISCOVERER, MIDAS, and SAMOS are programs of the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division with Lockheed as systems manager.

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Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA

CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII were finally forced to the conclusion that meant fission. Laurence tells of the spread of this discovery to New York. The reviewer can attest that it was no less exciting on its arrival in Berkeley a few days later.

Atomic energy project

Laurence then tells of the early work in fission in America and the struggling beginnings of the atomic energy project. He was close to these developments and offers some interesting sidelights to the story.

There follows a wonderful action story of the raids on the Norwegian heavy water plants. This, in fact, makes one of the most exciting episodes in the book.

The fact that Laurence had no connection with the most important years in the atom project – the vital and exciting years at Berkeley, Columbia, Chicago, Oak Ridge, Hanford, and Los Alamos – is reflected in the almost entire absence of the 1942-1945 period in the book. This is an unfortunate omission from the point of view of the overall picture, since these were the big years of the project.

The book then returns to episodes that Laurence is best known for – his reporting of the Alamogordo test and of the dropping of bombs on Hiroshima and Nagasaki. These are competently reported by someone who was there. There follows a remarkable chapter – which appears to be based largely on a report of Father Siemes, S. J., who went through it – of the bombing of Hiroshima and its aftermath. The report tells in simple form of the intial explosion, which seemed, in the suburbs, just like a blockbuster going off nearby. The unfolding of the story then shows the slow dawning of the magnitude of the disaster, as it becomes clear that it was not just one house, or just a block, or a neighborhood, or a district, but indeed a whole city that had been engulfed.

The rest of the book seems to lack any coherence whatsoever. One of the best known, and indeed dramatic, stories of the H-bomb development – the arguments and discussions leading to the Oppenheimer hearings – is not even mentioned in Part Two, "The Hydrogen Bomb." Perhaps Laurence was afraid that he would be damned no matter what he said on that subject.

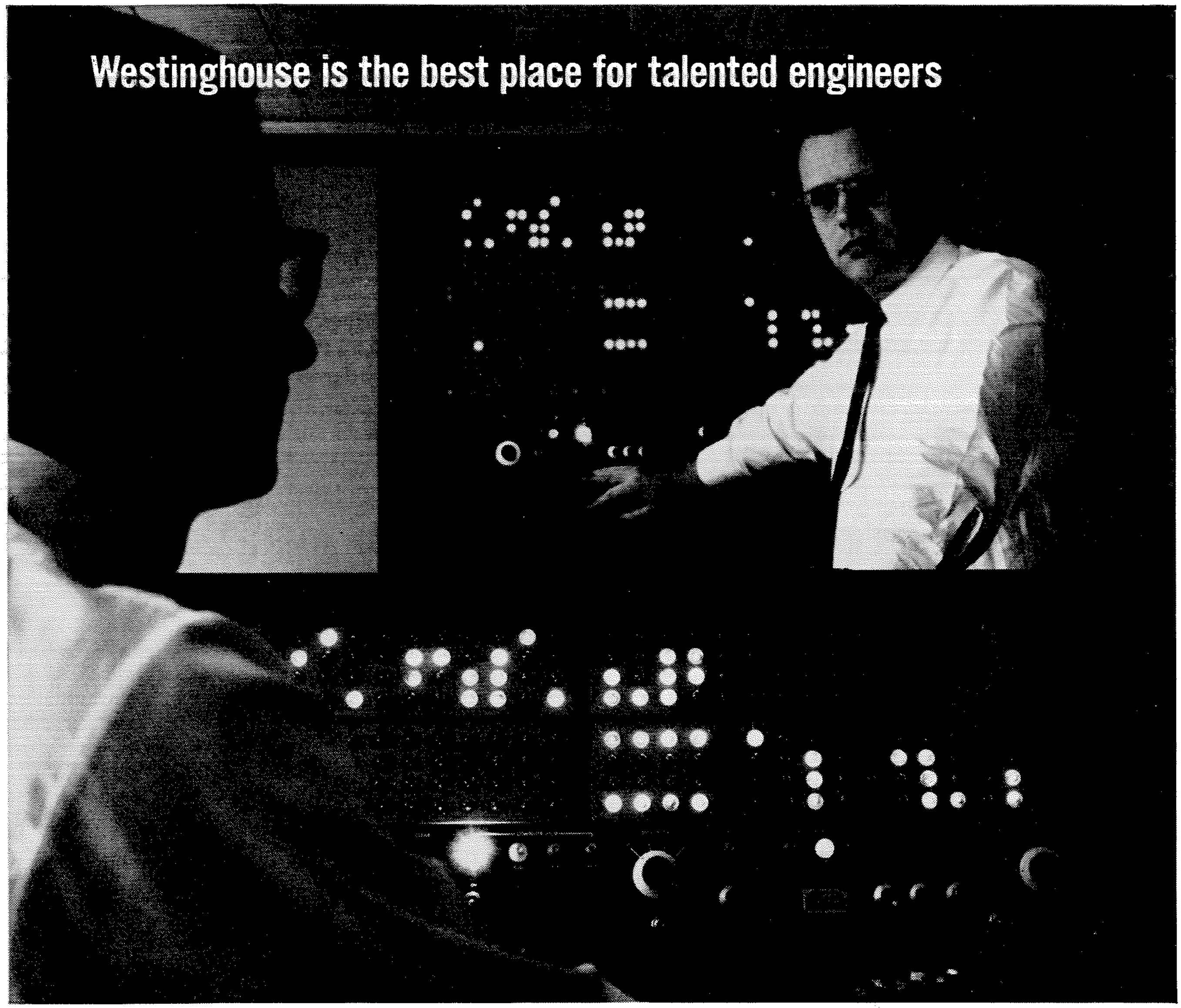
People in science

Part Three seems little more than a collection of essays – on people from the Curies to Einstein – which, although occasionally of interest, don't seem to be tied into the book at all.

Part Four, "Looking Forward," also reads like excerpts from various newspaper stories on the future of atomic energy, rather than the kind of well-organized material one expects to find in a book.

At this point the reviewer broke down and did not read Part Five, "Atomic Primer"–24 pages on the atom according to William L. Laurence.

Robert F. Christy, professor of theoretical physics at Caltech, worked on the atomic energy program at the Los Alamos Scientific Laboratory from 1943 through 1946.



Westinghouse mathematicians Burnham Moffat and Dr. Richard Durstine check on an electronic computer working out solutions to a heat transfer problem for the company's Atomic Power Division.

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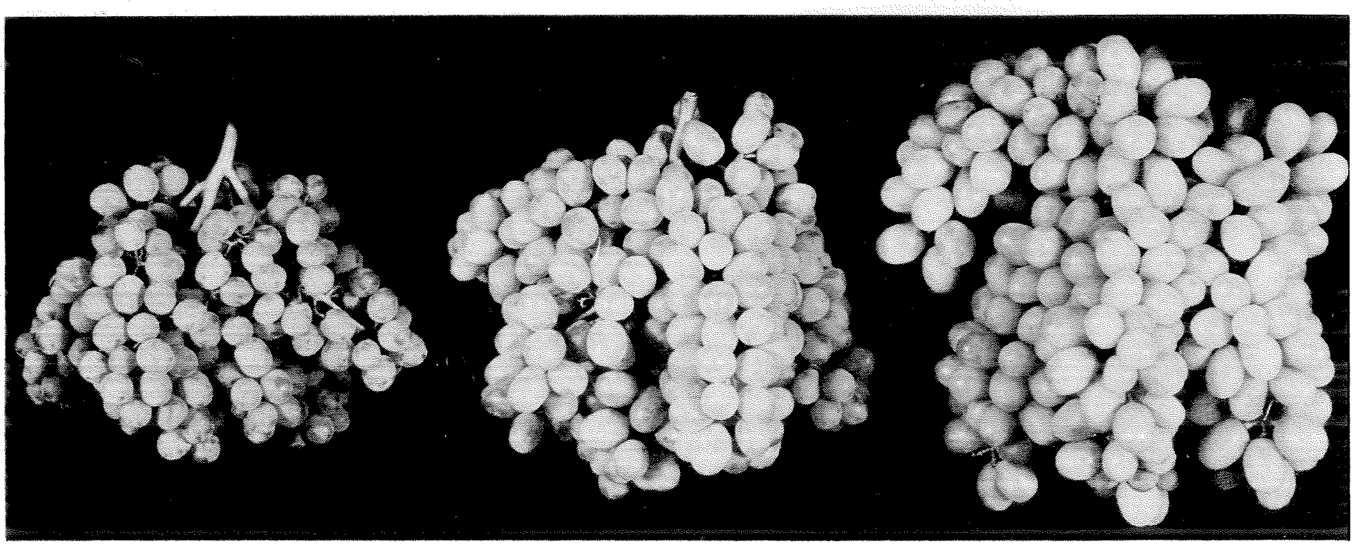


How gibberellin affects Thompson Seedless grapes. The grapes at the left got no gibberellin at all; the center ones were sprayed with 20 parts per million; those at the right with 50 ppm.

Gibberellin — A New Plant Hormone

by James A. Lockhart

One of the knottiest problems of plant physiology has been to explain the peculiar growth of dwarf plants. At one time or another, plant physiologists have attempted to explain it in terms of every known growth factor and metabolic act — and always without success. What seemed to be needed was an entirely new and different plant growth hormone. As it turned out, this hormone had already been found. It was only necessary to recognize it.

Growth of a corn plant may be reduced 80 percent by a defect in only one of the thousands of genes which control its heredity. Among these thousands of genes there are several dozen which must function properly for corn (or other plants) to attain normal size. A malfunction of any one of these genes results in a dwarf plant. The mature, dwarf corn plant may be only a foot high, with almost no stem, short, wide leaves, and an ear three to four inches long with only half a dozen kernels on it. This is certainly not a desirable or useful plant, but for many years plant physiologists have been at a loss to explain the cause of this dwarf growth.

We know that, as a general rule, each gene is responsible for forming one kind of enzyme. Each enzyme, in turn, is required for one step in the pathway of synthesis of one of the many chemical compounds necessary for normal metabolism and growth. Clearly, then, one or more chemical compounds are required — not for respiration, photosynthesis or organ formation, but simply to promote a normal increase in plant size.

In some species of plants — for example, in many deciduous fruit trees — the seeds require a cold treatment consisting of several weeks of low temperature (40-50°F.) before normal germination will occur. It is possible to force these seeds to germinate without a cold treatment, but when this is done the seedlings grow as dwarfs, similar in many respects to dwarf corn. Roots develop normally, leaves grow, but almost no stem elongation occurs and the plant appears as a rosette. As soon as these dwarf tree seedlings are given a cold treatment, stem growth begins and a normal plant results. This is a "physiological" dwarf — a plant which remains dwarfed until a certain temperature requirement is fulfilled. Here again, though, plant physiologists had no idea what the cold treatment supplied to the plant.

Another example of growth restriction and control is related to flowering in many long-day and biennial plants. In early spring or fall, when the days are short, long-day plants grow as rosettes. They form many leaves, but they have no stems and do not flower. During May and June, when day length is longest, these plants send up stems or flower stalks which bear flowers and fruits. Biennial plants generally grow in a similar fashion, but they form flowering stalks only after exposure to several weeks of cold weather. In some plants, day length may instead control vegetative stem growth. Many bushes and trees become dormant in the fall because of the shortening day length. They will resume growth only when the day length again becomes long in the spring.

Light may also inhibit stem growth. When seeds, tubers and bulbs germinate in complete darkness, the stem grows extremely rapidly and soon becomes very long and thin. Everyone has seen examples of this, as when potatoes or onions sprout in a closet or cupboard. In these dark places, stems become extremely long and spindly — while if these same plants were grown in sunlight, the stems would be short and stocky. Light is, of course, necessary for photosynthesis, and plants growing in darkness die when they exhaust the reserve food stored in the seed or tuber. In the meantime, however, they grow very rapidly. Some growth factor — probably a hormone — seemed to be involved here, too, but workers were unable then to gain an insight into the nature of this hormone.

Again and again, simple environmental factors exert an astonishing control over the type and extent of plant growth. The question plant physiologists ask is: How does the plant convert an environmental stimulus into a growth response?

Foolish seedling

While plant physiologists throughout the world were puzzling over these problems involving stem growth, a number of plant pathologists and biochemists in Japan were struggling with what appeared to be a completely unrelated problem. This was the "Bakanae" disease of rice. "Bakanae" means foolish seedling, so called because rice seedlings infected with this disease grow much faster and taller than normal plants. The seriousness of the disease lies in the fact that many seedlings die before forming grain, while the rest give very low yields.

It was only after a great deal of difficulty that K. Sawada and his student, E. Kurosawa, working at the Taiwan (Formosa) Agricultural Experiment Station in 1924, were able to demonstrate that the disease was caused by a fungus, *Gibberella fujikuri.* Soon after, in 1926, Kurosawa reported that the disease symptoms could be produced equally well by a culture solution in which the fungus had previously grown. Thus, the active principle causing overgrowth of rice had been extracted from the fungus.

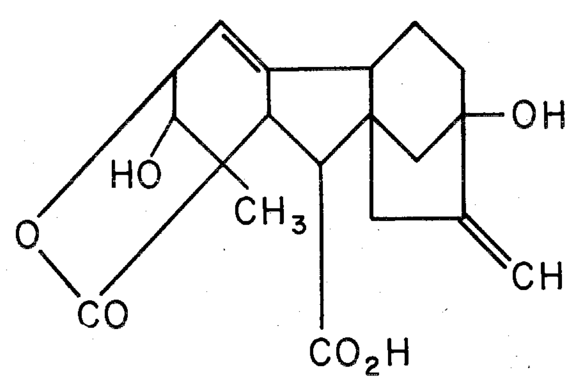
Kurosawa, as well as a group from Hokkaido University, soon demonstrated that the active principle was a small organic molecule. A group of chemists from the University of Tokyo, headed by Professor Yabuta, immediately took up the problem of purifying and identifying the active chemical. This proved to be a long and arduous task. Since much larger quantities of material were needed for purification, the Tokyo group had to work out a quantitative bioassay, then establish cultural conditions for maximum yields from the fungus, and solve other technical problems.

Isolation of gibberellin

Chief among these problems was the fact that the fungus also produced a potent plant growth inhibitor. In fact, the disease caused by *Gibberella* is sometimes characterized by growth inhibition rather than by overgrowth, a fact which created considerable confusion when Sawada and Kurosawa were trying to identify the organism which caused the disease. By 1934, Yabuta's group had identified the inhibitor and named it fusaric acid (5-n-butylpicolinic acid). They systematically developed a procedure for isolating the growth-promoting substance which is used, with only minor modifications, throughout the world today. In 1938, Yabuta and Sumiki announced the isolation of two crystalline, biologically active materials which they named gibberellins A and B.

Today, we know of five different gibberellins, differing only slightly, chemically and biologically. The structure of gibberellin A_3, the one most studied so far, is illustrated below. In general, the other gibberellins differ from gibberellin A_3 only in having different numbers of double-bonds. Two of them (gibberellins A_1 and A_5) have so far been isolated from higher plants.

Anyone familiar with the principles of organic chemistry will recognize that gibberellin A_3 has eight asymmetric carbon atoms. This means that an ordinary organic synthesis of this compound will yield 256 different compounds with the same basic struc-



Tentative structure proposed for gibberellin A_3 worked out by Professor Sumiki and his group at the University of Tokyo, and also by organic chemists at Imperial Chemical Industries in Great Britain.

ture, only one of which will be the same as the natural compound. No one knows yet how many of these compounds will have biological activity. But judging from previous experience with isomers of this kind, it may be expected that only a few will have the expected activity. Thus, gibberellin will be produced commercially by the fungus for a long time to come. However, synthesis and separation of the isomers might yield compounds with new and interesting activities.

Gibberellin in the West

When the first gibberellins were isolated, the quantities available to Japanese plant physiologists were very small, and tests of the effects of gibberellin on higher plants were limited. Gibberellins were observed to have marked growth-promoting effects on many higher plants, but no real hint of their subsequent importance was found. Due partly to the limited number of scientists in Europe and America who read Japanese, and partly to the wartime interruption of the normal flow of scientific literature, relatively little was known about gibberellin in the West until about 1950.

Investigations by plant pathologists in both the U.S. and Great Britain started at that time. However, physiologists in the West only became interested in gibberellin with the publication of a paper in 1955 by a group from Imperial Chemical Industries in Great Britain, headed by the plant pathologist, Dr. P. W. Brian. This work demonstrated that growth rate of dwarf pea plants was increased 5-6 times by gibberellin treatment, while gibberellin treatment of tall (non-dwarf) peas had relatively little effect. Here, then, published in one of the world's outstanding plant physiology journals (*Physiologia Plantarum,* journal of the Scandinavian Society of Plant Physiology) was a striking indication that this new growth-promoting substance was, in fact, of direct natural significance for higher plants. It appeared to be able to change the growth habit of peas from dwarf to normal.

Immediately, Professor B. O. Phinney, at UCLA, who had been working for several years on the problem of dwarf mutants, began investigations on the physiological significance of gibberellin which were to prove conclusively that gibberellin would completely and quantitatively restore a genetic dwarf to a normal plant. Phinney had inbred a large number of single-gene dwarf mutants of corn until he had genetic lines identical except for the single gene for dwarfness. Now he treated the dwarf plants periodically with gibberellin, and his highest hopes were realized. With proper gibberellin treatment, dwarf plants could not be distinguished from normal ones.

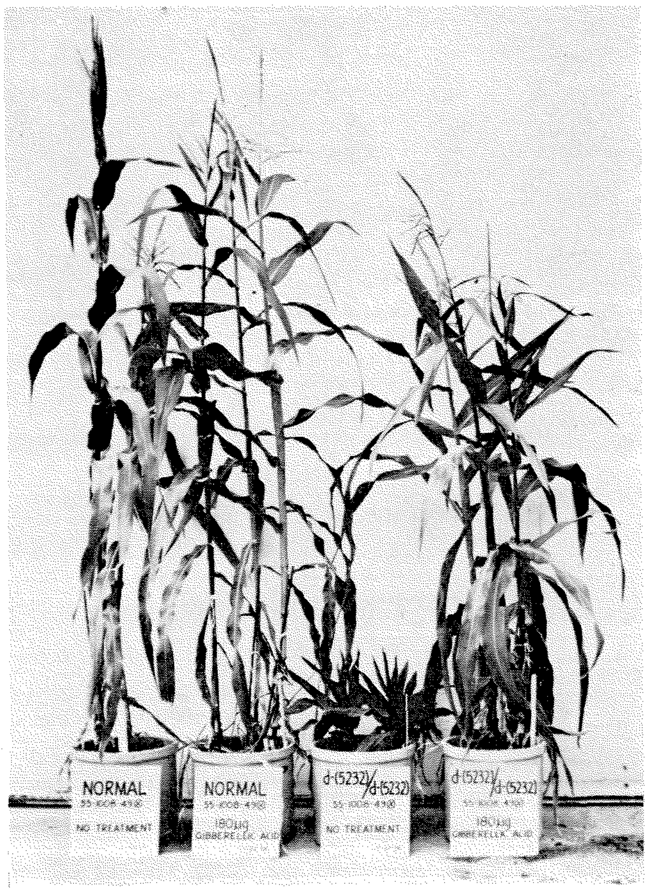
Gibberellin, then, could completely overcome the dwarf character and restore plants to normal growth. Genetically identical normal plants provided a quantitative measure of what the normal should look like. Thus, gibberellin application completely replaced the factor present in normal plants, but lacking in dwarfs, which was responsible for dwarf growth.

Carrots must be grown in low temperatures before they will flower. The rosette plant at the left has not been exposed to low temperatures; the flowering plant at the right has. The center plant was simply treated with gibberellin, which completely replaces low temperature in the carrot.

Flowering biennials

And now the rush was on. One of the major contributors to recent research in the field has been Anton Lang, who came to Caltech this fall from UCLA, as professor of biology. Professor Lang had long been interested in the problem of flowering in biennial plants; he had, in fact, published his first paper on the subject as early as 1939. Since flowering of biennial and long-day plants is characterized by a rapid concurrent elongation of the stem, Lang decided to find out whether gibberellin would induce flowering of these plants without the usual cold (or long-day) treatment. Again success.

In many species, the presently known gibberellins are fully as effective as the most favorable environment, but further work has shown that gibberellin will not always — or not completely — replace the effects of the long-day or cold requirement. Similarly Phinney found that gibberellin A_3 would correct the



Corn plants showing the different effects of gibberellin on normal plants and dwarf mutants. Gibberellin has little effect on normal plants (left), but the dwarf mutant on the right shows a complete conversion to normal as a result of the gibberellin.

dwarf habit of only 5 of 11 genetic dwarfs of corn.

While Lang and Phinney were doing this work, Dr. Lela Barton, at the Boyce Thompson Institute in New York, was examining the effect of gibberellin on physiological dwarfs — germinated seeds of apple which had not been given a cold treatment. She found that here, too, added gibberellin would completely replace the cold treatment and promote normal stem growth in these plants. It appears, then, that a natural gibberellin hormone must accumulate in those plants which require cold for normal development.

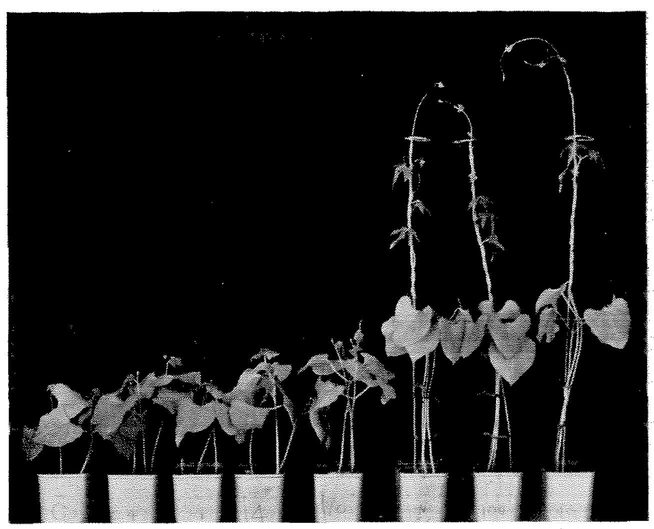
At the same time Caltech investigations were showing that gibberellin affected light inhibition of stem growth. It was easy to show that pea seedlings grown in light and treated with gibberellin would grow just as tall as if they had been grown in complete darkness. Adding gibberellin to dark-grown plants had no effect on growth. These results suggested that light was destroying some naturally-occurring gibberellin in the plant.

Gibberellin is indeed a natural hormone of higher plants. As soon as plant physiologists knew what to look for, it was relatively easy to find gibberellins in higher plants. This was first reported by Dr. Margaret Radley, working with Brian at Imperial Chemical Industries, and, soon after, Phinney and his students reported the extraction of substances with gibberellin activity from some 23 species of higher plants. Earlier workers had extracted gibberellin from higher plants occasionally, but it was not recognized at the time that these active extracts contained activity different from the known growth hormone — auxin.

Chemically, gibberellin and auxin are quite different, and yet they are both organic acids of relatively small molecular weight with generally similar solubilities. Thus, the crude purifications usually used in biological studies would not separate the two hormones. Some of their biological properties are also similar. Work in Caltech's Division of Biology showed that gibberellin, like auxin, is produced in the stem tip and they both move down the stem to the growing region. Furthermore, gibberellin, like auxin, acts primarily on the cell wall, increasing the plasticity of the cell wall and in this way permitting greater stem elongation. However, it is very easy to distinguish the two known plant growth hormones, auxin and gibberellin, by their various physiological activities:

	Auxin	*Gibberellin*
Site of production	tip	tip
Primary activity	cell wall	cell wall
Cure dwarfism	−	+
Reverse light inhibition	−	+
Replace vernalization	−	+
Promote flowering of long-day plants	−	+
Prevent abscission of leaves	+	−
Maintain apical dominance	+	−
High concentrations inhibitory	+	−
Cause curvatures, e.g., in Avena	+	−

In the past, plant physiologists attempted to explain dwarf growth and many other physiological responses in terms of the action of auxin. Correlations were



Bean plants are fast growers, but gibberellin will markedly stimulate growth even in these plants. The one at the left is untreated; the rest have received varying amounts of gibberellin up to 1/300,000 ounces.

often found between auxin and growth responses, but few causal relations could be demonstrated. It is now clear that both gibberellin and auxin must be present for normal stem growth. Auxin, due to the unique transport system by which it moves through the plant, is utilized for tropic responses, i.e., bending of the stem toward light (phototropism) and bending away from – or toward – the force of gravity (geotropism). Gibberellin, on the other hand, appears to be used for control of many of the development processes which take place in plants, as described here.

Here, in the last four years, is one of the most exciting chapters in the history of plant physiology, comparable only to the years immediately following the discovery of the first plant growth hormone – auxin – by Dr. Frits Went in 1928. Thus, a major step has been taken in the understanding of not one, but several, of the major subjects of plant physiology research in a single flurry of discovery. For the first time, we have the beginning of an insight into the general nature of the hormonal control of developmental processes in plants.

Frenzied activity

Since these basic physiological discoveries were reported, literally hundreds of agricultural workers have sprayed, poured, dipped and dusted gibberellin on thousands and thousands of plants. One of the reasons that gibberellin is so popular is that almost any plant will show a marked response to gibberellin treatment. Furthermore, it is nearly impossible to injure most species, no matter how much is applied. Thus, experiments with gibberellin are almost always a "success," and no one knows how many thousands of plants have been measured, weighed, cut up, and each individual part measured and weighed again. It is, of course, always possible that something of interest or practical use will come of this frenzied activity.

Naturally, many other excellent plant physiologists, horticulturists, and other plant investigators throughout the world are contributing greatly to our understanding of the gibberellins. In this, as in most other work which develops completely new insights into wide fields of research, no one person can be singled out as being the discoverer. The efforts of many workers – those mentioned here and many others as well – made possible the understanding that has been achieved in this new field.

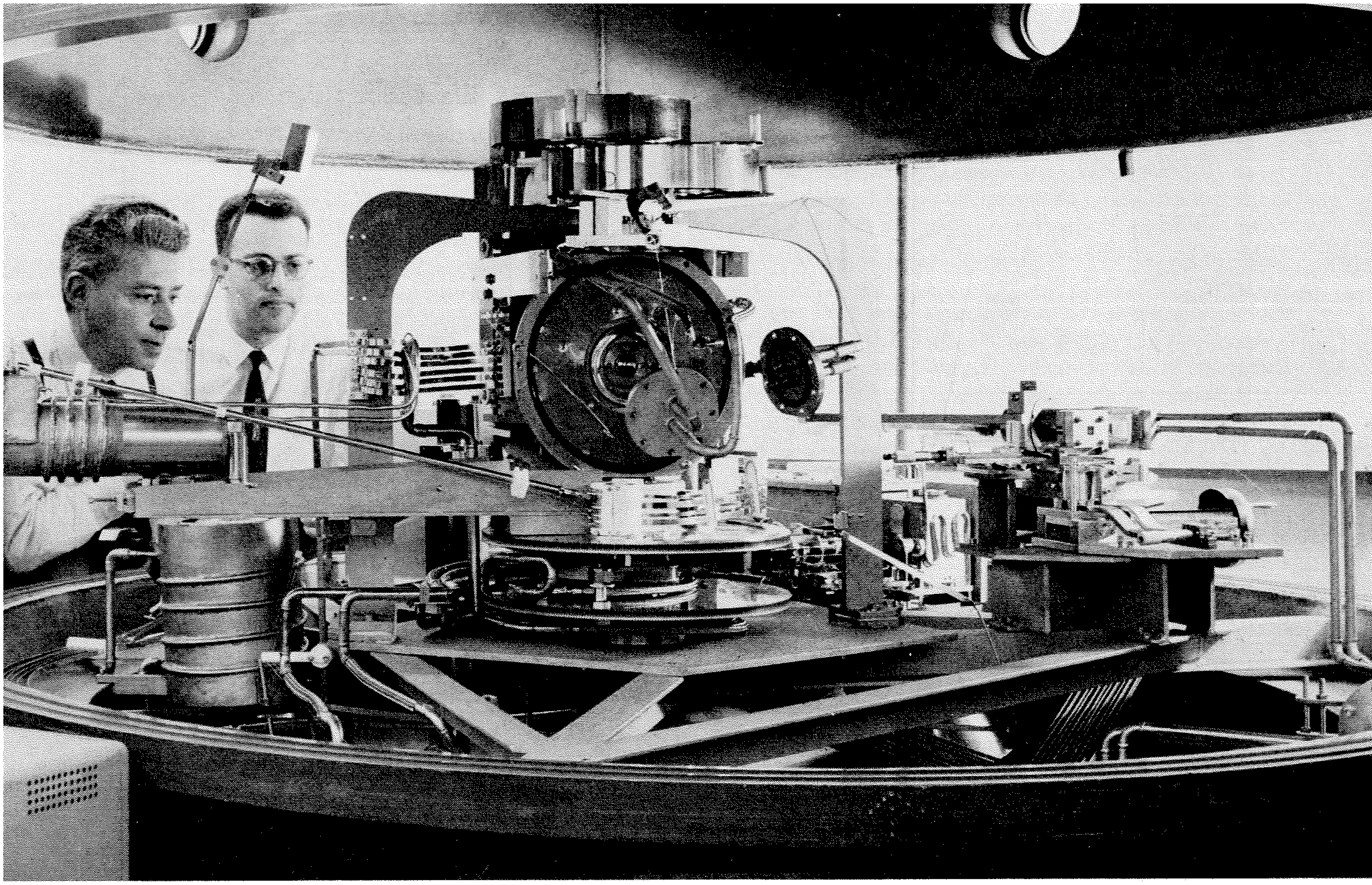
What of the practical uses of this great discovery? Mostly, they are yet to come. Some of the largest chemical companies in many countries – especially those with experience in the fermentation processes necessary to grow the gibberellin-producing fungus – have initiated programs to study production and uses of gibberellin. And it was, of course, Imperial Chemical Industries in Great Britain which was responsible for the breakthrough which started this flood of knowledge and understanding. But, in spite of some of the most extensive applied research programs in the history of the agricultural chemicals industry, commercial applications of gibberellin to agriculture have so far been limited. One worries whether the failure to find immediate large-scale commercial uses of gibberellin may jeopardize further large-scale research in this field.

One of the most successful applications so far involves spraying grapes, especially the Thompson Seedless variety. Gibberellin has been found to loosen the naturally tight bunches, and this actually results in larger fruit and bigger bunches. The next time you eat Thompson Seedless grapes, see if the individual fruit doesn't look more elongate and less nearly spherical than it did two to three years ago. This is a good indication that gibberellin helped to grow bigger grapes. (Since gibberellin is a natural product found, probably, in all plant products, it certainly cannot injure people at the levels used.)

This use on grapes, however, is of only minor importance compared to what has been visualized by many people for the future. It was 10 or 15 years before the discovery of auxin led to the commercial weed-killers of today, but now the agricultural chemical industry which grew from this discovery amounts to many millions of dollars a year. It may well be that in another 10 years an equally unexpected but revolutionary use for gibberellin will be helping agriculture to new highs of productivity.

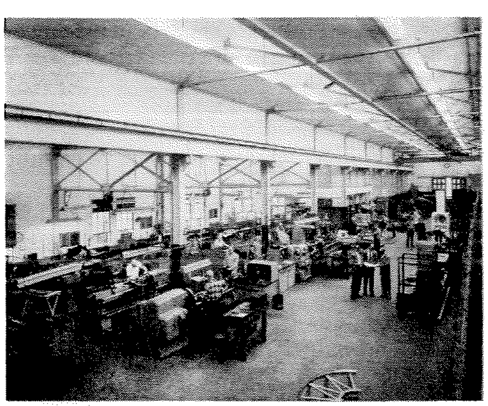
Chronological History of the Discovery of the Gibberellins

1924	Kurosawa and Sawada demonstrated that the fungus *Gibberella Fujikuri* was the casual agent of "Bakanae" disease of rice.
1926	Kurosawa showed that the active principle causing disease symptoms could be extracted from the fungus.
1934	Yabuta and his group identified fusaric acid, a growth inhibitor also produced by fungus.
1938	Yabuta and Sumiki crystallized two biologically active materials and named them gibberellin A and B.
1950	Work on isolation of gibberellin begun at U.S. Department of Agriculture and Imperial Chemical Industries.
1955	Publication of paper by Brian and Hemming on the effects of gibberellin on dwarf peas.
1956	Phinney reported complete reversal of dwarf habit in single-gene mutants of corn by gibberellin.
1956	Lockhart reported reversal of light inhibition of stem growth by gibberellin.
1956	Lang reported induction of flowering in biennial plant without a cold treatment by gibberellin.
1956	Barton reported reversal of dwarf growth habit of non-cold-treated seeds by gibberellin.
1956	Radley reported extraction of gibberellin-like compounds from pea seedlings.
1956	Lona reported induction of vegetative growth in a tree on short-days by gibberellin.



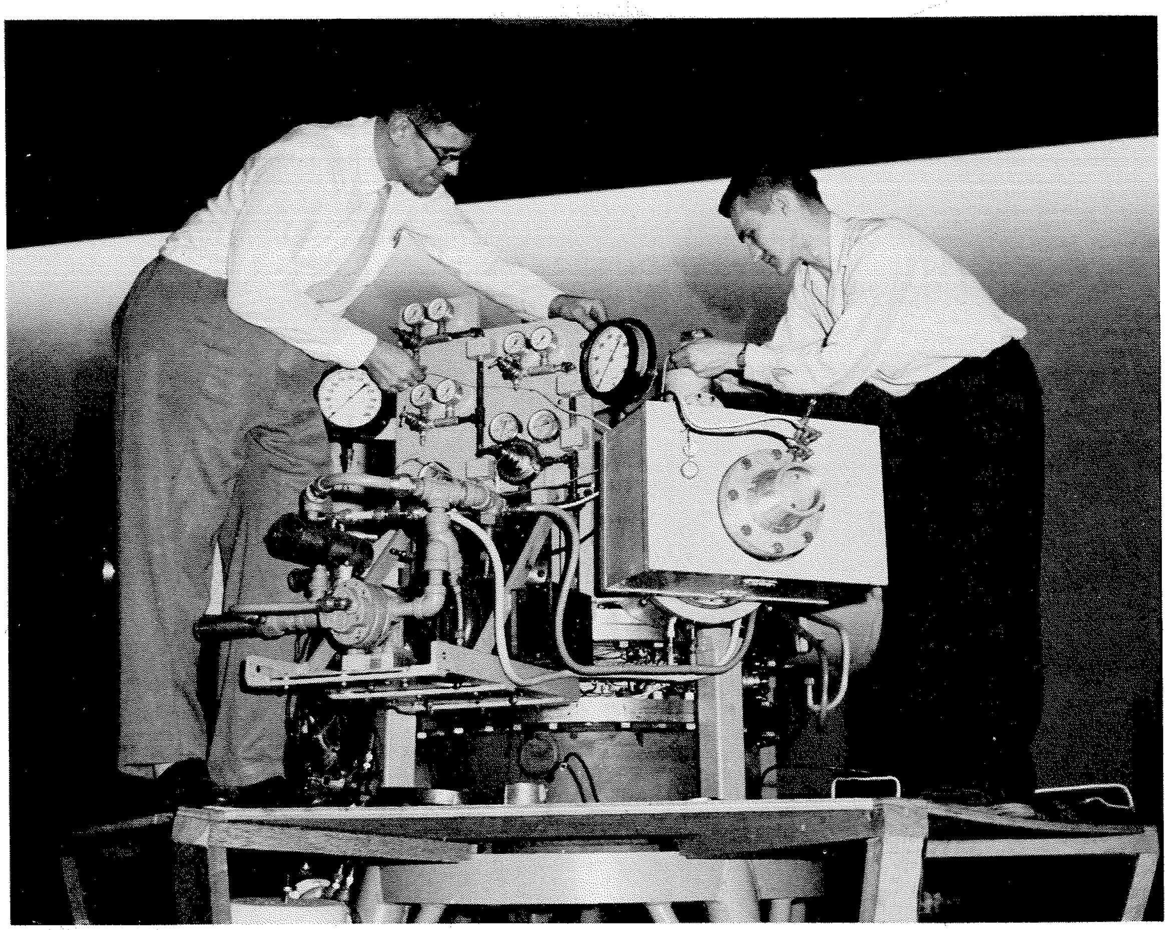
Caltech's new high temperature x-ray spectrometer analyzes the atomic structure of space-age metals. Pol Duwez, professor of mechanical engineering (left), and graduate student Ronald Willens, designed it. CES built it.

Big Business on Campus

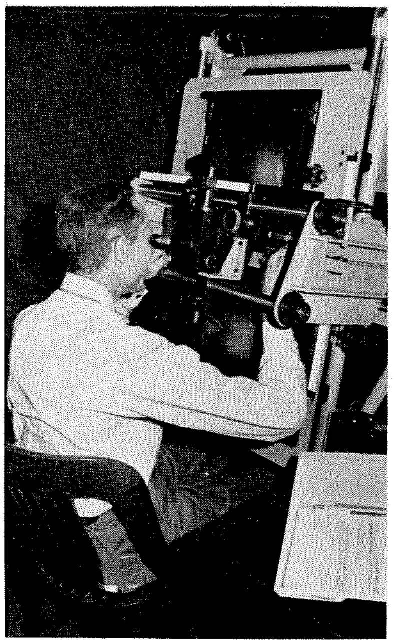


Scientific research calls for a steady flow of original and intricate equipment – most of which must be newly cre-ted. In fact, Caltech has had to create a separate unit to keep the Institute's countless research projects supplied with this necessary equipment. This unique organization, Central Engineering Services, was originally formed to design and build Palomar's 200-inch telescope in the early thirties. Today, it has grown into a \$175,000-a-year business. Some of the equipment it makes is so effective that other universities and research institutes ask for duplicates. On these pages, a sampling of some of the original instruments designed and built in Central Engineering Services.

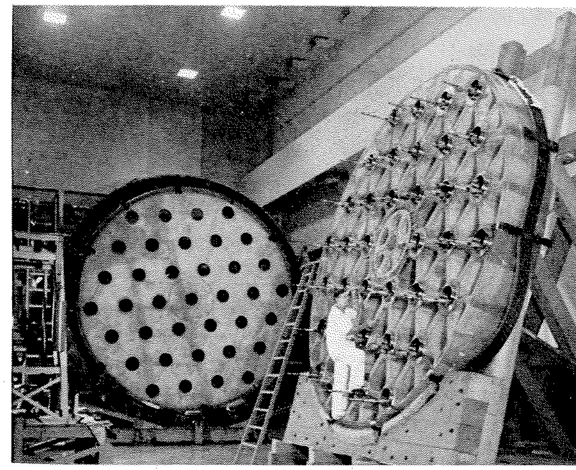
Bruce Rule (center), director of Central Engineering Services, and co-workers gingerly handle a block of fragile crystal. This will eventually be a part of a Cerenkov counter which detects high energy particles.



John Teem, senior research fellow in physics, and research assistant Joe Mullins operate a new bubble chamber which receives x-ray pulses from the Caltech synchrotron and photographs the tracks of pi and k mesons.



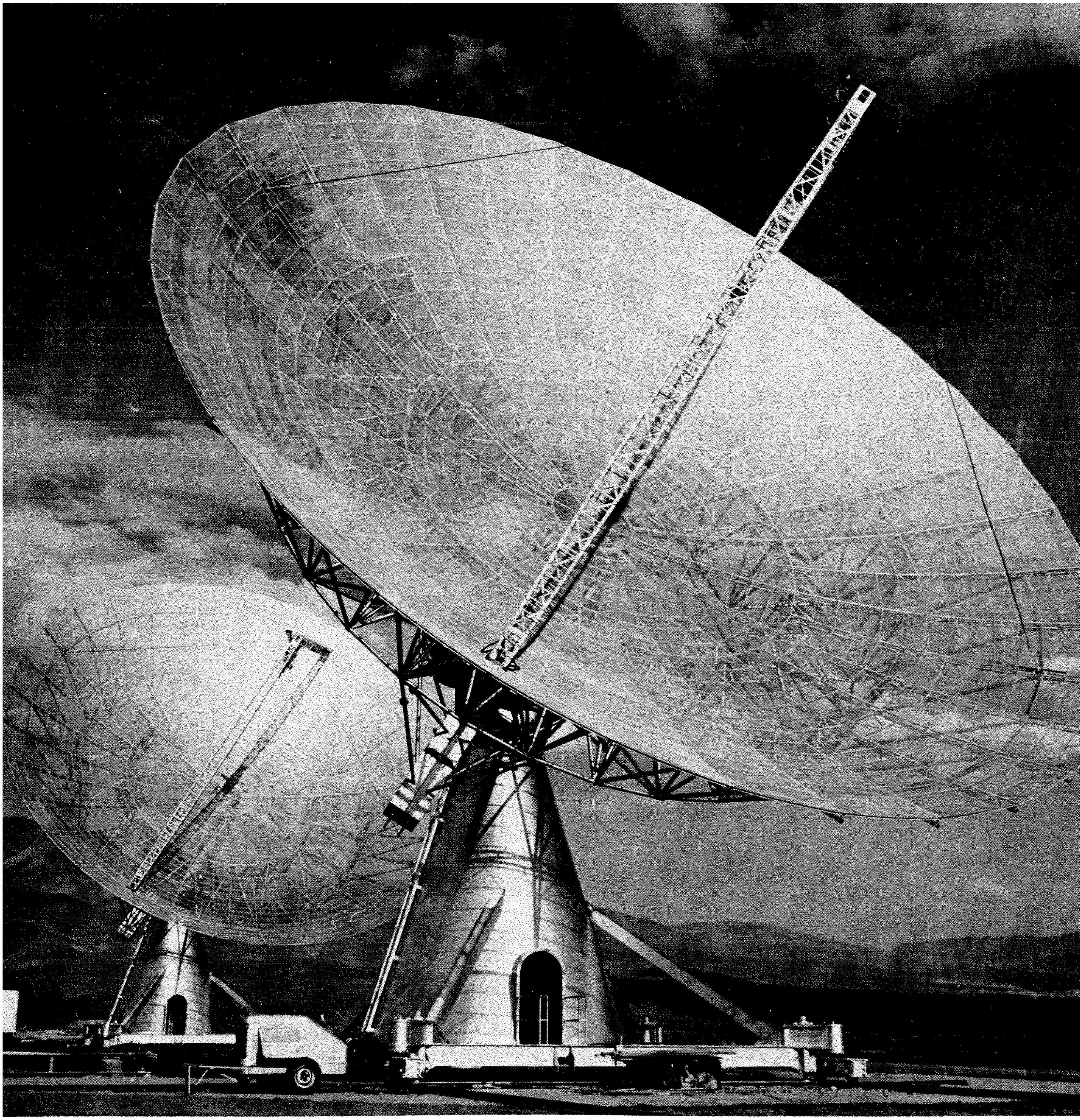
An astronomer uses the blink comparator, a viewing device which allows comparison of an old and a new picture of one astronomical field. This is how supernovae and other astronomical phenomena are found.



CES's first job – designing and building the 200-inch Palomar telescope.

Fred Birri, superintendent; Frank Tennant, precision machinist; and Robert Harrington, engineer-designer, examine a new CES instrument. This is a dual viscometer, which measures the viscosity of liquids used in basic studies of hydrodynamics.

Thomas Shortridge, precision machinist, shapes a piece of lucite for use as an x-ray beam catcher for the synchrotron.



At Caltech's new radio astronomy installation in Bishop, California, giant reflectors receive radio signals from space. All control apparatus, tracking equipment, timing mechanisms and differential drives for the project were built by Central Engineering Services. Original specifications were set up by John G. Bolton, professor of radio astronomy; and Bruce Rule, chief engineer of the radio astronomy project.

The spiral galaxy, NGC 4725, photographed by the 100-inch telescope at Mt. Wilson. The picture on the left shows the galaxy before the supernova explosion. At right the arrow indicates the supernova.

Search for Supernovae

by Fritz Zwicky

Supernovae are cosmic explosions which, at maximum brightness, radiate away as much energy every day (in the form of light and corpuscular radiation) as the sun does in a hundred million years.

Studies of these phenomena may be of great importance for views on the evolution of stars and stellar systems, the nature of neutron stars, and the origin of cosmic rays. Also, there is the possibility that data on supernovae may be used to calibrate distances to the very periphery of the visible universe.

The original supernova search began at Caltech in 1933 and continued until 1942, when the war – and the work load – forced its abandonment. In 1956 it was decided to renew the search for supernovae through the cooperative effort of several observatories, such as Palomar, Lick, and Steward in this country, and Berne in Switzerland. This international enterprise, of which I am director, is largely financed by funds from the National Science Foundation and from the Swiss National Science Fund.

From this combined effort, a dozen supernovae have been found in the last few years. (Only about 60 have been recorded in history.) Two of the most important ones were discovered by a collaborator in my group, Dr. M. L. Humason (who retired in June 1957 as a staff member of the Mount Wilson and Palomar Observatories).

Existence of the supernova phenomenon was first clearly proved from observations at the Palomar Observatory in 1937, with the aid of the 18-inch Schmidt telescope. With this instrument, specifically built for the supernova search, Dr. J. J. Johnson (then research fellow in astrophysics) and I, discovered 19 supernovae in the period from September 1936 to January 1942. This investigation showed that, on the average, one supernova flares up in a normal galaxy about once in 360 years.

It was also found, from the analysis of the light curves and of the spectra, that there are several types of supernovae. The two most prominent are designated as types I and II.

Perhaps the most important result to come from this study was the conclusion, drawn first in 1937 (long before the H-bomb experiments) that the supernova phenomenon is caused by a stupendous *nuclear fusion chain reaction.*

Data on supernovae may be used to calibrate distances to the very periphery of the visible universe

Type I supernovae are the brightest known so far. Their spectra, which consist of ill-defined bands, have completely defied interpretation in spite of concerted efforts by the world's best spectroscopists. This failure to understand the origin of even one single feature in the spectrum of the brightest supernovae is one of the reasons the search for supernovae was resumed a few years ago.

In some cases the decline in luminosity (as seen in blue light only) of type I supernovae is approximately exponential for periods of several hundred days, starting from 50 to 100 days after maximum. This means that the photographic magnitude increases linearly with time.

During the past few years, some observers have published data indicating that the photographic brightness of supernovae of type I, regardless of absolute brightness, declines by one magnitude every 52 days. This supposition induced a number of investigators to propose that the light curves of supernovae of type I can be explained by assuming that the decay of some radioactive isotope (Californium 254, for instance) is responsible for the emission of light by the gas clouds expelled by the supernova. This theory has proved to be incorrect because the decay rates of supernovae of type I, found so far, are not all the same; they lie in the range from 28 to 52 days.

From our extended search with the 18-inch Schmidt telescope on Palomar Mountain, between 1936 and 1941, it was found that supernovae of type II are intrinsically fainter than those of type I. In contradistinction to the spectra of those of type I, the spectra of type II supernovae seem to show considerable similarity with the spectra of some of the common novae. In fact, Dr. R. L. Minkowski (staff member of the Mount Wilson and Palomar Observatories) obtained strong evidence, from the widths of the emission lines of hydrogen, that gas clouds are being ejected with velocities between 5000 and 7000 km/sec.

Two new supernovae

The first of the two important new supernovae discovered by Dr. Humason last June appeared next to a spiral arm, and slightly within an absorbing lane, of the giant spiral galaxy, NGC 7331. This object is probably the brightest supernovae of type II ever found. Its apparent magnitude was +12.5 and its absolute photographic magnitude was estimated as about −17 (or about 600 millions times brighter than the sun).

Fortunately, Dr. J. L. Greenstein (Caltech professor of astrophysics and staff member of the Mount Wilson and Palomar Observatories) and Dr. Minkowski were at hand to repeatedly photograph the spectrum of this explosion. As a result of their efforts, it was clearly established that the spectrum is actually similar to that of some common novae – as Minkowski's spectra had indicated 20 years ago. The gas clouds, which are ejected at a velocity of about 6000 km/sec instead of only 1000 km/sec – as in common novae – seem to be of unexpectedly large mass.

Contrary evidence

Also, not only were the emission lines of the Balmer series of hydrogen photographed, but emission lines of other elements such as helium and highly ionized carbon could be identified as well. There is no indication, however, that heavier elements were ejected in any great abundance, which is clearly contrary to the idea advocated by Professor Fred Hoyle (now visiting professor of astronomy at Caltech, from Cambridge University) and others, that supernovae populate interstellar space with the heavier elements.

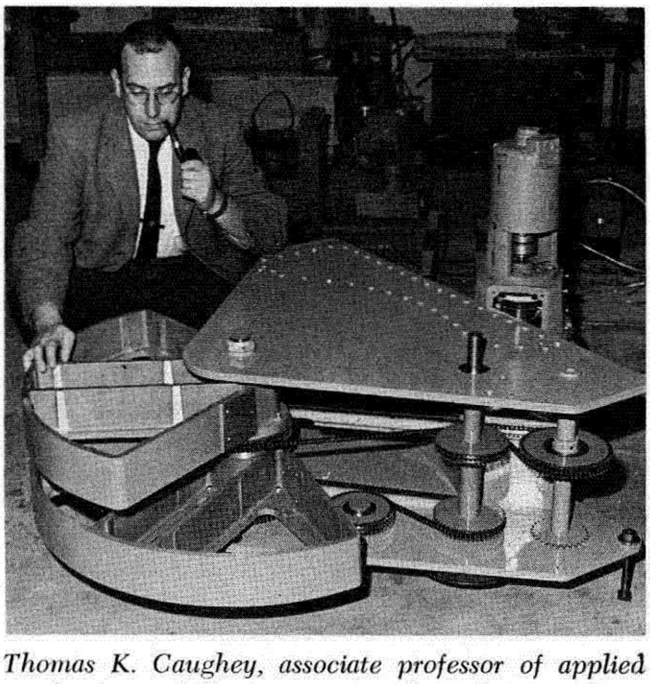
The second bright supernova discovered by Dr. Humason made its appearance in an open barred spiral galaxy which may be a member of the large Virgo cluster of galaxies. This supernova was of type I and, spectacularly enough, at maximum it was several times as bright as the entire galaxy of stars in which it occurred. Its apparent photographic magnitude at maximum was about +13.5.

The two newly discovered supernovae have temporarily disappeared from sight. Early in 1960, when the respective constellations come into reach of our telescopes again, we hope to be able to photograph them at later stages of their development. Then we may be able to determine the physical characteristics of the tail ends of their light curves by photographing them in several colors. This should enable us to establish the necessary data for the use of supernovae as distance indicators to the most remote parts of the universe which can be reached with present telescopic equipment.

Earthquakes to Order

Because nature only comes up with the genuine article at rare intervals, Caltech engineers have now designed a machine that will manufacture earthquakes on demand. When it is placed in a building, this instrument can shake and crack the structure with all the violence of a natural quake. And by cracking some real buildings under controlled conditions, the Caltech engineers hope to produce information that will lead to practical, economical designs for buildings, dams and bridges that can withstand earthquakes without damage.

Because of the wide demand for this information in countries where earthquakes are prevalent, scientists from Japan, India, Argentina and Chile are co-operating on this research in the Caltech earthquake engineering laboratories. The work is under the direction of George W. Housner, professor of civil engineering and applied mechanics; and Donald E. Hudson, professor of mechanical engineering. The project is sponsored by the Earthquake Engineering Research Institute, a nationwide non-profit agency composed of engineers and scientists and headed by Dr. Housner, under a contract with the California State Department of Architecture.



Thomas K. Caughey, associate professor of applied mechanics, and the new earthquake-making machine.

The CSDA's chief concern is with public school buildings. Many school buildings in California do not conform to earthquake codes, though they are still in use because school building programs haven't caught up with the population growth.

The shake-making machine is small compared with the formidable quake it can produce. It is compact enough to carry through doorways — with help. It weighs about 500 pounds, including its 1½-horsepower motor. The shaking is produced by a pair of 20-inch swing boxes that counter-rotate unbalanced amounts of lead weights horizontally. Up to 400 pounds of the weights can be packed into each box. The boxes swing between heavy triangular steel plates, 46 inches long by 26 inches on the shorter two sides. The 15-inch-high assembly is bolted to the floor.

Varying the quakes

The ability to vary the weights in the boxes and to regulate the speed of the rotations between four and five hundred revolutions per minute makes it possible to produce quakes of varying magnitudes. The direction of the shaking is also controlled. The machines can be used singly or in teams on each floor of a building to produce motions in various phase relations.

Present plans call for constructing four of the machines, which were designed by Dino Morelli, associate professor of mechanical engineering. Thomas K. Caughey, associate professor of applied mechanics, devised the electrical design.

Drs. Hudson and Housner are now looking for a building in which to give the device a shakedown test. The ideal situation for testing the machine and for producing earthquake engineering data would be the erection of a test building about 20 feet square and 40 to 50 feet high. Such a structure would require only a steel framework and floor slabs.

Additional work is planned on other buildings, such as commercial structures or warehouses scheduled to be torn down on freeway clearance projects.

With data produced by the vibrator, and by some 100 small seismographs that are being installed in Los Angeles and San Francisco, Drs. Hudson and Housner hope to develop quake-resistant designs for structures, and to help produce sound building codes in areas subject to earthquakes.

The Month at Caltech

Caltech on the Air

Caltech's 1959-60 series of radio programs, "Atomic Age Answers," can now be heard on Wednesdays from 7:05 to 7:30 p.m. on KFI, Los Angeles. Programs coming up include:

November 18—
"The San Andreas Fault and What a Geologist Does."
Clarence Allen, associate professor of geology.

November 25—
"Techniques Involved in Modern Geology. Methods of Determining the Age of Rocks."
Charles McKinney, senior research fellow in geology.

December 2—
"Neuron Pathways of the Brain. Brain Mechanisms."
Roger Sperry, professor of biology.

December 9—
"The New ONR Tandem Electrostatic Accelerator at Caltech."
Ward Whaling, associate professor of physics.

December 16—
"An Astronomer at Work."
Halton C. Arp, staff member of Mt. Wilson and Palomar Observatories.

December 23—
"Genetics"
George Beadle, chairman of the Division of Biological Sciences.

December 30—
"The Many Facets of Chemical Engineering."
George Neal Richter, assistant professor of chemical engineering.

January 6—
"Disappearing Boundaries Between the Basic Sciences."
Norman Davidson, professor of chemistry.

Ford Foundation Grant

Caltech has received a grant of $3,200,000 from the Ford Foundation for the advancement of engineering education. The grant was part of $19,050,000 which will go to 10 educational institutions in the Foundation's new program in support of science and engineering.

The grants have two objectives: to help promote excellence on engineering faculties, both by additional training of present faculties and by recruiting and development of increased numbers of well trained engineering teachers; and to support promising plans for the development of imaginative educational programs. The Caltech grant is to be used over a period of 10 to 15 years.

Of the total amount, $800,000, together with the 10-to-15-year income from it, will be used for salaries for four new senior professorships in engineering.

Approximately $900,000, plus income, will be used for salaries or salary supplements for a minimum of seven additional assistant and associate professorships.

Approximately $800,000, plus income, will provide salaries for senior positions for four or five key professors now on the engineering faculty.

Approximately $500,000, plus income, will be used to provide or construct equipment needed for faculty or graduate research in engineering.

An additional $100,000 is earmarked for use over a period of one to three years, for fellowships and loans to graduate students: $75,000 is allocated to provide travel and study opportunities for faculty members at the Institute; and $25,000 will cover costs of faculty members from sister institutions who come to Caltech to study.

Honors and Awards

Norman H. Brooks, associate professor of civil engineering, has won two 1959 awards of the American Society of Civil Engineers for his paper on "Mechanics of Streams with Movable Beds of Fine Sand," the J. C. Stevens Award and the Collingwood Prize for Junior Members, each consisting of a cash award and a certificate.

President DuBridge received the Arthur R. Berman Human Relations Award on October 19 at a ceremony in the Pasadena Jewish Temple and Center. The award is presented annually by the Pasadena Lodge of B'nai B'rith to a member of the community who, in public or private life, has made a significant contribution to the betterment of human relations in the community or in the nation.

Renato Dulbecco, professor of biology, and Dr. Marguerite Vogt, senior research fellow in biology, have received the $1,000 Kimble Methodology Research Award for their technique that speeds up both research and control of virus diseases. The award is sponsored by the Kimble Glass Company, an Owens-Illinois subsidiary. The Dulbecco-Vogt technique uses animal tissue, instead of the entire animal, in virus research.

Wesley L. Hershey, executive secretary of the Caltech YMCA, has been elected national president of the Student YMCA Secretaries Association. During his three-year term, he will head a professional staff of more than 100,000 members.

Lester Lees, professor of aeronautics, will receive a Fellow Membership in the American Rocket Society at their 14th annual meeting in Washington, D.C., November 16-20. The award is given in recognition of his outstanding contributions to aeronautics and space technology.

Milton Plesset, professor of applied mechanics; and Frank Press, director of the Caltech Seismological Laboratory, have been appointed by Governor Edmund G. Brown to the scientific advisory committee of California's new office of Atomic Energy Development and Radiation Protection.

Bruce H. Sage, professor of chemical engineering, will receive the 1959 William H. Walker Award of the American Institute of Chemical Engineers at the 52nd annual meeting of the Institute in San Francisco, December 6-9. The award has been made each year since 1936 to some of the nation's outstanding chemical engineers for authorship of important papers.

Hallett D. Smith, chairman of the Humanities Division, has been appointed a Phi Beta Kappa Visiting Scholar for the 1959-60 academic year. The appointment involves appearances for lectures and informal talks at eight colleges and universities that have chapters of the national scholarship fraternity.

Undergraduate Chemical Engineering

Caltech is offering an undergraduate program in chemical engineering for the first time this year. In the past, undergraduates interested in this field majored in applied chemistry; chemical engineering courses were available only at the graduate level.

This change has been made possible by several curriculum changes, including the introduction of rigorous quantitative analysis in the freshman year. Both chemistry and chemical engineering students now complete their basic organic chemistry by the end of the junior year, making it possible for them to include several chemical engineering courses in the junior and senior years. The new program is also facilitated by an increase in the professional staff and an expansion of laboratory facilities.

Josef J. Johnson

Josef J. Johnson, research associate in astrophysics at Caltech from 1935 to 1952, died of cerebral thrombosis at his home in Pasadena on September 30. He had been retired from the Institute since 1952 because of ill health. Dr. Johnson was a graduate of Caltech (BS '30, PhD '35) and received an MS from Ohio Wesleyan. His particular interests in astrophysics were the observation of solar eclipses, theories of the solar corona, and studies of spiral nebulae.

Paul Perigord

Paul Perigord, who was professor of European history at Caltech from 1919 to 1924, died on November 4 at his home in Palisades, N. Y. Dr. Perigord was a graduate of the University of Toulouse and received his PhD from the University of Minnesota. In 1924 he left Caltech to become professor of French Civilization at UCLA.

Space Science Research Conference

Caltech and JPL exchange ideas in a new field of research

by Henry L. Richter, Jr.

As a sign of the times, a new weekly seminar has been added to the list of regular academic activities. The establishment of the Space Science Research Conference is a direct result of the interest on the part of both faculty and students in this new and expensive research activity. It is also an indication of the ever-closer association between the Jet Propulsion Laboratory and the Institute. As far as we know, this is the first organized seminar of its type at any American academic institution.

Until the influence of the IGY programs, and with the exception of some upper atmosphere rocket research work, the bulk of American rocketry has been shielded from the public view by military secrecy. Even the contacts between the Caltech campus and JPL have been restricted in recent years by the military nature of much of the work at the Lab. But since JPL's participation in the launching and instrumenting of the Explorer satellites – and particularly since JPL was transferred to the National Aeronautics and Space Administration – the work at the Lab has been approaching that of scientific and supporting research.

It seems logical that, along with the Laboratory's proven ability as a maker of rocket and satellite vehicles, many of the fundamental experiments in space research should be carried out by JPL personnel working in conjunction with scientists and engineers on the Caltech campus. A space science division has recently been formed at JPL, to work with interested persons on campus and elsewhere in the carrying out of space, planetary and lunar exploration.

It seemed that one method of strengthening the contact between those at JPL and the campus would be the establishment of a regular weekly research conference in which both groups could participate and exchange ideas. A committee was appointed to plan and oversee the Space Science Research Conference, consisting of Albert R. Hibbs (Chairman) and Henry L. Richter, Jr., from JPL; and R. B. Leighton and Harrison S. Brown, representing the campus.

A series of lectures has been scheduled for the first ten meetings; these are aimed toward two goals. One is the dissemination and discussion of the results obtained from scientific experiments carried aboard spacecraft. The second is to expose people who have been sheltered from the limitations and constraints imposed on spaceborne instruments to the factors that must be considered when planning, designing or constructing instruments for space research; or when interpreting scientific data received from instruments carried in such vehicles. Every effort is going to be made to avoid describing our glorious plans for the future.

The first seminar consisted of a discussion of the purposes of the Space Science Research Conference, and a summary of the scientific spacecraft launched to date, along with the instruments known to be aboard each. Subsequent and future seminars for the first quarter include:

October 13	Rolf Dyce Stanford University	Radiation Around the Earth
October 20	Eberhardt Rechtin JPL	Space Communications
October 27	Harrison S. Brown Caltech	Meteorites and Their Properties (I)
November 3	Harrison S. Brown	Meteorites and Their Properties (II)
November 10	L. G. Jacchia Smithsonian Astrophysical Observatory	Solar Radiation and the Atmospheric Drag of Artificial Satellites
November 17	H. C. Urey University of California, La Jolla	Problems of Lunar Structure
November 18	H. C. Urey	Some Chemical and Physical Properties of the Meteorites
November 19	H. C. Urey	Some Observations on the Origin of the Solar System
November 24	G. Kuiper Yerkes Observatory	Moon
December 1	Open	Satellite Geodesy
December 8	R. Richardson Griffith Observatory	Mars

THE STUDENT HOUSES

— The last chance to observe the old order?

The opinions expressed in this article are those of the author; they are not an expression of editorial opinion by Engineering and Science. *All complaints and comments should be addressed to the author c/o* E & S – *Ed.*

The atmosphere that has confined rivalry between the Houses in recent years to organized competitions, semi-subtle political machinations, and private conversations has also resulted in a lack of open criticism. Although everyone is eager to point up the separate identity of each House, few are willing to proceed to concrete descriptions. With three new Houses in the works, this may be the last chance to observe the old order.

Life at Caltech centers about the four Student Houses. (The official "four Student Houses and Throop Club" is a diplomatic fiction that extends little beyond the structures of interhouse government.) Sharing some of the characteristics of fraternities, dormitories, and eating clubs, the Houses share little else. Meals are served from a central kitchen, but each House has its own physical appearance, symbols, traditions, behaviors and attitudes.

Though the Houses were established at Caltech in the early thirties, it was not until after World War II, and a period of general reorganization, that each House became interested in some particular element of its pre-war tradition and proceeded to develop this element into a full-fledged basic principle. Social evolution has carried things to the point where now the character of each House – from campaign issues to off-campus behavior – is influenced by a single fundamental concept.

Blacker

The least restrictive of House fundamentals is Blacker's "individualism." Its main purpose is to rule against any action even remotely akin to social pressure. In this way, the individual is assured of expression, and the advantages thereof may be enjoyed by all. Unfortunately, the desire to be different often finds expression before one's individuality has developed. As a result, Blacker is uniformly nonconformist, exerting a militant social pressure to stamp out all other social pressures. Instead of producing a greater concentration of creative persons, this environment is inclined to inhibit their appearance and growth. Thus, when a worthwhile person does turn up in Blacker, he must be a truly capable individual to have pushed his way through the confused clutter of common Blacker men.

To the other Houses, Blacker represents a homogeneous group of Nebbish-like creatures, all looking somewhat alike (usually barefoot and unshaven) and seldom doing anything of note. By design, Blacker is not a House. It is just a group of guys who happen to live together.

Reform movements have never made significant gains in Blacker. Its leaders have always found enough "House spirit" to hold things together in spite of the conflict with basic doctrine. But many are the times when a little more unity would have been enough to put Blacker on top. And last year's revolt and consequent banishment of Hell Alley may have shaken foundations sufficiently to cause an overall reappraisal. The other Houses will concede that Blacker has the greatest amount of untapped potential. So, if an internal policy change *is* in the offing, this may really be the year to "look out for Blacker."

Ricketts

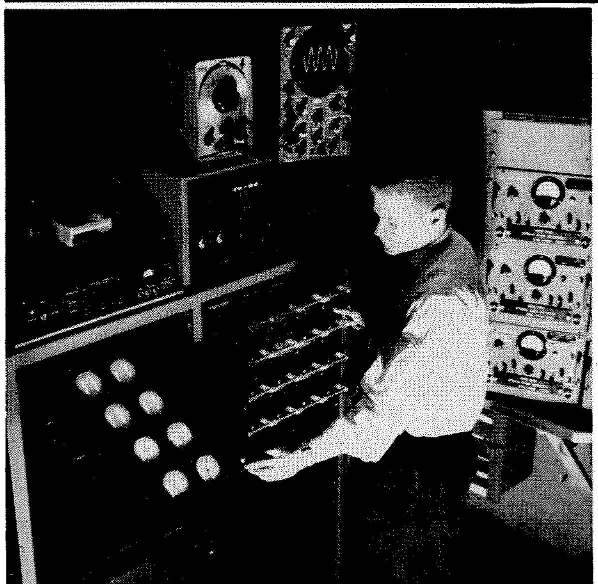
For as long as any of them have been at Tech, members of the other Houses have been predicting the decline of Ricketts. As soon as the first trophy leaves, spectators begin to gather to witness the fall. But the mild skid is usually followed by an overwhelming comeback that sends the crowds reeling home to cry in their beer and ask, "How do they do it?"

Two interconnected ideals enable Ricketts to attract bright and shiny young frosh to the Land of Millikan's Pot. The first is the basic idea of the "Ricketts Rowdy." The second is the guarded tra-

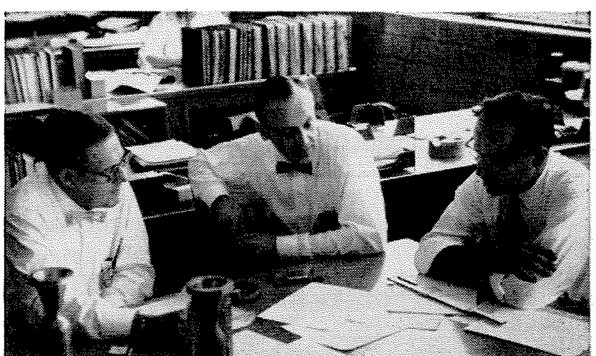
continued on page 34

engineers

and what they do



Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.



Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

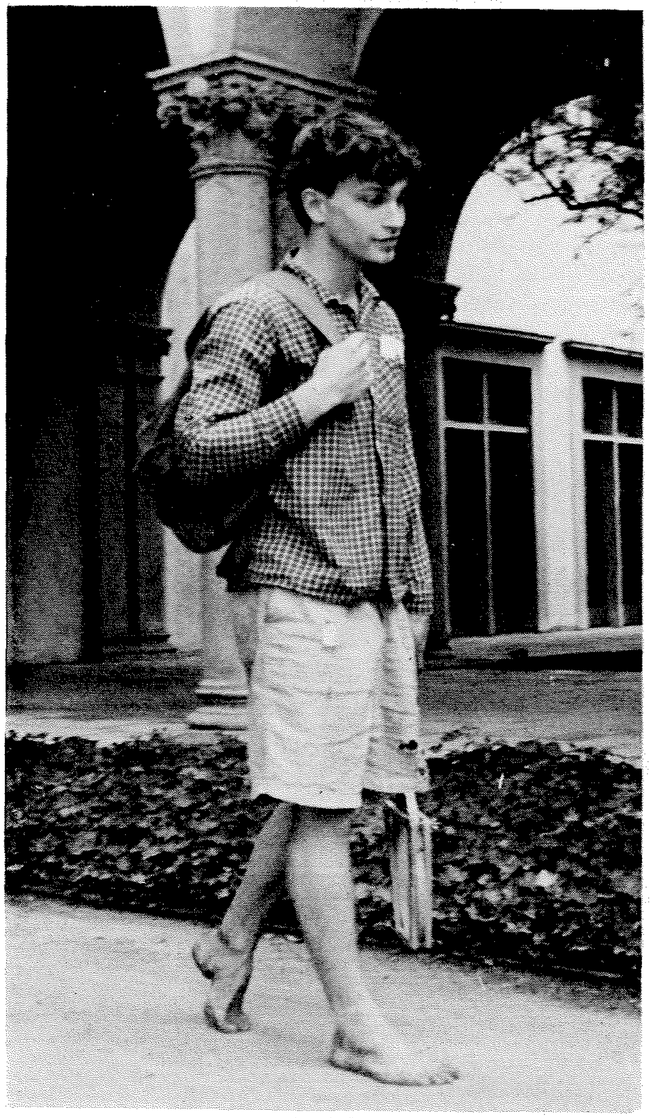
Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.



Blacker individual.

dition of "The House of Politicians." These phrases embody two cherished aims of almost every new college student – and particularly of new Techmen.

High school seniors enter college filled with visions of college pranks, gleaned from the reminiscences of parents and teachers, and the pages of the *Saturday Evening Post*. And the lad who comes to Tech is *especially* ready to be Joe College after having had to be a good boy in high school.

Then there is the political prospect. The new Techman was either president and/or chairman of everything in his school – or else he was little noticed outside of the Chess Club. Both types come to Tech with ideas of easy political conquests at a school where most people are too busy studying to run for anything. So much for science-fiction.

The "rowdy" feeling is adaptable to many forms and varying degrees, and is therefore easy to live with. But the politics angle is a constant source of friction. A large portion of Ricketts House is thoroughly uninterested in politics, and the constant emphasis on same leaves them cold. Defeated candidates make up another large portion of the House.

Although less sharply defined now, the three social strata of Ricketts House are just as important as when they formed a few years ago. The Outs are such a large minority that they take pride in their status and strive to remain "out of it" at all costs. The Ins, on the other hand, find it all the more necessary to be in things if they are to maintain any feeling of confidence in the face of the exuberant spirit displayed by the Outs. The third group, known as the Straw Hat Set, consists of rebels dissatisfied with the cheap contrivances of the Ins, yet too proud to be "out of it." So they go in for carefully chosen

Fleming diners.

activities in a most devoted manner, and remain out of things not up to their standards. The members of this group no longer wear their straw hats, but their superior nature is still to be detected.

Let no one say Ricketts is divided; outside competition is sufficient to keep the three groups united and strong. But if the other Houses could conceivably ignore Ricketts for a time, the spectators would really be treated to a spectacle; Ricketts is not split – but the strain gages are being worked overtime.

Dabney

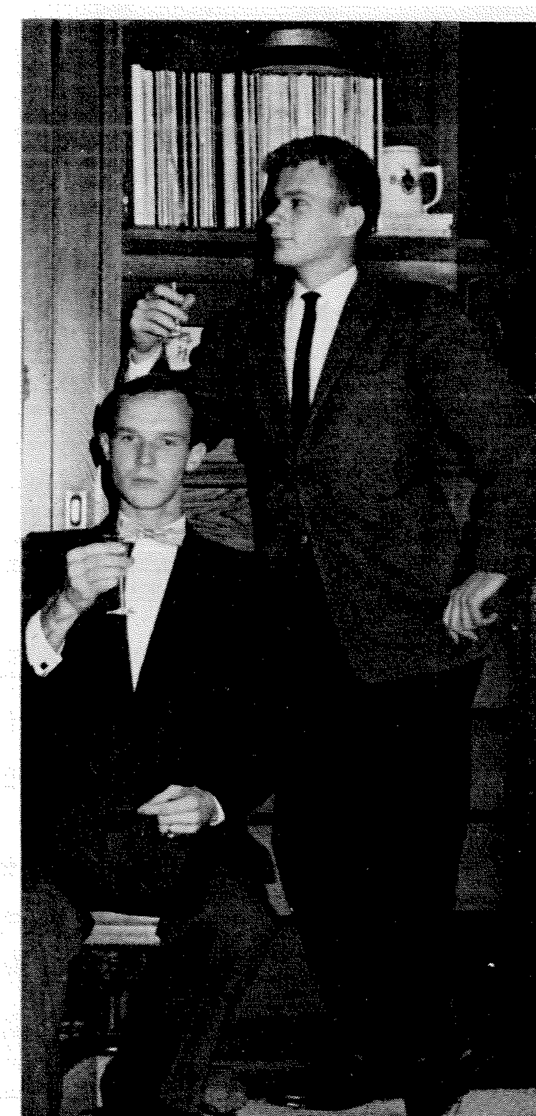
Members of Dabney have frequently seemed somewhat aloof to the men in the other Houses. This is because Dabney men are often preoccupied with internal issues. Their most common controversy is the abstract principle that is Dabney's tradition: "Dabney is the House of Gentlemen."

The range of opinion on this type of ideal is extreme. The crux of the controversy is where to draw the line between acceptable social conduct and having a good time. Darbs don't like to be labeled prudes, yet they are determined to display a degree of courtesy that is higher than the Caltech norm.

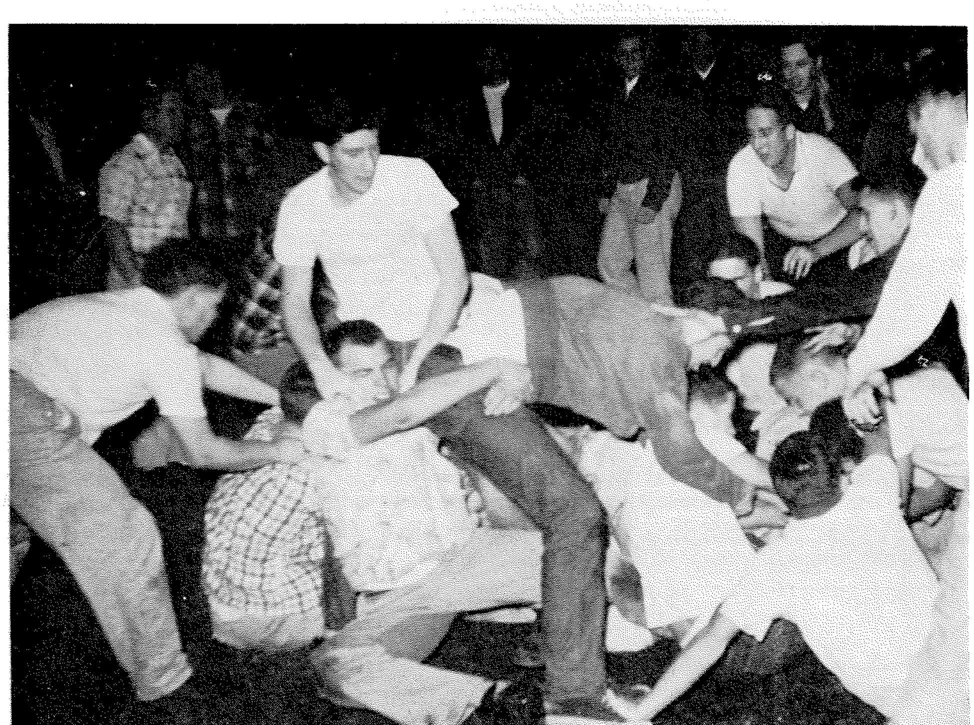
The issue is further confused by a slight feeling of inferiority, brought on by the fact that Dabney is smaller than the other Houses by 20 to 25 members. Feeling an extra need to guarantee House unity, members try to maintain a greater than normal number of contacts within the House, and the usual group formation along lines of common interests is consequently diluted.

This hyper-desire for unity is behind the effort to

continued on page 38



Dabney gentlemen.

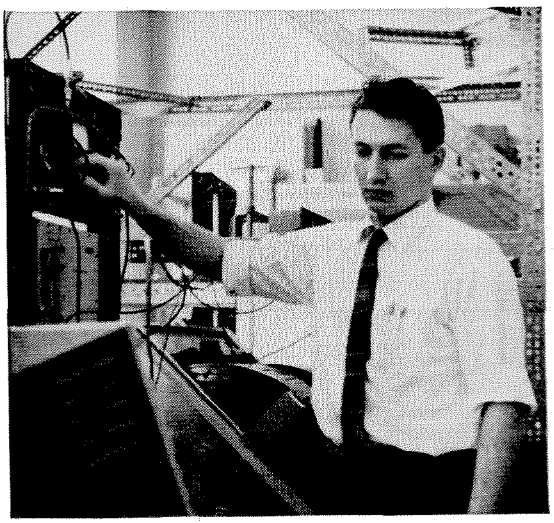


Ricketts rowdies.

Basic Research at IBM

A day at the laboratory

IBM scientist Gerald Burns studies ferroelectrics to improve understanding of their basic properties.



A basic research project

"I'm using nuclear resonance to explore ferroelectrics," says IBM scientist Gerald Burns. "We're trying to discover how the ions in a ferroelectric crystal are arranged, and why and how they change position and structure with temperature changes. Ferroelectric crystals have a reversible spontaneous polarization . . . that is, they can be polarized in either of two directions, and, by the application of an electric field, polarization can be reversed."

How did Gerry Burns come to work on this problem? "I started this particular research project because it was related to other work I had been doing and I felt it would prove challenging and rewarding. Little is known about what goes on in a ferroelectric crystal—or why. Our basic objectives are to find out *what* and *why.*

"At the planning stage, the project seemed to offer a great research potential, but none of us was sure how long the project might last or what its ramifications might eventually be. It's a good example of the basic research done at IBM."

A day at the laboratory

One of the eight scientists in the Ferroelectric Research Group, 26-year-old Gerald Burns began a recent day by setting up equipment for the first daily run.

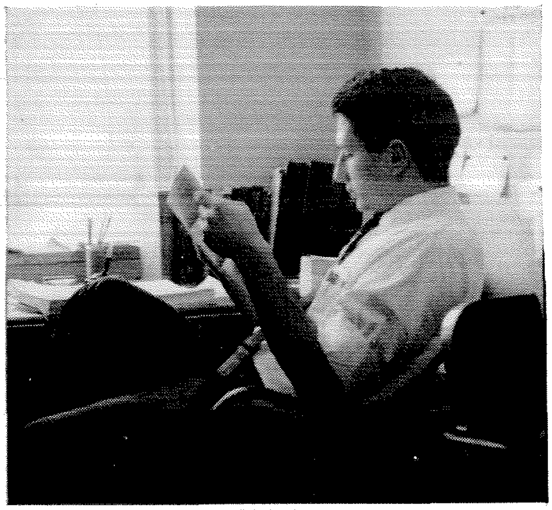
"The experiment is conceptually quite simple," he explained. "A ferroelectric crystal is placed in the tank circuit of an oscillator, between the pole pieces of a large electromagnet. The sample is surrounded by a dewar so that the temperature can be accurately regulated. Then the magnetic field is slowly decreased. When the field reaches certain values, the nuclei in the crystal absorb energy from the oscillator. The trick is to detect this absorption which is quite small. Runs at various temperatures are made, and the temperature dependence of this absorption is studied.

After setting up the first run, Gerry Burns met with the head of his group. Together, they discussed the temperature dependence of the nuclear quadrupole resonance coupling constants. Several helpful suggestions were made.

Gerry Burns then talked with chemists who grow the crystals used in the experiments. They discussed possible variations in the crystal-growing method and considered the growth of other crystals in order to broaden the experiments.

Early in the afternoon, he attended a seminar conducted by a visiting professor on the subject of the atomic structure of solids. Each week, several such seminars on a variety of technical matters are given.

After the seminar, Gerry Burns returned to set up another run at a different temperature. He also talked to a technician about building a new piece of equipment to be used in future experiments.



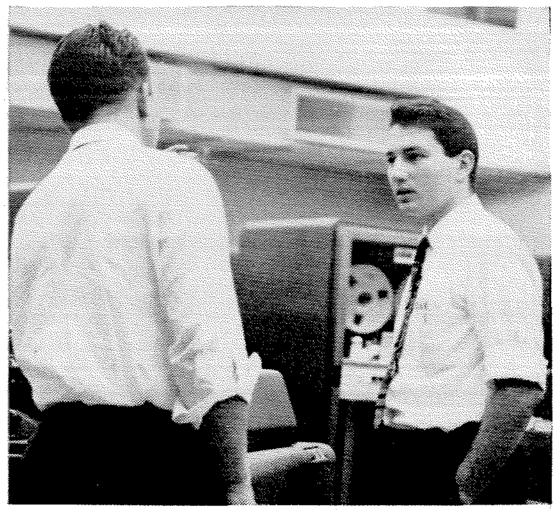
Excellent facilities and programs

"Besides these experiments, I'm also doing some theoretical calculations in the field of nuclear quadrupole resonance. The actual computations were done here at the Laboratory on an IBM 704, which can perform *in minutes* computations which would take weeks if done by other methods.

"This is one of the advantages of working at IBM. Large-scale high-speed computers are available to research scientists when needed. Furthermore you will find your colleagues always willing to help when you are stumped by a problem. Many of these men are recognized authorities in their fields. The exchange is always informative and often stimulates new ideas and approaches.

"Our Company offers many educational opportunities—both in general education and for advanced degrees," Gerry Burns said. "As an example, engineers and scientists may earn a Master's Degree in a post-graduate program conducted by Syracuse University right here in Poughkeepsie.

"We also have a very useful library. Just the other day I dropped in to pick up some technical papers I needed as source material for an article. I've already published one paper on my experiments," he noted. "You're encouraged to publish your findings and to participate in professional society meetings. It's important for a research man to work in an atmosphere where independent thinking is encouraged and where every effort is made to facilitate research investigations."



Some IBM advantages

Employee-benefit plans, paid for by the Company, are comprehensive, liberal, and kept up to date to meet changing conditions. They include life insurance, family hospitalization, major medical coverage, sickness and accident pay, permanent disability pay, and retirement benefits.

* * *

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INTERNATIONAL BUSINESS MACHINES CORPORATION keep domestic problems inside the confines of House meetings. The entire House acts as one large lobby, and a concerted effort is made to achieve unanimity on any issue even before it is brought to a vote.

It is as though the members fear that any sign of disagreement would be sufficient to split the House beyond repair. Parliamentary procedure is followed to the letter, yet is hardly needed. A House meeting in Dabney is one of the more useless gatherings on campus, yet nowhere else is there such an abundance of railroad-sensitive voters. The result is a House of unparalleled unity that is too busy with discussion of policy to find time to apply its findings.

Capable as it is in other fields of endeavor, Dabney tends to be childish about its attempts at gentlemanly behavior. With a lesser emphasis on the picayunish elements of Emily Post, and a more positive attempt at common courtesy as dictated by common sense, Dabney might closer approach its ideal.

Fleming

With the founding of three additional Houses next fall, the nature of each of the existing four will tend to become established in its present form. Assuming that the average House would like to be on top of the heap every so often, this could be the year that showed whether Fleming would ever make it.

Even before the war, Fleming was identified by the big bohunk type – beer-drinking, ruckus-raising, proud of slovenly living, sacrilegious activities, and fast eating. Fleming's one and only claim to fame was in being Caltech's "Jock House." But since the war, the athletic Techman has ceased to be a bohunk. The Varsity Rating Trophy is the last trophy on Fleming's mantelpiece – and *it* may even leave soon. Fleming is still the "Jock House" – it's just that all the campus athletes live in other Houses.

Phlegms now pursue their art of slovenly living with a strong bent toward obscenity. Needless to say, few new frosh find this type of atmosphere inviting. Each year produces its inevitable crop of Fleming frosh who are dissatisfied with their house assignment – and who thus help to further the cynicism that is already so rampant in the House. So the vicious circle continues.

Some of the most cultured members of the student body, as well as some of the most effective campus leaders, have lived in Fleming. But, so far, they have been unable or unwilling to reshape the House.

Caltech students have not relished the reputation the Institute has gained through the actions of various members of Fleming House. And their contrived excuses for such actions (viz., those displayed on last spring's Economy Run and Glee Club Tour) only cloud the problem and antagonize the home front.

Members of other Houses were involved in these incidents, to be sure. But when Fleming House takes significant action against such behavior, Caltech's "great unwashed" will be defenseless. When members of Fleming can bring their parents or wives to dinner without advance warning, and not be afraid of embarrassment, a milestone will have been reached.

– Doug Shakel '60

SOME COMPARABLE ASPECTS OF THE HOUSES

	Blacker	Dabney	Fleming	Ricketts	Throop
House color	Blue	Green	Red (House coats are black)	Maroon (Brown when maroon is hard to get)	Yellow (or whatever is left)
Symbol on House coat	Script "B"	Coat of Arms	Coat of Arms	Coat of Arms	(No House coat)
Associated with	(Maybe that blue stripe around their courtyard)	Green elephant	Kloke's	Millikan's Pot	Wives and kids
Consider themselves	Individuals	Gentlemen	Jocks	Rowdies	Off-campus
Are considered	(Unprintable)	Prudes	Slobs	ASCIT also-rans	Out of it
Social character	Faculty tea	Party-party	Beer blast	Apache dance	Occasional
Intrahouse competitions	Fur-lined athletic garment	Auerbach trophy Coe trophy	Brass spittoon	Brake drum Skill games	?

ANOTHER WAY RCA
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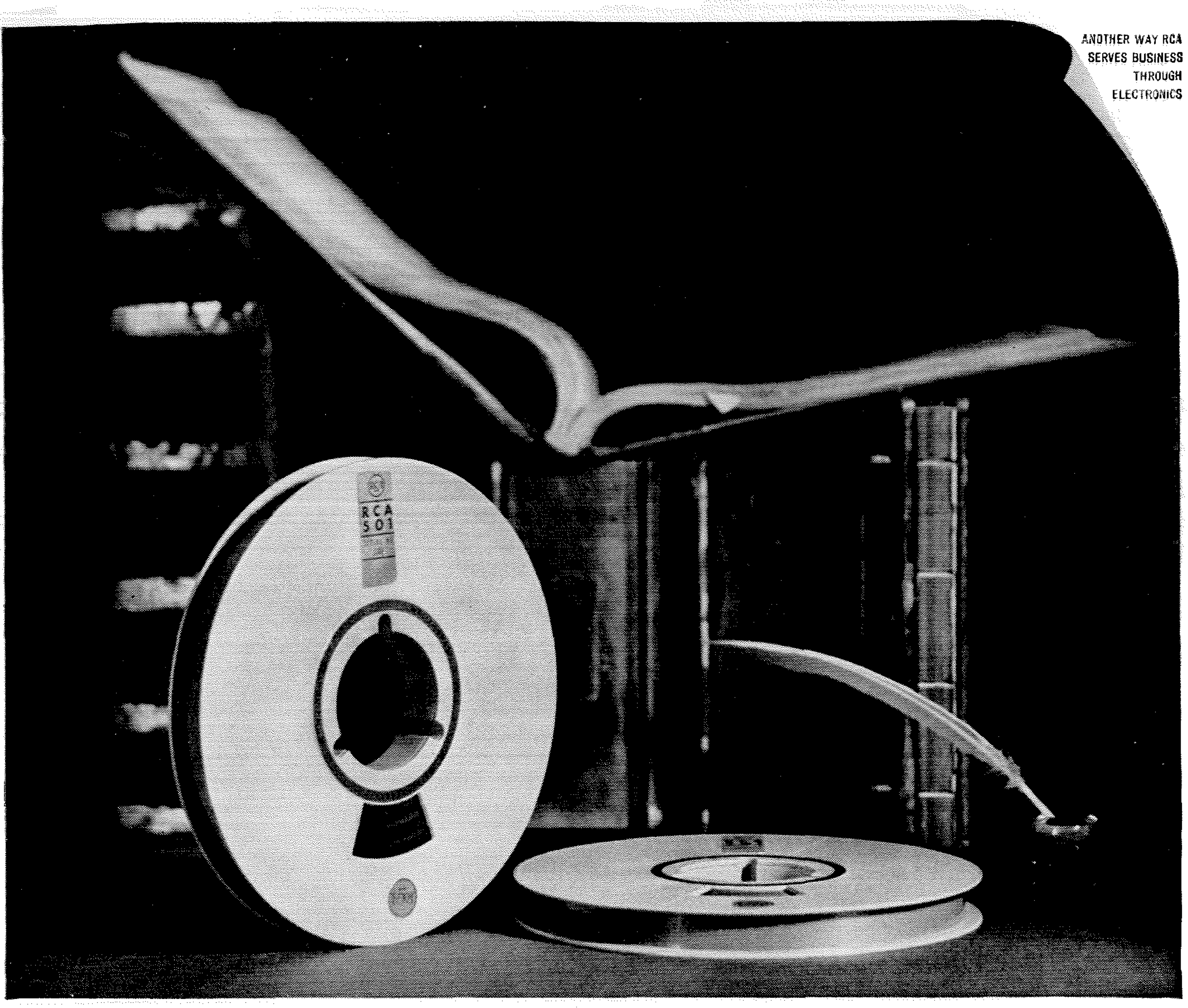


RCA Electronics creates the "501" to streamline the paper work of business—it reads, writes, figures and remembers on tape

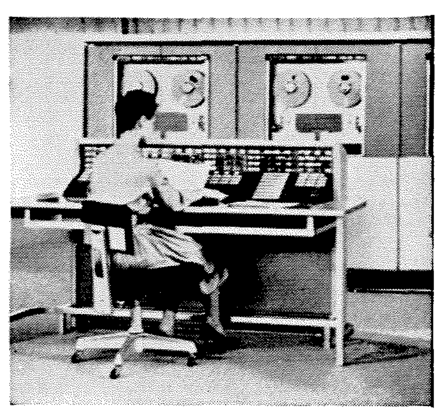
Much of today's traffic jam in paper work is being eliminated by electronic data processing. But to build a system that would be practical and economical for even medium-sized organizations was a job for electronic specialists.

To solve the problem, RCA drew on its broad experience in building computers for military applications and combed its many laboratories for the latest electronic advances that could help. The result was the RCA "501" high-speed electronic data processing system—the most compact, flexible, and economical ever built. It is a pioneer system with all-transistor construction for business use.

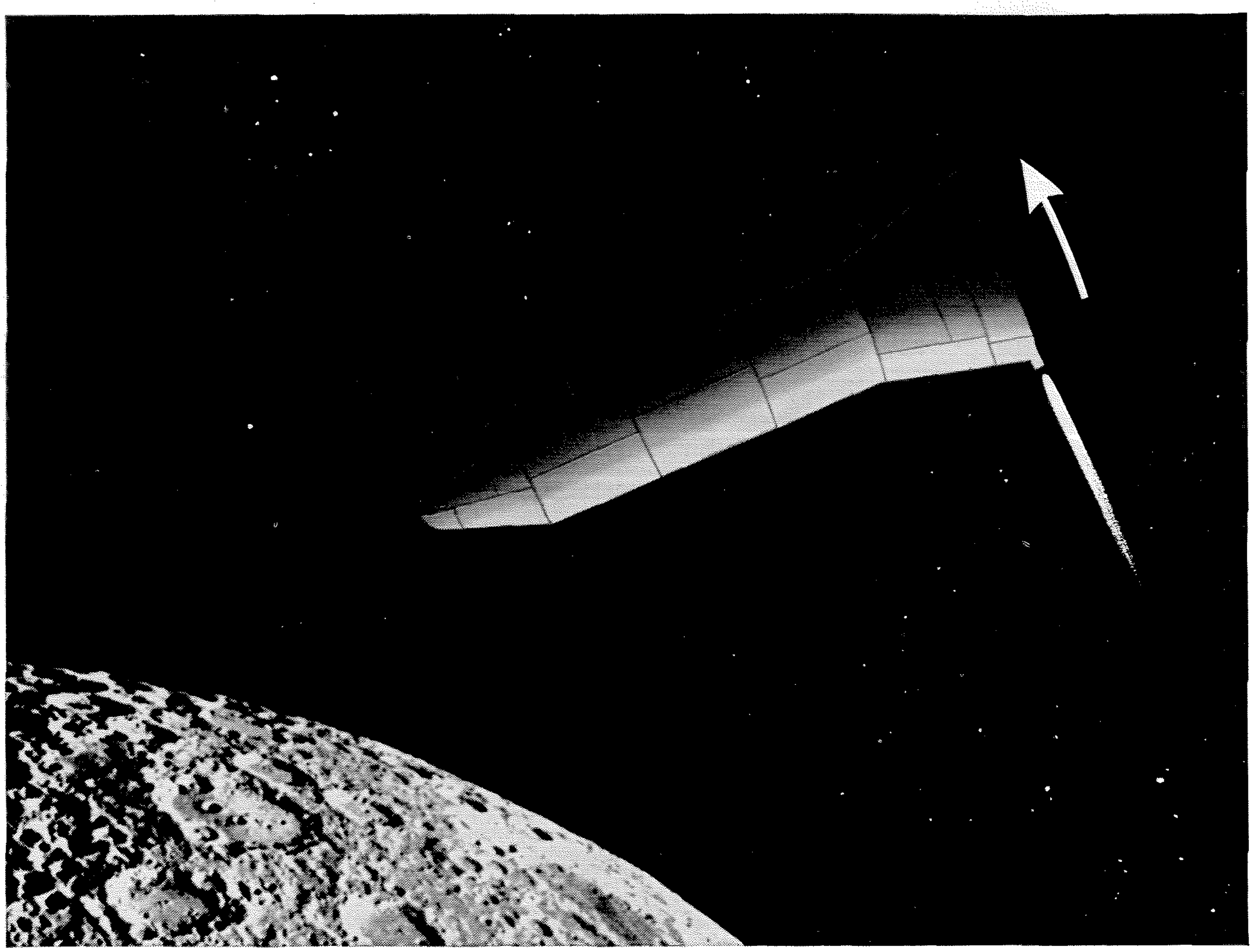
The "501" cuts out paper work bottlenecks for many government agencies and businesses, from stock brokerage firms to public utilities, banks, insurance companies, and steel mills.

It "remembers" millions of letters, numbers, and symbols that are "read" onto its magnetic tapes by such things as punch cards and paper tapes. In a fraction of a second, it can do thousands of calculating, sorting, and comparing operations—and checks each step. Finally, it writes such things as bills, reports, payrolls in plain English at 72,000 characters per minute.

This economical and practical answer to an acute business problem is another way RCA Electronics is helping to simplify the growing complexity of business.

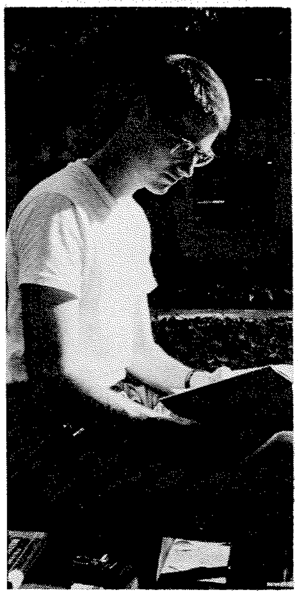


RADIO CORPORATION OF AMERICA



Alumni News

Alumni Scholar



Karvel K. Thornber, a freshman from Portland, Oregon, is the sixth Caltech student to receive an Alumni Scholarship. The award – a four-year, full-tuition grant made possible by an endowment created by Caltech alumni, through past contributions to the Alumni Fund – has been given each fall since 1954. Karvel ranked first in his class of 360 at Franklin High School, and was on the Honor Roll for four years. His athletic activities include swimming and basketball (he was a high-school letterman in both), track and mountaineering. His father is a civil engineer for the U.S. Government. Karvel hopes to go on to graduate work in electrical or mechanical engineering after he gets his BS.

Alumni Tour

Word is reaching the Alumni Association of the interest and enthusiasm with which Professor and Mrs. Royal W. Sorensen are being greeted on their tour across the country, visiting alumni in many cities, in order to show the tremendous changes taking place on campus.

Professor Sorensen spoke before about 54 alumni and wives at a dinner meeting held on October 12 at the Fior D'Italia Restaurant in San Francisco, according to Lee A. Henderson '54, secretary-treasurer of the San Francisco Chapter.

Richard G. King '49, secretary of the Washington, D. C., Chapter, also writes of a successful dinner meeting attended by about 20 alumni and wives.

Professor and Mrs. Sorenson were the guests at a meeting held on October 19 in the Fifth Avenue Hotel, New York City, attended by nearly 50 alumni and wives. Harry J. Moore '48, current secretary of the New York Chapter, reports that this was the annual meeting at which new officers for 1960 were elected. Professor Sorensen showed slides and talked on the building program at Caltech and about his India trip. A second meeting at the Bell Telephone Laboratories in Murray Hill, New Jersey, was attended by 21 alumni.

On October 23 Professor and Mrs. Sorensen were guests of the Detroit area alumni at a dinner held at Kingsley Inn in Bloomfield Hills, arranged by Jay C. Taylor '35.

A dinner and meeting is planned for alumni in and near Houston, Texas, for November 16 or 17, to honor the Sorensens and learn of the development program at the Institute. John G. McLean '38 and W. F. Wilson '22 are working to make this an outstanding event.

— Donald S. Clark, Secretary, Alumni Association

Frontiers in Science

Frontiers in Science, the book made up of articles from *Engineering and Science,* has sold over 17,500 copies since it was published in May, 1958, by Basic Books, Inc. Royalties received to date amount to $9,029.90. The Board of Directors of the Caltech Alumni Association has voted to contribute all royalties to the Development Program, for credit to faculty salaries.

Dinner, Game and Dance

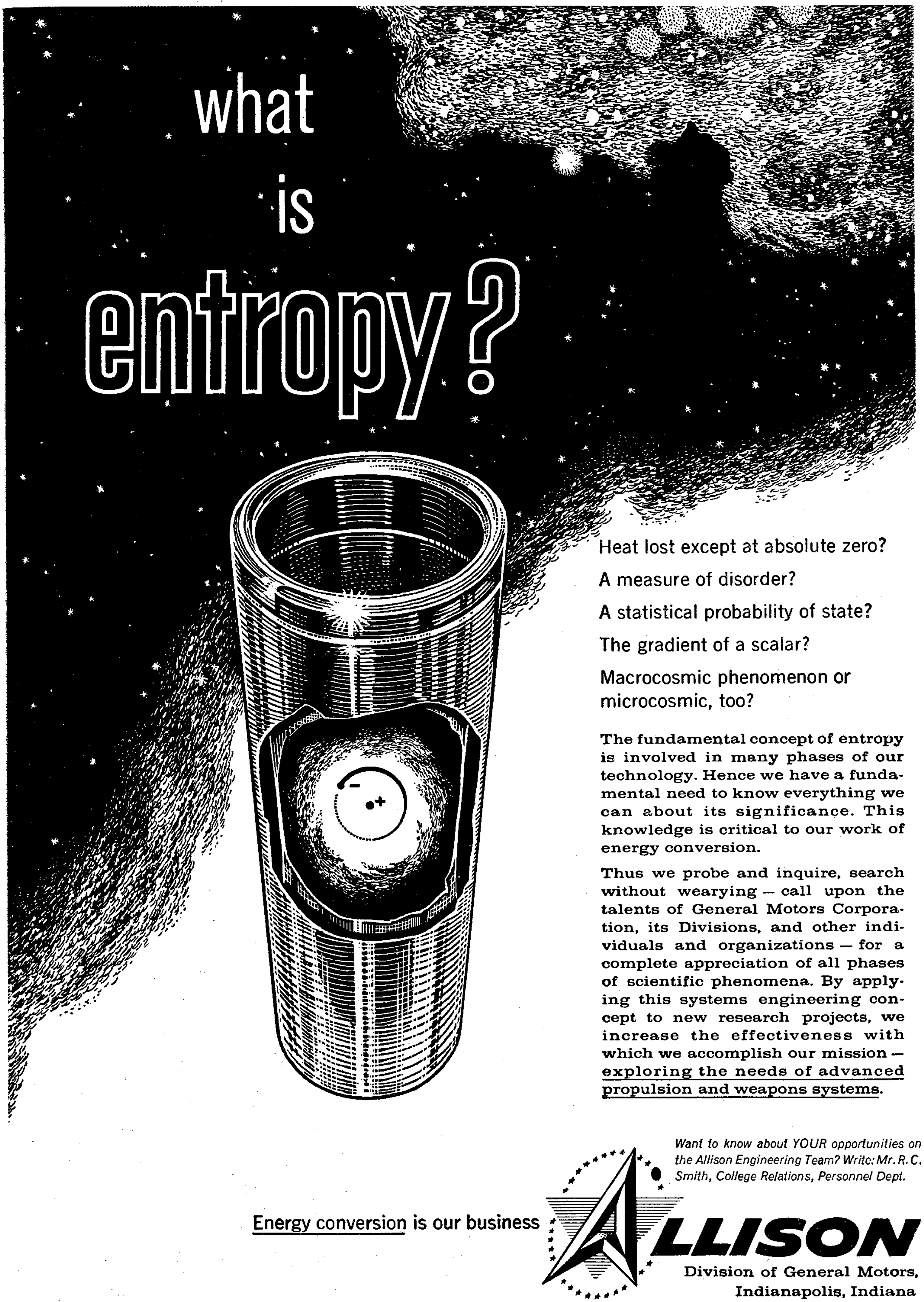
Caltech students have invited the alumni and their wives and friends to join them for a buffet dinner in the Student Houses before the Claremont-Harvey Mudd game in the Rose Bowl on November 20. This is Caltech's last football game of the season. A dance will be held in the Fleming-Ricketts courtyard after the game. This will be a fine opportunity for a social gathering of alumni and undergraduates. Make up a group and come along for dinner and an enjoyable evening. *Announcements will be in the mail to all* alumni in southern California early this month.

— John D. Gee, Chairman, Program Committee

Among the Missing

The Alumni Association is trying to complete its file of Caltech publications and is still lacking some early issues of the school's annuals. Would anyone who has copies of the following publications be willing to send them to the Association?

1896 through 1912 – *The Polytechnic*
1913 through 1920 – *The Throop Tech*


what is entropy?
Heat lost except at absolute zero?
A measure of disorder?
A statistical probability of state?
The gradient of a scalar?
Macrocosmic phenomenon or microcosmic, too?
The fundamental concept of entropy is involved in many phases of our technology. Hence we have a fundamental need to know everything we can about its significance. This knowledge is critical to our work of energy conversion.
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Personals

1915

Charles H. Wilcox, retired staff engineer of the Southern California Gas Company in Los Angeles, died of heart failure on September 8. Charles was a member of the Lafayette Escadrille and had won several Croix de Guerres with palms and stars. In 1915-16 he served as vice president of the Caltech Alumni Association. He leaves his wife and sister.

1921

George N. Hawley, vice president of the Southern California Edison Company in Los Angeles, died on September 8 of a heart attack. George had been with the Edison Company since 1928, when he joined the firm as an industrial heating specialist. He was made vice president in 1952.

1930

Robert I. Stirton, PhD '34, formerly manager of the product development department of the Oronite Chemical Company in San Francisco, is now general manager of the company's new commercial development department.

1938

Elburt F. Osborn, PhD, dean of the College of Mineral Industries at Pennsylvania State University in University Park, Pa., is now a fellow of the American Ceramic Society.

Robert Barry, president of Barry and Company, consulting management engineers, in Los Angeles, is also keeping busy this year as a member of the Sales Executives Club, Oneonta Club, National Association of Accountants and the Jonathan Club, besides serving as president of the South Pasadena Community Chest.

Charles F. Robinson, MS, PhD '49, has been appointed associate director of research at the Consolidated Electrodynamics Corporation in Pasadena. He has been with CEC since 1947, and was formerly chief research physicist.

1941

William B. Hebenstreit is now program director for communication satellites in the Systems Engineering Division of Space Technology Laboratories, Inc., in Los Angeles.

Col. Carl W. Carlmark, MS, has retired from the U.S. Air Force and is now at the Hawaiian Preparatory Academy in Kamuela, Hawaii.

John R. White, MS '42, is manager of the new monitor and control division of Fenwal, Inc., in Ashland, Mass. He was previously manager of airborne systems sales for the company, which manufactures fire detectors, electronic systems and temperature controls.

Robert E. Rundle, PhD, professor of chemistry at Iowa State College and senior chemist in the Ames Laboratory of the Atomic Energy Commission, has won the 1959 Iowa Medal of the American Chemical Society's Iowa Section. The medal is awarded to an Iowa chemist or chemical engineer annually for meritorious achievement in teaching, research or industry.

1942

E. W. Van Ness has been elected a vice president of the Ralph M. Parsons Company in Los Angeles. He is manager of the construction company's petrol-

continued on page 50

IT'S LITERALLY ALL AROUND YOU!

The word *space* commonly represents the outer, airless regions of the universe. But there is quite another kind of "space" close at hand, a kind that will always challenge the genius of man.

This space can easily be measured. It is the space-dimension of cities and the distance between them . . . the kind of space found between mainland and off-shore oil rig, between a tiny, otherwise inaccessible clearing and its supply base, between the site of a mountain crash and a waiting ambulance—above all, Sikorsky is concerned with the precious "spaceway" that currently exists between all earthbound places.

Our engineering efforts are directed toward a variety of VTOL and STOL aircraft configurations. Among earlier Sikorsky designs are some of the most versatile airborne vehicles now in existence; on our boards today are the vehicles that can prove to be tomorrow's most versatile means of transportation.

Here, then, is a space age challenge to be met with the finest and most practical engineering talent. Here, perhaps, is the kind of challenge *you* can meet.

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eum and chemical engineering division.

Capt. Sheldon W. Brown, AE (U.S.N., Ret.) has been appointed as a consultant on the general planning staff of the All American Engineering Company in Wilmington, Delaware. Before his retirement from the Navy, he was Force Material Officer, Naval Air Force, Atlantic Fleet.

1943

Hewson Lawrence, MS, is now director of division customer relations at the Aerojet - General Corporation of Azusa. He has been with the company since 1946.

1944

Harrison W. Sigworth, research engineer at the California Research Corporation, is now at the Stanford Graduate School of Business on a Sloan Fellowship from the Standard Oil Company of California. Harrison was secretary-treasurer of the San Francisco Chapter of the Caltech Alumni Association in 1954, vice president in 1955, and president in 1956. The Sigworths have four children – three boys, 13, 10 and 8, and a girl 2½.

Paul H. Winter, structural engineer with Neptune & Thomas and Associates in Pasadena, has now been made vice president of the firm. Paul, who has headed the structural engineering department for the past three years, was formerly director of the Afghan Institute of Technology, and advisor on school building projects as a member of the United Nations Technical Assistance Mission to Afghanistan. He is currently lecturing in the School of Engineering at USC, and spending all his spare time with his family aboard their 30-foot auxiliary sloop, *The Intrepid*.

1945

Albert R. Hibbs, PhD '55, is acting chief of the Jet Propulsion Laboratory's new Space Science Division, which has been formed to devise, plan, develop, operate and analyze experiments for the NASA-JPL space exploration program.

1946

William N. Lipscomb, Jr., PhD, formerly chief of the division of physical chemistry at the University of Minnesota, is now professor of chemistry at Harvard University.

John E. Richter has been named housing specialist in the Los Angeles office of the Portland Cement Association. He's been with the company since 1956. The Richters, who live in La Canada, have three children.

Morris Lebovits, MS, is section chief of aerodynamics at the Solar Aircraft Company in San Diego. He was formerly chief of aerodynamics at Radioplane, a division of the Northrop Corporation.

1947

Adrian Pauw, MS, PhD '52, writes that "I left the Rice Institute at Houston, Texas, in 1953, and have been with the University of Missouri in Columbia since then as professor of civil engineering. We now have four children – three boys and a girl, Janet, who is 3. We spent last summer in Austin, Texas, where I was visiting professor at the University of Texas."

Manfred Eimer, MS '48, PhD '53, is

continued on page 52

Personals . . . *continued*

now section chief of the Research Analysis Section of JPL's new Space Science Division. He has been with JPL since 1953 and also serves on the NASA Committee for Missile and Space Craft Aerodynamics.

1948

Max Garber, formerly manager of Consolidated Electrodynamics Corporation's Eastern Regional Office in Philadelphia, has now been appointed director of a new division in Rochester, N.Y.

Howard B. Lewis, Jr., BS '48 ME, BS '51 EE, is now chief engineer of the transducer division of the Consolidated Electrodynamics Corporation in Pasadena. He has been with the company since 1952.

1949

Col. John A. Dodge, MS, has now joined Dr. Herbert J. York, director of Defense Research and Engineering in the Office of the Secretary of Defense. He has headed the Re-entry Vehicle Development program for the Ballistic Missile Division since September, 1955, and has been directly concerned with the Air Force-Lockheed X-17 project.

John Hann is now test project engineer on the DC-8 project at Douglas Aircraft's Long Beach plant.

R. L. Walquist is now manager of the communications and tracking department of the Telecommunications Laboratory of Space Technology Laboratories, Inc., in Los Angeles. He has been with STL since 1955. The Walquists and their son live in Rolling Hills.

1950

Allan Beek has been appointed senior project engineer in the Lockheed Electronics and Avionics Division. He was formerly with the Alwac Division of El-Tronics and the Electrodata division of the Burroughs Corporation.

1951

Thomas W. Layton is now associate manager of the inertial guidance department in the electromechanical laboratory at Space Technology Laboratories in Los Angeles. He has been with the company since 1955.

Bruce B. Hedrick has been senior sales engineer and manager of special equipment sales for Dynapak/Convair Pomona since January. The Hedricks have two girls, 7 and 5, and a boy, 1½.

1952

Henry Richter, Jr., PhD '56, heads the Space Instruments Section of the new Space Science Division at JPL. He has been with the Lab since 1955.

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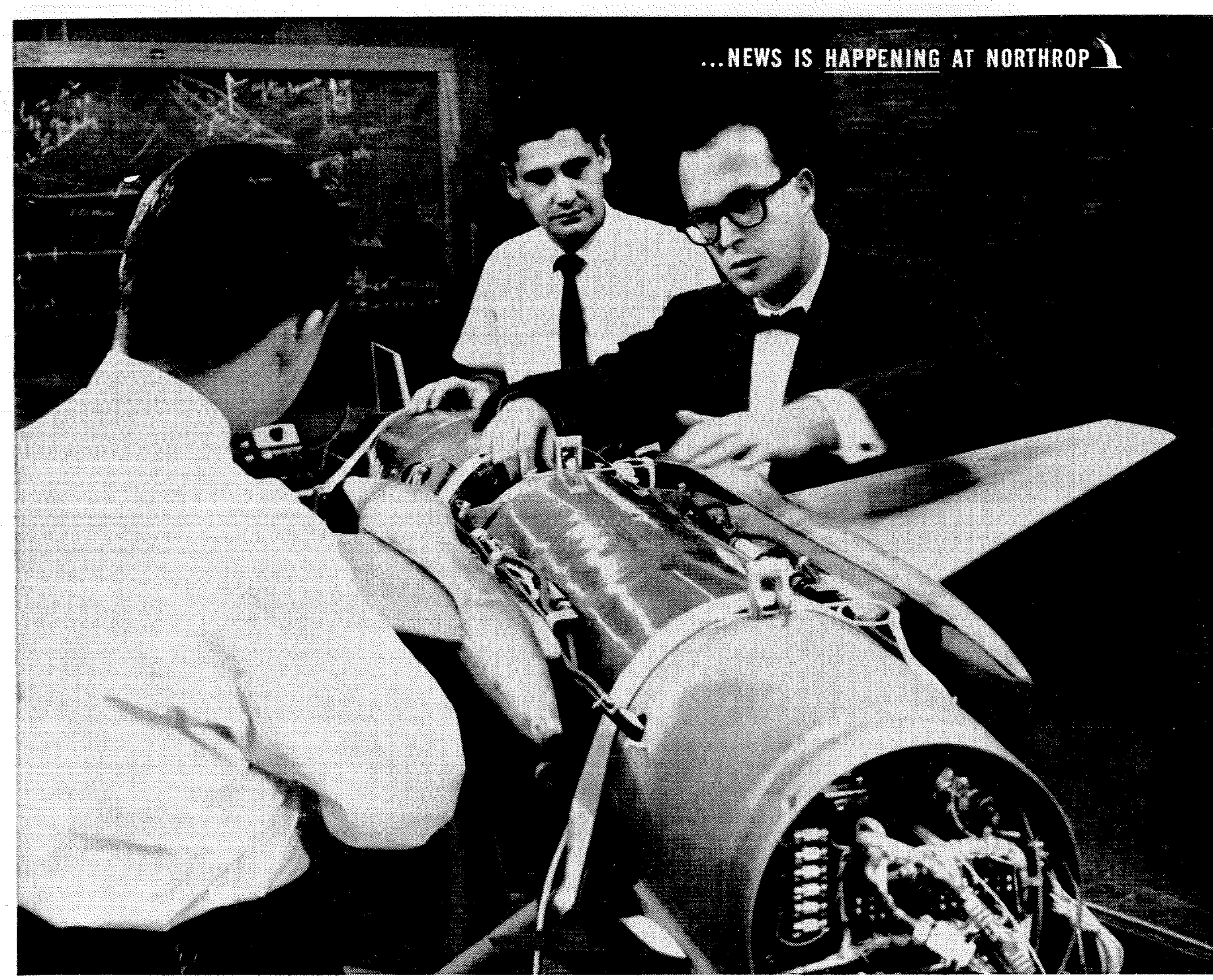

Engineer Larry Klivans reviews the results of a computer-simulated ground checkout of Radioplane Division's near-sonic RP-76 rocket-powered target drone. Formerly at Norair Division, Larry came to Radioplane in 1955. At 31, he is Manager of the Division's 140-man Electronic Support Group, is working toward his doctorate at UCLA.

YOUNG ENGINEERS ARE NORTHROP'S NEWSMAKERS!

Northrop Corporation's dynamic and diversified corporate structure creates an ideal work climate for forward-thinking scientists and engineers. Our three autonomous divisions are all in Southern California – are all headed by progressive management eager to examine and try new ideas.

Let's assume that *you* are a man who can qualify for one of our engineering teams – a man who can create history!

YOU'LL EARN what you're worth, get increases as often as you earn them – based on your own individual achievements. Our salary structure is unique in the industry; our vacation policy extra-liberal, as are all of our other fringe benefits.

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RADIOPLANE DIVISION. Creator of the world's first drone family; has produced and delivered tens of thousands of drones for all the U.S. Armed Forces. Now developing ultra-advanced target drone systems for weapon evaluation, surveillance drone systems, and missile systems.

NORTRONICS DIVISION. Pioneer in celestial and inertial guidance. Currently exploring infrared applications, airborne digital computers and interplanetary navigation; developing ground support, optical and electro-mechanical, and data-processing equipment.

NORAIR DIVISION. Creator of SAC's intercontinental USAF Snark SM-62. Currently active in programs for the ballistic recovery of orbiting man; flight-testing the USAF T-38 supersonic trainer; readying the N-156F NATO-SEATO fighter for flight tests.

NOW WRITE! Get full information on Northrop Corporation and all of its Divisions. Then choose the division that offers *you* the most challenge. To reserve your spot where news is *happening,* write: Engineering & Scientific Personnel Placement Office, Northrop Corporation, P.O. Box 1525, Beverly Hills, California.

Divisions of NORTHROP CORPORATION

Personals . . . *continued*

1953

John S. Winslow, MS '59, is now a research engineer in the solid state division of Electro-Optical Systems, Inc., in Pasadena. He had been working with the Consolidated Electrodynamics Corporation.

J. Morgan Ogilvie, formerly Chicago sales service representative in the Du Pont Company's petroleum chemicals division, is now sales promotion coordinator in the division's Eastern Region. He has been with the company since 1955.

1955

Donald B. Roberts writes that he "just started in the first year class of Harvard Medical School. After graduating from CIT in June, 1955, I spent two years in the Air Force at McClellan AFB in Sacramento, one year in physics at MIT graduate school, and 15 months working at MIT's Lincoln Laboratory and the MITRE Corporation, where I was doing logical design of digital computers for processing of radar data."

1956

Ralph O. Kehle, MS '57, writes that he is now "instructor of mathematics in the Natural Science Division, General College, University of Minnesota, in Minneapolis . . . and also registered as a graduate student in the department of geology where I shall complete my PhD studies.

"Until September 16 I was employed by the University of Michigan as a research associate in the department of geology. For six months I worked under the direction of Dr. James H. Zumberge on the IGY-sponsored Shelf Ice Deformation Project. We compiled and analyzed data collected during the 1957-58 and 1958-59 antarctic field seasons."

1957

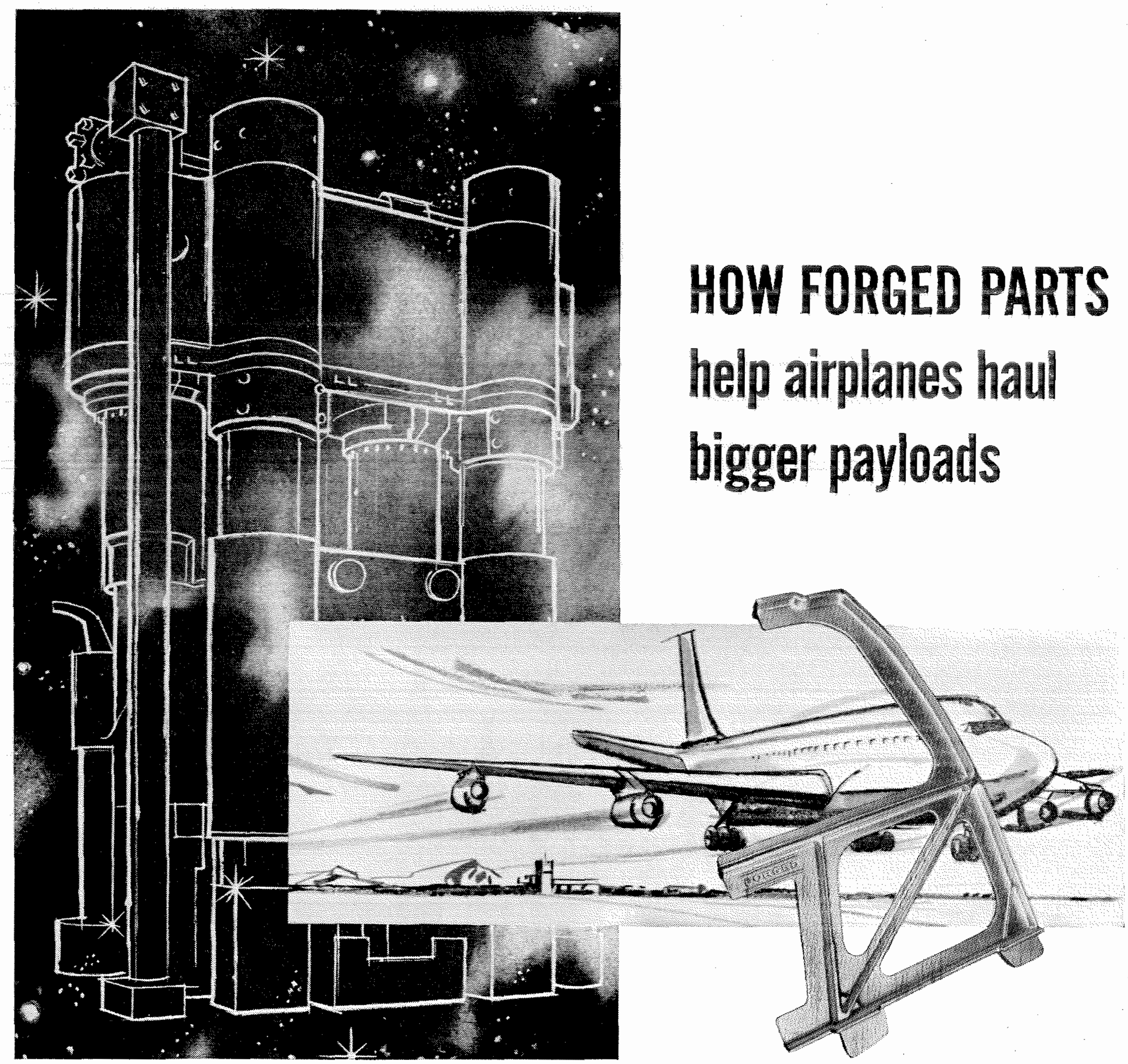
James E. Conel, MS, is at Caltech, working for his PhD in geophysics on a Pan American Petroleum Foundation fellowship.

Gerd A. Tuchen, MS, engineer with the Bell Telephone Laboratories, received his MS from New York University in June, after completing a two-year program of advanced study at the new NYU-Bell Laboratories graduate center in Murray Hill, N.J.

1959

Nelson Byrne is studying for his PhD in physics at Stanford on a National Science Foundation grant.

Robert J. Kwik, MS, is in his first year of study at the Princeton Theological Seminary. He is married and has one son.



HOW FORGED PARTS help airplanes haul bigger payloads

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In commercial products ... trucks, cars, materials-handling equipment ... the pounds of dead weight you eliminate by using forgings make money year-after-year for the operator. The forging process lets you put the metal exactly where you need it to carry the load, withstand shock or vibration, endure torsion. And with not a surplus ounce of non-working weight going along just for the ride.

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Names of sponsoring companies on request to this magazine

Lost Alumni

The Institute has no record of the present addresses of these alumni. If you know the current address of any of these men, please contact the Alumni Office, Caltech.

1906
Norton, Frank E.

1911
Lewis, Stanley M.

1921
Arnold, Jesse
Fletcher, Harold O.

1922
Cox, Edwin P.
Cronin, John A.

1923
Hickey, George I.
Skinner, Richmond H.

1924
McKaig, Archibald
Merceraeu, James T.
Springer, Harold O.
Tracy, Willard H.
Sheffield, Harold C.

1926
Chang, Hung-Yuan
McCarter, Kenneth C.
Yang, Kai Jin

1927
Evjen, Haakon M.
Langer, R. Meyer

1928
Chou, P'ei-Yuan
Hicks, Hervey C.
Martin, Francis C.
Morgan, Stanley C.
Wingfield, Baker

1929
Briggs, Thomas H., Jr.
Burns, Martin C.
Nelson, Julius
Robinson, True W.
Sandberg, Edward C.
Wolfe, Karl M.

1930
Chao, Chung-Yao
Douglass, Paul W., Sr.
Janssen, Philip
Lea, William F.
Shields, John C.
White, Dudley

1931
Hall, Marvin W.
Ho, Tseng-Loh
Voak, Alfred S.
West, William T.
Woo, Sho-Chow
Yoshoka, Carl K.

1932
Patterson, J. W.
Schroder, L. D.
Wright, Lowell J.

1933
Applegate, Lindsay M.
Ayers, John K.
Downie, Arthur J.
Hsu, Chuen Chang
Kitusda, Kaname
Koch, A. Arthur
Larsen, William A.
Lockhart, E. Ray
Michal, Edwin B.
Murdock, Keith A.
Rice, Winston H.
Shappell, Maple D.
Smith, Warren H.

1934
Harshberger, John D.
Liu, Yun Pu
Lutes, David W.
Radford, James C.
Read, John

1935
Becker, Leon
Bertram, Edward A.
Huang, Fun-Chang
McNeal, Don

1936
Chu, Djen-Yuen
Creal, Albert
Kelch, Maxwell
Kurihara, Hisayuki
Ohashi, George Y.

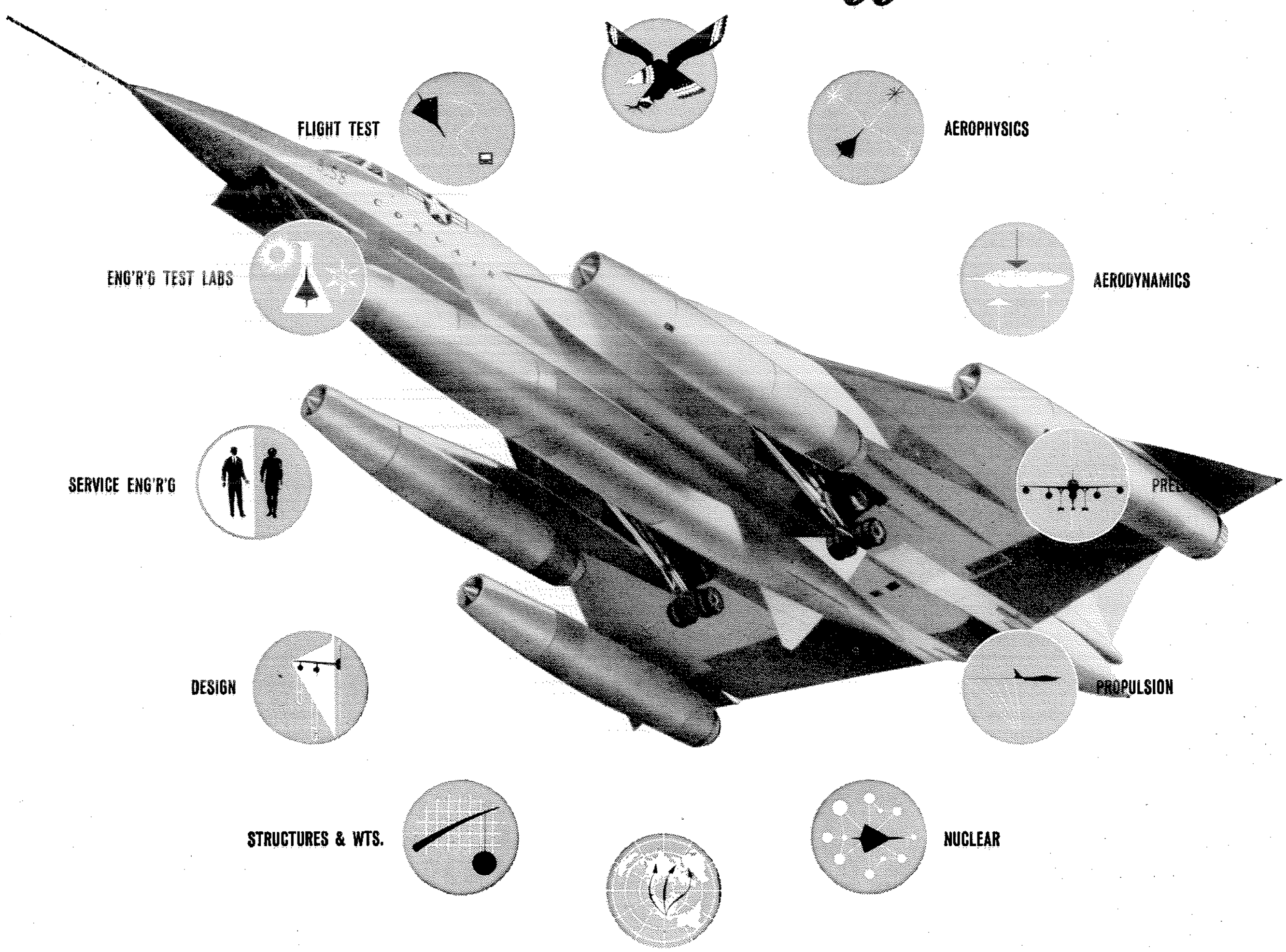
1937
Axelrod, Joseph
Burnight, Thomas R.
Cheng, Ju-Yung
Easton, Anthony
Fan, Hsu Tsi
Jones, Paul F.
Lotzkar, Harry
Maginnis, Jack
Moore, Charles K.
Munier, Alfred E.
Nojima, Noble
Penn, William L., Jr.
Rechif, Frank A.
Servet, Abdurahim
Shaw, Thomas N.

1938
Gershzohn, Morris
Goodman, Hyman D.
Kanemitsu, Sunao
Lowe, Frank C.
Ofsthun, Sidney A.
Okun, Daniel A.
Rhett, William
Tilker, Paul O.
Tsao, Chi-Cheng
Wang, Tsun-Kuei
Watson, James W.

1939
Asakawa, George
Brown, William Lowe
Burns, Martin R.
Easton, R. Loyal
Liang, C. Chia-Chang
Neal, Wilson H.
Ortiz, Jose Pulido
Robertson, Francis A.
Tatom, John F.
Tsien, Hsue-Shen
Wilson, Harry D.

continued on page 62

"Best individual effort...



...best combination of ideas"

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INCORPORATED

DALLAS 9, TEXAS

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join TI engineers in such challenging programs as micro-miniaturization

TI develops new semiconductor solid circuit with component densities up to 34 million per cubic foot!

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A rewarding opportunity awaits you in one of the many programs now in progress at TI's Central Research Laboratory, Semiconductor-Components, Apparatus, and GeoSciences and Instrumentation divisions.

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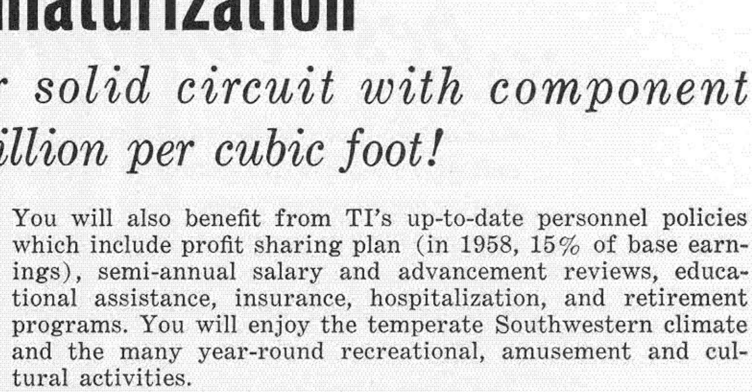
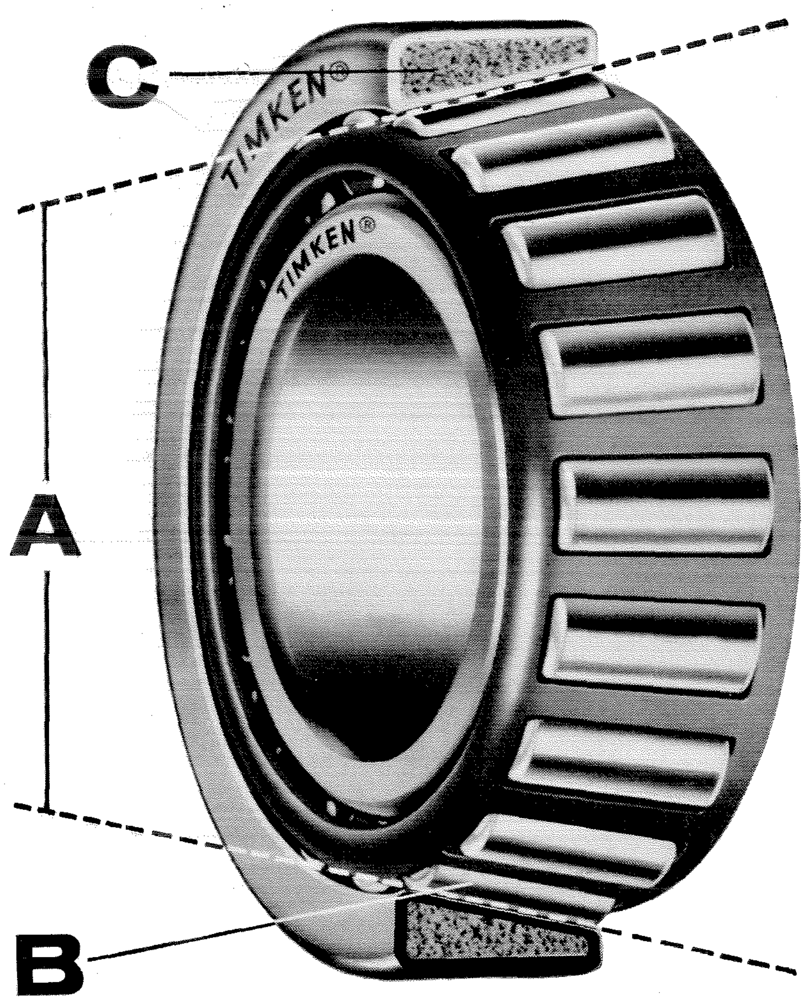
To join this fast-moving company at the forefront of scientific technologies, please send resume to W. T. Hudson, Dept. 1306, Texas Instruments Incorporated, 6000 Lemmon Avenue, Dallas 9, Texas.



(Graph courtesy of Dallas Times Herald, January 7, 1959)

Dallas' 12-month weather chart shows that temperature averaged 65.9° in 1958, with humidity at a comfortable low level. Dallas skies are predominantly clear and sunny, devoid of industrial haze or smog.



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B. *Full line contact* between rollers and races gives Timken bearings *extra* load-carrying capacity. This enables a design engineer to cram maximum capacity into minimum space. And Timken bearings can be pre-loaded for accurate gear or spindle alignment.

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If you would like to help create Better-ness on our engineering team, write Manager, College Relations, The Timken Roller Bearing Company, Canton 6, Ohio.

BETTER-NESS rolls on

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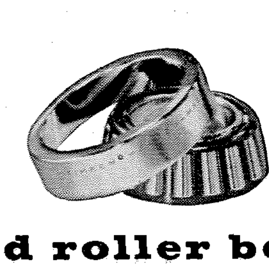


tapered roller bearings

First in bearing value for 60 years

Lost Alumni . . . *continued*

1940

Batu, Buhtar
Brasch, Martin F.
Green, William J.
Hsu, Chang-Pen
Menis, Luigi
Paul, Ralph G.
Tajima, Yuji A.
Tao, Shih Chen
Torrey, Preston C.
Ustel, Sabih A.
Wang, Tsung-Su

1941

Arnold, John K.
Clark, Morris R.
Dieter, Darrell W.
Easley, Samuel J.
Geitz, Robert C.
Green, Jerome
Harvey, Donald L.
Hubbard, Jack M.
Kuo, I. Cheng
Noland, Robert L.
Robinson, Frederick G.
Spitzer, Ralph W.
Standridge, Clyde T.
Taylor, D. Francis
Tiemann, Cordes F.
Waigand, LeRoy G.
Whitfield, Hervey H.
Yui, En-Ying

1942

Bebe, Mehmet F.
Chastain, Alexander
Curtis, Thomas G.
Go, Chong-Hu
Hughes, Vernon W.
Johnston, William C.
Levin, Daniel
MacKenzie, Robert E.
Martinez, Victor H.

1943

Angel, Edgar P.
Bethel, Horace L.
Bridgland, Edgar P.
Brown, James M.
Bryant, Eschol A.
Burlington, William J.
Carlson, Arthur V.
Colvin, James H.
Emmett, Glenn E.
Hamilton, William M.
Hillyard, Roy L.
Hilsenrod, Arthur
King, Edward G.
Koch, Robert H.
Kong, Robert W.
LaForge, Gene R.
Lee, Edwin S., Jr.
Leeds, William L.
Ling, Shih-Sang
Lobban, William A.
Lundquist, Roland E.
Mampell, Klaus
McNeil, Raymond F.
Mixsell, Joseph W.
Moore, Robert A.
Nesley, William L.
Neuschwander, Leo Z.
Newton, Everett C.
O'Brien, Robert E.
Patterson, Charles M.
Pearson, John E.
Rambo, Lewis
Rivers, Nairn E.
Roberts, Fred B.
Rupert, James W., Jr.
Scholz, Dan R.
Shannon, Leslie A.
Smitherman, Thos. B.
Tindle, Albert W., Jr.
Vincente, Ernesto
Walsh, Joseph R.
Washburn, C. L.
Weis, William T.
Wood, Stanley G.

1944

Alpan, Rasit H.
Baranowski, John J.
Barriga, Francisco D.
Bell, William E.
Benjamin, Donald G.
Berkant, Mehmet N.
Birlik, Ertugrul
Budney, George S.
Burch, Joseph E.
Burke, William G.
DeMedeiros, Carlos A.
Fu, Ch'eng Yi
Gray, J. Doyle
Harrison, Charles P.
Hu, Ning
Johnson, William M.
Kern, Jack C., Jr.
Labanauskas, Paul J.
Leenerts, Lester O.
Marshall, John W.
Nicholson, James C.
Pi, Te-Hsien
Rasof, Bernard
Shults, Mayo G.
Stanford, Harry W.
Stein, Roberto L.
Sullivan, Richard B.
Sunalp, Halit
Trimble, William M.
Unayral, Nustafa A.
Wadsworth, Jos. F., Jr.
Williams, Robert S.
Wolf, Paul L.
Writt, John J.
Yik, George

1945

Ari, Victor A.
Arreguin-Lozano, B.
Bunze, Harry F.
Gibson, Charles E.
Jenkins, Robert P.
Kuo, Yung-Huai
Levy, Charles N.
Pooler, Louis G.
Romney, Carl F.
Tatlock, William S.
Tseu, Payson S.

1946

Allison, Charles W., Jr.
Barber, John H.
Burger, Glenn W.
Conradt, Robert H.
Dethier, Bernard
Dyson, Jerome P.
Esner, David R.
Foster, R. Bruce
Hayne, Benj. S., III
Huestis, Gerald S.
KeYaun, Chen
Lang, Serge
Lewis, Frederick W.
Maxwell, Frederick W.
Parker, James F.
Pollack, A. D.
Prasad, K. V. Krishna
Simmons, George F.
Sledge, Edward C.
Smith, Harvey F.
Tung, Yu-Sin
Uberoi, Mahinder S.
Weldon, Thomas F.

1947

Atencio, Adolfo J.
Clarke, Frederic B.
Clements, Robert E.
Clock, Raymond M.
Dagnall, Brian D.
Darling, Donald A.
Hsu, Chi-Nan
Hsueh, Chi-Hsun
Huang, Ea-Qua
Leo, Fiorello R.
MacAlister, Robert S.
McClellan, Thomas R.
Miller, Curtis E.
Molloy, Michael K.
Monoukian, John
Moorehead, Basil E. A.
Mowery, Irl H.
Nelson, Conrad N.
Orr, John L.
Ramaswamy, Guruvayur S.
Ruderman, Malvin A.
Sanders, Lewis B.
Sappington, Merrill H.
Vanden Heuvel, G. R.
Wan, Pao Kang
Wellman, Alonzo H. Jr.
Ying, Lai-Chao

1948

Agnew, Haddon W.
Bingham, Andrew T.
Blue, Douglas K.
Bunce, James A.
Burt, Frederick B.
Collins, Burgess F.
Cotton, Mitchell L.
Crawford, William D.
Garber, Max
Hager, James W.
Hom, John D.
Hsieh, Chia Lin
Hsiao, Chien
Latson, Harvey H., Jr.
Lawton, Elmore G.
Leavenworth, C. D.
Mason, Herman A.
McCollam, Albert E.
Morehouse, Gilbert G.
Oliver, Edward D.
Rhynard, Wayne E.
Swain, John Sabin
Swank, Robert K.
Winniford, Robert S.
Woods, Marion C.
Yanak, Joseph E.

1949

Barker, Edwin F., Jr.
Bauman, John L., Jr.
Baumann, Laurence L.
Clancy, Albert H., Jr.
Clendening, H. C.
Cooper, Harold D.
Foster, Francis C.
Galstan, Robert H.
Heiman, Jarvin R.
Krasin, Fred E.
Laberge, Jerome G.
Lowrey, Richard O.
MacKinnon, Neil A.
McElligott, R. H.
Merrell, Richard L.
Orme, Eric C.
Petty, Charles C.
Ringness, William M.
Rudin, Marvin B.
Stappler, Robert F.
Weiss, Mitchell
Yi, Sien-Chiue

1950

Bryan, William C.
Edelstein, Leonard
Hendrickson, James B.
Li, Chung Hsien
McDaniel, Edward F.
McMillan, Robert
Merrifield, Donald P.
Nelson, Robert C.
Pao, W. K.
Paulson, Robert W.
Petzold, Robert F.
Roberts, Morton S.
Scherer, Lee R., Jr.
Schneider, William P.
Vivian, James A.
Wright, Amos L.

1951

Arosemena, Ricardo M.
Chong, Kwok-Ying
Davison, Walter F.
Denton, James Q.
Hawk, Riddell L.
Lafdjian, Jacob P.
Li, Cheng-Wu
Padgett, Joseph E., Jr.
Pfieffer, Walter F.
St. Amand, Pierre
Summers, Allan J.

1952

Abbott, John R.
Arcoulis, Elias G.
Gerington, Thomas E.
Jepson, James O.
Loftus, Joseph F.
Long, Ralph F.
Lunday, Adrian C.
O'Brien, Joseph
Primbs, Charles L.
Robieux, Jean
Schaufele, Roger D.
Shelly, Thomas L.
Weber, Ernesto J.
Wiberg, Edgar
Woods, Joseph F.
Zacha, Richard B.

1953

Clark, David J.
Fink, George B.
Lennox, Stuart G.
Mishaan, Alberto
Vidal, Jean L.

1954

Mertz, Charles III
Quiel, Norwald R.
Sargent, H. L., Jr.
Yin, Mih

1955

Benton, William C.
Crowe, Thomas H.
Lim, Macrobio
Martin, Frederick
Moore, William T.
Muraru, Vasile
Powell, Robert V.

1956

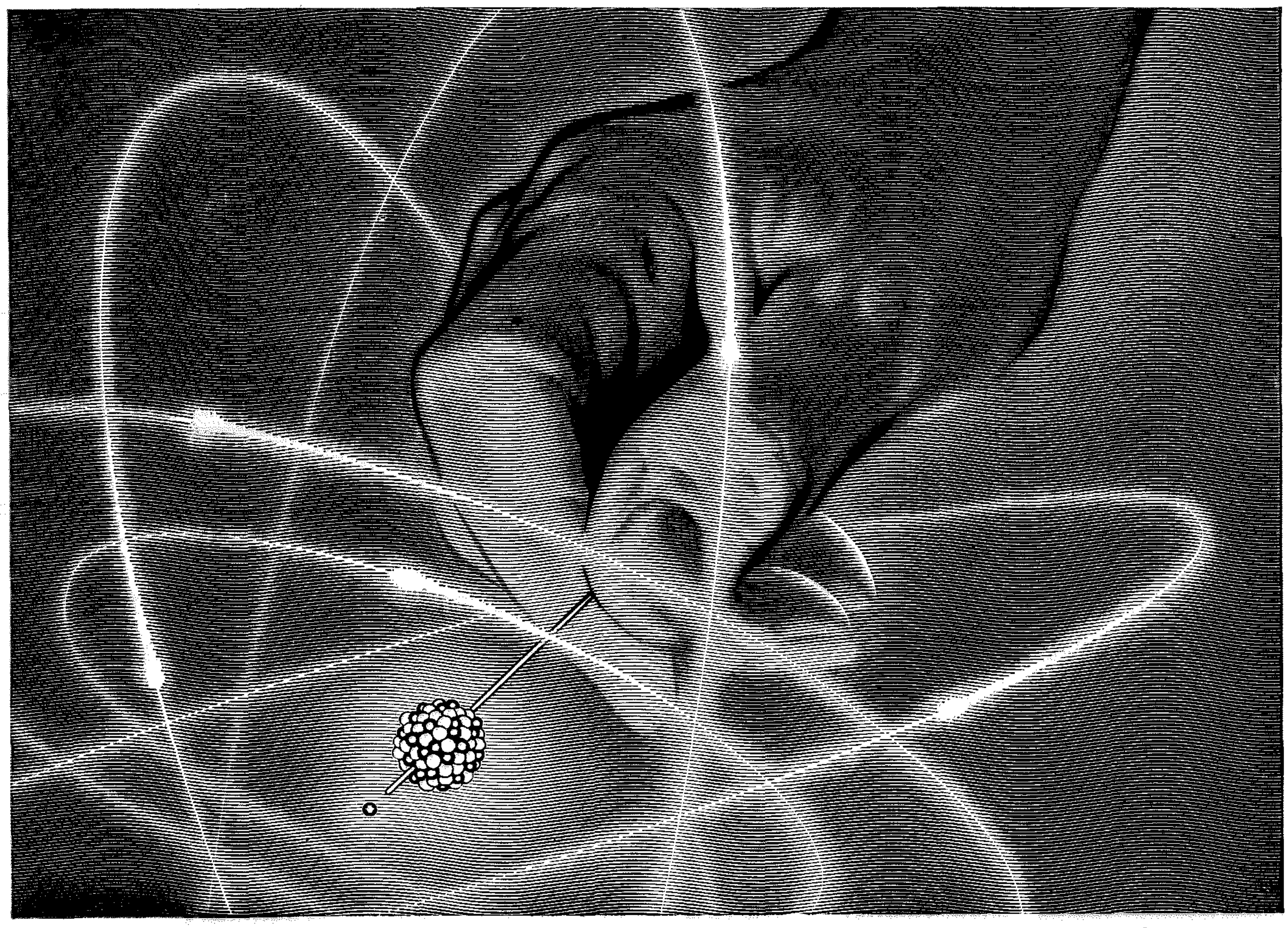
Hershberger, Edw. E.
Herzog, Robert T.
Hsu, Nan-Teh
Marcy, William L.
Spence, William N.
Tang, Chung-Liang
Witteborn, Fred

1957

Howie, Archibald
Leader, Elliot
Lee, Wonyong
MacGillivray, A. D.
Moore, Robert T.
Stuteville, Joseph E.
West, Clinton
Wong, Chi-hsiang

1958

Schenter, Robert E.
Schumann, Thomas G.



. . . a hand in things to come

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Every day brings the benefits of atomic energy closer to our daily living. It presents a whole new field of exploration for scientists all over the world.

A longer, healthier life is hopefully ahead as radiation is helping doctors learn more about the basic processes of life by revealing how certain elements are put to work by the body. The controlled rays of the atom are also being used to pin-point malignant tissues for subsequent treatment. And radiation studies of how plants absorb nutrition from sun and soil are showing the way to improved food supplies.

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UNION CARBIDE

...a hand in things to come

CALTECH CALENDAR

ALUMNI EVENTS

November 20	Football Game and Dance
December	Fall Dinner Meeting
January	Winter Dinner Meeting
March	Annual Dinner Dance
May 7	Annual Seminar
June 8	Annual Meeting
June	Annual Picnic

ATHLETIC SCHEDULE

Cross Country

November 13
Claremont-H. Mudd at Caltech

November 20
Caltech at Redlands

Water Polo

November 10
Caltech at Redlands

November 13
Claremont-H. Mudd at Caltech

November 17
Caltech at LA State

Soccer

November 14
UC, Riverside at Caltech

November 21
Caltech at Redlands

November 24
Caltech at Pomona

FRIDAY EVENING DEMONSTRATION LECTURES

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

November 13
Regulation of California Utilities
– Ray Untereiner

November 20
Cancer and Viruses
– Howard M. Temin

December 4
Physiological Variations Within Plant Species
– Thomas O. Perry

December 11
F. Scott Fitzgerald – The Cost of Fame
– H. Dan Piper

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Donald S. Clark, '29

VICE-PRESIDENT
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TREASURER
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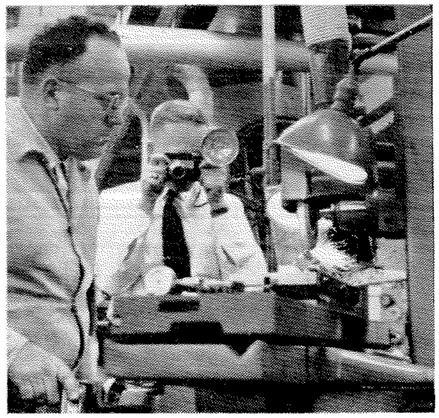

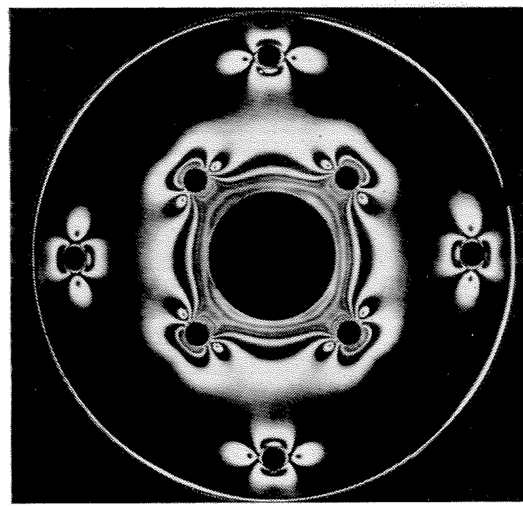

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies —mature, knowledgeable men— have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

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